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Honey bees show dance pattern to communicate – A review

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ABSTRACT

The honey bee language is considered by many to be one of the most interesting systems for animal communications, used for recruitment to food sources. Honeybee's forager dancers communicate food and other resources to the household by quantity, consistency, direction, and spatial location. The waggle dance was interesting and complex, which bees used for spatial information on desired resources. All honeybee species use the waggle dance to convey their position and distance from food sources and possible new nest sites. The research was carried out on dance communication, earlier ideas, controversies, and solutions gave a broad overview. In this analysis, unique problems are focused on as follows: (a) multiple dance forms. (b) Distance and path calculation (c) How bees do dark hive dance.? Several experiments verified that bees perform various kinds of dance, depending on their particular task. There is, however, still a lack of comprehensive knowledge on other types of dances, which help us solve numerous questions and help us better understand the meaning of the different kinds of dances carried in and outside the hive by honeybees.

Keywords: Communication, dance, distance, direction, the honeybee.

INTRODUCTION: Bees dance to tell their nestmates about the positions of useful resources, and dances effectively recruit new foragers (Wray, 2012). It was described as the only known form of 'symbolic communication' in the invertebrates (Duangphakdee *et al.,* 2011). During 1973, the Austrian scientist Karl VonFrisch received the Nobel Prize for his study on honey bee dance (Duangphakdee *et al.,* 2011). Honey bees interact with waggles, traveling on a comb in a repetitively eight-shaped pattern, where a rich source of food is located (Duangphakdee *et al.,* 2011). Mechanisms by which bees can encrypt a food source's distance and direction (Duangphakdee *et al.,* 2011). And the debate about whether recruits should use dance knowledge is now settled (Esch *et al* ., 2012; Munz *et al* ., 2016). The dance, which is carried on by a honey bee when a good food source has returned to its colony, provides information about its presence, odor, consistency, direction, and distance from this food source, which permits nesting companions to take advantage of it (Riley *et al.,* 2005;Grüter and Ratnieks, 2011). The direction information is transmitted via the waggle run orientation, while distance data is conveyed during the waggle run for details see (Von Frisch *et al*., 1967; Riley *et al* ., 2005; Preece and Beekman, 2014). This direction of contact and distance is unique to honeybees (Kohl *et al*.,2020) (also known as "dance language"). The honey bee dance is one of the most advanced social contact methods in animals, enables nests to look for food and communicates a symbolic source of information (George *et al* ., 2020). Useful waggle dances perform by successful foragers for high-quality food and nest-sites during swarming. Research shows that the "language of dancing" is most useful when food sources are diverse and challenging to locate. The dances of the current honey bees are substantially varying. The Phylogenetic studies indicate that dance complexity increases over time: the first appears species with the least complicated dance (Couvillon, 2012; I'Anson Price and Grüter, 2015). The dance communication mechanism for honeybees (*Apis mellifera*) is a marvel of group behavior, but the additional benefit it provides for the efficiency of the colony is not well understood (Esch *et al.,* 2012; Hasenjagar *et al*., 2020). To investigate the possible importance of various signals in the contact phase. George and others researched the behavior of dance signal receptors, the dancers (Riley *et al*., 2005; George *et al*., 2020) We asked whether dance enthusiasts' action varies between the three primary Asian honey bee species *Apis Florea, Apis dorsata, and Apis cerana.* This may correlate with variations in the dancer's signals foragers. The signs and signals that distinguish between species could attract the followers to the dancer or increase their desire to begin feeding in nest environments. (Riley *et al*., 2005; George *et al*., 2020). Interestingly, most bees (86%) wanted to update the dance length for two or more forages. It shows that honey bees have a high potential to have two memories: navigation experience recently gained and (ii) flight experiences previously stored. Double shift studies, in which the feeder has advanced and has been reversed, have produced experimental conditions in which honey bee foragers have not updated dance time (Munz *et al*., 2016; Chatterjee *et al*., 2019; George *et al*., 2020). Recent evidence indicates the importance of crop pollination worldwide of wild insect species' resources and abundance. The West Silk Bee (*Apis mellifera*), the most common pollinator species for crops globally, provides a valued pollination service for various agricultural plants. Finally, when introduced *A.mellifera* populations reach high density, they can compete or jeopardize reproductive success with other

pollinators (Duangphakdee *et al*., 2011; Hung, Kingston *et al*., 2018). The communication of this direction and distance (also known as "dance language") is unique to honey bees and will be the study's subject. In comparison, the value of the location information to honeybee forging performance is over-estimated in the recently reported studies (I'Anson prince and Grüter, 2015; George *et al*., 2020; Zarchin *et al*., 2017) and experiments performed in the late 60s (Hasenjager *et al*., 2020; Kumari *et al*., 2020). Here we discuss the importance of honeybee foraging in the dance language and explore why dance foragers follow it.

