THE BIOLOGY AND BEHAVIOUR OF THE HONEYBEE *APIS FLOREA*

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SUMMARY

Our present knowledge of various aspects of the behaviour and biology of *Apis florea* (including temperature regulation, foraging, communication, colony reproduction, absconding and migration) is reviewed and suggestions made for further studies. Present methods of beekeeping with *Apis florea* colonies are described, and developments that are necessary to improve beekeeping are discussed.

RESUMEN

La Biologia y el comportamiento de la abeja Apis florea

Nuestros conocimientos actuales sobre varios aspectos del comportamiento y biología de *Apis florea* (incluyendo regulación de temperatura, forageo, comunicación, reproduccion de la colonia, huida y migracion) son revisados y se presentan sugestiones para estudios posteriores. Los métodos actuales de cria con las colonias de *Apis florea* son descritos, y los desarrollos que son necesarios para incrementar la cría son discutidos.

Apis florea is one of the four species of honeybee of the genus *Apis*. Although it is among our most advanced social insects, knowledge of it is fragmentary and most is assumed by implication from discoveries about *Apis mellifera*. I will briefly review existing knowledge and indicate research

topics that are potentially rewarding. *Apis mellifera* occurs from Oman and Iran in the West, through the Indian sub-continent to Indonesia in the East. It is absent north of the Himalayan mountains (Stitz & Szebe, 1903, Buttel-Reepen, 1906, Maa, 1953).

Nest and comb

An *Apis florea* colony usually builds a single wax comb, up to 35 cm wide and 25 cm deep, which is often attached to the thin branch of a bush or tree. The upper part of the comb forms a «crest» above and surrounding the supporting branch and is used for storing honey ; cells of the crest may be two or three times the length of those below. The top of the crest forms a wide approximately horizontal platform. Below the crest is the area for storing pollen and rearing brood, the pollen occurring as a band between the honey and brood. Most of cells below the crest are workers, but in mature colonies a band of drone cells are built along the lower edge of the comb, and drone brood may occupy between a quarter and a third of the total brood area (Thakar & Tonapi, 1962 ; Sakagami & Yoshikama, 1973). Drones are relatively large compared to other *Apis* species. The size of the worker cells and the adult workers increases from South to North (Rahman & Singh, 1946). But no attempts seem to have been made to investigate the relative importance of environmental and inheritance in determining this trend.

Worker activities

The comb of an *A. florea* colony is enveloped by a curtain of workers, three or more bees thick, that protect the colony from enemies and from extremes of heat and cold. Bees regulate the temperature of their brood nest within fairly narrow limits ; at environmental temperatures ranging from 18 to 33°, the bees maintained the central area of the comb between 33 and 37° (Lindauer, 1957 ; Akratanakal, 1977 ; Free & Williams, 1979). It is agreed that with increase in environmental temperature the distance between the curtain of bees and the comb increases, but there is a discrepancy as to whether the bees become more or less tightly packed under such circumstances. Although it is known that bees collect water it is not certain whether they use it to cool their colony. Ventilation fanning occurs but bees fan only when in direct sunlight and by merely shading the comb they can be made to cease fanning immediately (Free & Williams, 1979).

Apis florea colonies need to defend themselves against a variety of enemies including ants, hornets, other *Apis* species and man (Koeniger &

Fuchs, 1975 ; Akratanakal, 1977). When an intruder does land on the comb it is attacked by defending *A. florea* workers which are sometimes so numerous that they form a clump around it. Such a clump of bees often passes slowly down the curtain of bees covering the comb, forms a bulge at the comb base, and eventually drops off onto the ground (Free & Williams, 1979). The degree of aggressiveness shown by *A. florea* varies greatly (Ghatge, 1949 ; Morse et al., 1967 ; Akratanakal, 1977). In Oman attempts to induce *A. florea* to fly to the attack were unsucessful. The curtain that helps protect the colony obscures the activities of bees on the comb surface, and makes it difficult to study the colony's social organisation. It has been estimated that up to 80 % of the adult workers are in the curtain (Akratanakal, 1977) ; if so this seems to be a relatively ineffective way of using the labour force, even if bees in the curtain do perhaps spend some time secreting wax and brood food.

Nothing is known about the division of labour among the workers. Much could be learned by marking, observing and dissecting individuals. Sandwiching the part of the comb that is beneath the crest between sheets of glass, so the curtain is reduced to one bee thickness, should facilitate observation. Most foragers visit the crest platform on return to their nest. The pollen gatherers then proceed to the comb face, but many nectar gatherers remain on the crest or supporting stick throughout the time they are in the nest and give nectar to the other bees (Free & Williams, 1979). Foragers also indicate a food source by round dances and wagtail dances on the crest platform, the straight run of the wagtail dance pointing directly to the food source (Lindauer, 1957). It was believed that the comb of *A. florea* is always built round a branch, where the bees have a good view of the sky, and that when dancing bees were unable to see the sky their dances were disorientated. It was also supposed that *A. florea* is only capable of the direct form of communication possible in a horizontal dance, and is unable to transform information to a vertical plane (Lindauer, 1957).

However, it is now known *A. florea* colonies frequently suspend their comb from cave rooves, where sky is not always visible from the comb and there is no horizontal platform (Dutton & Simpson, 1977 ; Dutton & Free, 1979). In these circumstances bees dance on the vertical comb surface. Resting a sheet of cardboard on top of the crest platform so bees were unable to dance on it, induces foragers to perform vertical dances on the upper surfaces of the comb face (Lindauer, 1957 ; Free & Williams, 1979).

