Communication through Dance: Honey Bee Strategies for Food Location

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ABSTRACT

This abstract explores fascinating dances used by honey bees to communicate about food sources. The round dance is used for nearby food within about 50 meters, where bees move in circles to signal its presence. It doesn't give direction but tells other bees food is close. The wagtail dance is for food farther away, over 100 meters. It involves a figure-eight pattern where the direction of their straight run shows which way the food is relative to the sun. These dances show how bees share information to help their colony find food efficiently.

INTRODUCTION

Honey bees exhibit sensitivity to odours, including pheromones, tastes, and colours, including ultraviolet. They demonstrate sophisticated capabilities such as colour discrimination through both classical and operant conditioning, retaining this learned information for several days at least. Honey bees communicate detailed

information about the location and characteristics of food sources to hive mates. They adjust their foraging activities according to the availability of food throughout the day. Moreover, honey bees may possess the ability to create cognitive maps of their environment, enhancing their navigation and foraging efficiency.

The bees that first venture out to locate new food sources are known as scout bees. Upon returning to the hive, they use specific dance patterns, called the 'bee dance,' to convey this information to young foraging bees. Karl von Frisch, a scientist who won the Nobel Prize in 1946, successfully decoded this dance language of honey bees (Michelsen, A., 2003).

Honey bees use round or waggle dances to indicate the distance and direction of a food source. If the food source is abundant, the scout bees open scent glands located in the 5th and 6th abdominal segments. The emitted odour attracts other foraging bees to the area.

Round dance

When a scout bee finds a plant with flowers within 50 meters of the hive, it performs a round dance. The scout bee runs one to two circles clockwise and then counter clockwise. This dance informs other bees of the distance to the food source but not the direction. The first few bees go out to locate the plant and, upon finding it, emit powerful scents from the glands in the 5th and 6th abdominal segments to guide other workers to the source. The richness of the flower source is indicated by the frequency and vigour of the dance.

Wagtail dance

When the food source is located about 100 meters or more from the colony, honey bees perform the wagtail dance. In this dance, the bee makes a half-circle to one side, runs in a straight line to the starting point, and then makes a half-circle in the opposite direction, completing a full circle. This dance communicates both the distance and direction of the food source. The number of dances completed in a unit of time indicates the distance; the faster the dance, the closer the food source.

Table-1: Distance of foraging during dancing behaviour of Honey bee

Distance between the hive and food source (in m)	Dances per quarter minute
10,000	1
5,000	2
1,000	5
500	6
100	10

A waggle dance consists of one to 100 or more circuits, each with two phases: the waggle phase and the return phase. During the dance, a worker bee runs through a small figure-eight pattern: a waggle run (waggle phase) followed by a turn to the right to circle back to the starting point (return phase), another waggle run, followed by a turn and circle to the left. This alternation between right and left turns after waggle runs continues in a regular pattern. While performing the waggle dance, bees produce and release two alkanes, tricosane and pentacosane, and two alkenes, (Z)-9-tricosene and (Z)-9-pentacosene, onto their abdomens and into the air.

- The direction of the food source is communicated through the wagtail dance. If the food source is directly toward the sun, the straight run is upward.
- If the food source is in the opposite direction from the sun, the straight run is downward.
- When the food source is to the left or right of the sun, the dance is performed with identical angular deviations, with the straight run being either upward or

downward depending on the food's position relative to the sun.

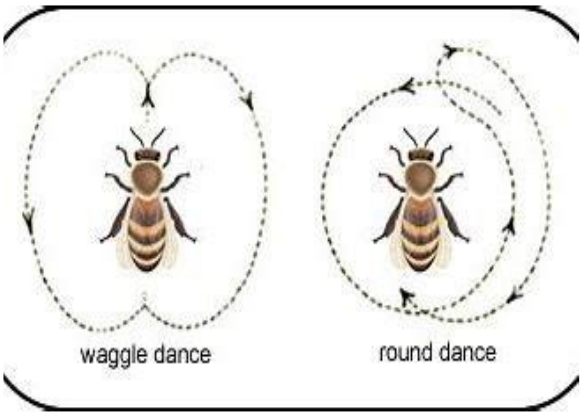

Fig-1: Bee dance

Mechanism of wagtail dance

Honeybees accumulate electric charge while flying and through movements or friction between their body parts. During the waggle dance, bees emit both constant and modulated electric fields. These electric fields, which include both low- and high-frequency components, induce passive movements in the antennae of stationary bees based on Coulomb's Law. Mechanoreceptor cells with electrically charged flagella are particularly responsive to these electric fields, especially when combined with sound. Recordings from axons of the Johnston's organ, a sensory structure in bees, indicate its sensitivity to electric fields. These findings suggest that electric fields generated by the surface charge of bees stimulate mechanoreceptors and likely contribute to social communication during the waggle dance (Greggers *et al*., 2013).

Sickle dance

If the food source is between 50 and 100 meters away, the dance performed is a combination of the round and wagtail dances. This intermediate dance conveys both distance and direction, bridging the communication methods of the two distinct dances.

Stinging behaviour of honey bee during foraging

When brood or adult bees are accidentally injured or crushed, other bees rush to sting the intruder. The smell of the sting attracts more bees to the scene. When a bee stings, its sting apparatus is left in the victim's body, causing a massive abdominal rupture that leads to dehydration and death. This phenomenon, known as 'sting autonomy,' is uncommon in Indian bees. Typically, Indian bees attempt to retract their sting after stinging by rotating their abdomen.

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