Early theories and controversies: Frisch (I'Anson prince and Grüter, 2015; Singla, 2020) conducted experiments through the European honeybee, *A. Mellifera* to feeders, and bees were initially thought to use floral fragrances or other scents to locate the source of food. But later, the dances were taken care of by the returning foragers. In 1947 finally, he reported that bees had been used as a symbolic contact – a "language" or "secret sign" distance and direction of the bees forger.

Bees dance to tell their nestmate about the location of essential resources, and dance effectively recruits more foragers (Wray *et al*., 2012; Seeley *et al*., 2009). It is defined in the invertebrates as the only available 'symbolic mode of communication (Munz, 2005). All bees in the genus *Apis* dance, but outside of *Apis*, there is nothing quite like it. Honey bee dancing is also one of the most interesting things in animals' life, maybe the most fascinating part of their biology. The dances, performed by a working bee who has come back to a honeycomb with pollen or nectar, are essentially a language that tells other workers where food stands. The bee employs a dance language to recruit and guide other workers to gather pollen and nectar by signaling distance and direction with particular movements (Couvillon, 2012).

Late Karl von Frisch is credited with interpreting the honey bees movement's significance, a zoology professor at the University of München in Germany. He and his students conducted decades of study in which the various components of each dance were carefully identified. Their results led them to the dance language idea. Like Adrian M. Wenner, Emeritus Professor of Nature History at Santa Barbara University, many scientists have different opinions (Von Frisch, 2014). You think dance does exist, but you are not sure that a food source's location is transmitted. These critics claim that floral scents on a forger's body are the key indices that permit recruiting bees to find new food sources. This alternative hypothesis is tested in several studies, and the significance of floral odors in foodstuffs has been shown. Tania Munz's thesis on Karl von Frisch is part of a significant "Culture of Scientific Observation," a project currently being worked on by Munz and her colleagues at the Max Planck Institute for History of Science. Based on Karl von Frisch's work too, also evolved observational opportunities can be demonstrated. The marking system he developed for bees offered entirely new observational possibilities: individual bees were marked in the hive and various nutrition sources for the first time. But today, bee researchers are much more advanced in their methodology due to the emergence of new technologies. They can also track bees in flight using radio transmitters, for instance. Honey Bee Dance Language Controversy" by Tanya Munz in 2005 (Munz, 2005) mentions: "Von Frisch was not the first to investigate insect communication. In his 1923 paper, he already cited nine other well-known authors who'd studied bee and ant communication. (Lubbock, 1883; Wasmann, 1899; Buttel-Reepen, 1900; Forel, 1910). "In 1967, American biologist Adrian Wenner launched an extensive challenge to Karl von Frisch's (1886–1982) theory that bees communicate to each other the direction and distance of food sources by a symbolic dance language (Von Frisch, 2014).

Types of dances: Karl von Frisch published 'Dances of the Bees' in 1946, which showed active bee foragers performing traditional dances to tell their peers the helpful tools' location. (Couvillon, 2012). The meaning of the dance is correlated with the distance from the food. We expect that insects flying will display search patterns that maximize resource rediscovery if food sources in a known location are no longer available (Wolf *et al*., 2016). The forger's question starts when a Scout bee charged with plenty of food from a newly discovered source gets back to the hive. She restores the sample to hive bees for 30-45 seconds.

The dance begins after its kindness attracts a lot of people. There are three broad styles of bee dance: round dance, sickle dance, and transitional dance (Singla, 2020). However, Grad also discusses other dances, such as Shake Dance, Tremble Dance, Whir Dance, Care Dance, Massage Dance, Alarm, and Joy Dance. The nature of the dance is related to food supply distance. The dance rate (number 180° turns per minute) and the chance of dance were higher than a lower quality combination of pollen with alpha-cellulose forager bees (1:1 by volume). The simple round dance is performed if the source of food is close to the colony. A sickle dance is performed more often. Last, as far as possible, waggle dance takes place from the nest at intervals. The bailer produces a detailed and coded message in "dance language" that describes the direction and distance from the new food source hive that the dancer finds in space and time. Karl von Frisch inferred the use of the encoded information to direct bees 'recruited' to provide distant food (Riley *et al*., 2005; Giurfa *et al*., 2021).

Details of dance performed: Round dance: May pass information about a food supply, including its profitability. Profitability is typically defined by its nectar energy content, which mainly includes sugars (Munz, 2005; Riley *et al*., 2005). A forger performs a round dance when a food source is very close to a hive less than 50 meters away (Wolf *et al*., 2016; Bukovac *et al*., 2017).