Investigations are need to determine :

– whether dances on the vertical comb face are correctly orientated,
– whether a dancing bee needs to be able to see the sky,
– the distance to the source of forage at which round dances are superceded by wagtail dances.

Studies on the location and direction indicating efficiency of dances made by bees in the swarm should also prove rewarding.

There are a number of behaviour patterns whose function is unknown (Free & Williams, 1979). For example, bees scattered over the surface of the curtain hold their wings slightly extended, raise their abdomens and move them vigorously from side to side. Often each performing bee has a circle of others facing toward her. After a few seconds she moves on and performs elsewhere. This dance is performed before a colony absconds ; perhaps it occurs in other circumstances also.

Reproduction

Near the peak of colony growth swarm queen cells are produced along the edge of the comb (Ghatge, 1949 ; Thakar & Topani, 1962 ; Tirgari et al., 1971). Little is known about the swarming process although it appears that the old queen leaves with the first swarm. A colony may continue to send off up to five swarms headed by virgin queens, until few or no bees remain in the parental nest (Akratanakal, 1977). Contrary to previous suppositions it has been shown that on removal of the queen, emergency queen cells are produced by modifying worker cells containing eggs and young larvae (Free & Williams, 1979). Once emergency queen production has begun it may continue even after a colony's queen has been returned. Preliminary tests have been made of the response of *A. florea* workers to cages, containing queen odours, presented at the periphery of the comb. Workers were attracted to their queen, and to the odour alone of their queen and many exposed their Nasonov glands ; they were similarly attracted to the odour of 9-oxo-*trans*-2-decenoic acid (9-o-2, the major component of the queen's mandibular glands) but without Nasonov gland exposure.

A stationary queen on the comb is surrounded by a «court» of workers. When polyethylene blocks were impregnated with 9o2 and put on the comb surface they were surrounded by a circle of workers that looked similar to the court surrounding a stationary queen. However, 9-hydroxy-trans-2-decenoic acid (9H2) another major component of the mandibular gland pheromone failed to elicit such a response, either alone or with 9o2. (The additions of 9H2 also diminishes the attractiveness of 9o2 to *A. mellifera* workers). These experiments obviously need expanding, and the effect of 9o2 compared with the extract of the queen's mandibular glands and other odours.

Colony absconding and migration

A colony may abscond two or three times a year. There seem to be three main causes : scarcity of forage ; high temperatures ; attacks by predators

(Pandley, 1974). Scarcity of forage is probably the main factor concerned and could be the primary one responsible for the supposed seasonal migration from the plains to the hills where forage is more abundant. However, proof of such long distance migration is lacking. Temperature changes are also important in governing changes of nest site, often within a small area (Tirgari, 1971 ; Koeniger, 1976 ; Dutton & Free, 1979). At the beginning of the hot season colonies move into the dense foliage of trees and bushes and move back from the entrances of caves for protection from the sun ; at the approach of cooler conditions colonies move forward in the caves and to the south side of trees and bushes where the early morning sun strikes the comb. Both accurate communication of the nest site and integral colony movement must be involved in migration but these have been little studied.

Foraging

It is well known that *A. mellifera* foragers collecting sugar syrup release a pheromone from their Nasonov glands that attracts recruits. In contrast, *Apis florea* does not expose its Nasovov gland when visiting rich sources of forage, but, the bees do leave a pheromone at the source of forage that is attractive to other foragers (Free & Williams, 1979). *A. mellifera* foragers use a similar forage-marking pheromone (Ferguson & Free, 1979) ; it is probably a more primitive form of communication than the Nasonov pheromone.

A. florea honey is highly esteemed for its quality and reputed medicinal and mystical properties (Drieberg, 1922 ; Muttoo, 1956), and in many countries the combs are collected for human consumption (Beeson, 1941 ; Morse & Benton, 1967 ; Sakagami & Yoshikawa, 1973 ; Akratanakal, 1977 ; Dutton & Free, 1979). Although brood is often eaten as well honey, sometimes the honey-gatherers remove only the crest of the comb for consumption. The remainder of the comb is sandwiched between the split stalk of a date palm leaf, the ends of which are suspended from the branches of a tree or rested on supporting stones. In time, bees build a new crest over the date palm stalk and more cells are built in the lower part of the comb to house the brood. When the new storage cells are in turn filled with honey, the beekeeper cuts them away again. Such a method of beekeeping has two main problems associated with it :

Firstly, present methods of taking the honey crop wastes wax comb, and necessitates much wax production and reconstruction by the bees. However, when the honey storage section of a comb is put on in a wooden frame, immediately above the brood section, the workers rapidly spread over the two adjacent frame bars. Possibly therefore, a system of beekeeping could

be devised in which the honey storage section of the comb be removed in its frame and returned to the colony after the honey had been extracted.

Secondly, the tendency of colonies to abscond must be discouraged. A possible way might be to confine the colony in a box or hive whose entrance is covered with appropriate queen excluder gauze, so the workers can forage but the queen is confined to the hive. Clearly, there is much scope for improvement in beekeeping techniques. Hopefully future investigations into colony organisation and behaviour will provide the answers.

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