Round dances are best considered as round dances than a particular type of dance to local food sources. 22 When a honeybee forage (A.mellifera) senses a lucrative supply of food close to the hive, she conducts a round dance to tell where her place is to be (Barron and Plath *et al*., 2017; Le Moël and Wystrach *et al* ., 2020; Von Frisch *et al*., 2011). Frisch originally thought Round Dancing was a nectar resource (Munz, 2005; Riley *et al*., 2005; Riley *et al*., 2005).The training of Frisch on a bee and nectar feeder near the hive caused the error in two forms of dances, while pollen foragers usually treated nature tools further away from the hive. Later, Fresh findings (Preece and Beekman, 2014) reported that the round dance has been used and shows the distance, but there is no clear information about the route of food and the form of food.

Sickle dance Sickle dance is a food supply that is 50 to 150 meters from the hive at intermediate distances. This dance is in the form of the crescent and a transitional dance (Riley *et al*.,

2005; Seeley, 2009).

Waggle dance: Bees feed on supplies and perform the beekeepers' dance, more than 150 meters away from the coat. In comparison to round dance, this dance expresses scope and direction. The bee that performs the cargo dancing continues directly for a short time, returns to the point of departure in a six-part circuit, passes straight, and completes a full figure-eight circuit in the opposite direction semi-circuit. When running down the dance's straights, the body vibrating leads to a thorough movement; the bee's body, especially the abdomen, moves powerfully alongside each other. Simultaneously, the bee sends a reacting signal formed by 250 to 300 hertz or cycles per second, with a low audio frequency (Abrol, 2013). The pulsing rhythm is approximately 20 milliseconds and at a pace of 30 per second. Distance is calculated at a minimum, and the length of the natural part of the dance, measured in seconds, is the most basic and precise distance measurement.

In contrast, other variables (e.g., dance "tempo" or period of sound buzzings) are used for the distance. The distance to the food source also increases with the duration of the "waggle sprint" ("waggle run")—for example, a forager conducting a 2.5-second food race around 2.625m. The relationship is approximately linear (Riley *et al.*, 2005; Seeley, 2009). Foragers function as food collectors in their colonies and as natural sensory selection units to gather information about the drill sites' location and productivity. By way of waggle dances, they transfer this knowledge to colony members (Válková and Vácha, 2012; Von Frisch, 2013). The waggle dance contains the most nuanced data. There are repeated 1-100 or more bands for each waggle dance, each comprising two phases: the waggle and return phases. For a bee worker, a waggle dance involves going through the small sequence of Figure 8, a carry-on (waggle-phase) and then a turn right, and then turning right, and then back into the point of departure (return), waggling, a left loop, etc (Nürnberger *et al.*, 2019). A pulsed sound of almost 200 cps. It is explained that during the straight sprint, the honey bee waggle is made. This sound offers a new opportunity to identify how information is transmitted between bees concerning the food source's distance from the hive. The following four elements (or a combination of them) of the honeybee waggle dance are now the best way to provide data about the food source's distance, as shown in figure 1 (Von Frisch, 2013).

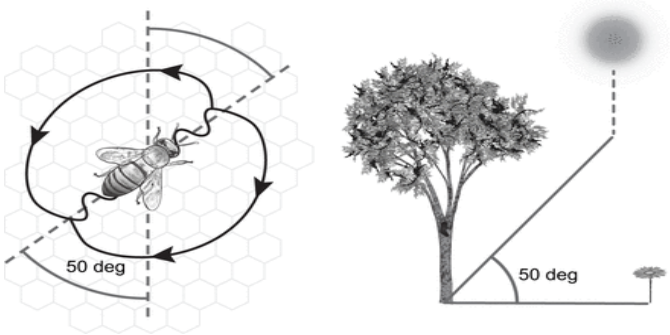

Figure 1: Schematic diagram of the waggle dance of *Apis mellifera*. The dance is usually executed on vertical combs inside the hive (left). The angle of the waggle phase of the dance relative to vertical on the comb corresponds to the direction to the advertised resources on departure from the hive relative to the solar azimuth (right).

1. During the straight run time of the waggling
2. Several waggles were produced in the direct run.
3. Time of the direct sound output.

Several sound pulses are produced in line (Al Toufailia *et al.*, 2013; Couvillon et *al.*, 2012). The dancer tells her friends how far and how to dance the bee into a rich food supply (Frisch, 2014). The findings show bees using the position of their bodies to determine their routes (Von Frisch, 2014).

Other dances observed within the hive: Within the hive are also other dances observed.

Jostling and spasmodic dance: The foragers perform jostling and spasmodic dances, and both tend to be used for others to come to the dance floor to "see" the food dance. A forger will come back in the chattering dance and knock on other bees, which causes a generalized disturbance. A returning forager also performs the spasmodic dance. It involves roaming around her abdomen but is short-lived, and her food is unloaded (Carreck, 2016).

Dvav dance:A worker performs the dorsal, ventral abdominal dance and grabs another worker. It seems that another fodder staff is eager to come and see a drilling dance on the dance floor. On the queen, the dance is also used. It seems in this case that the queen does not try to kill queen cells before swimming. The queen appears pleased because she is ready and eager to leave the hive with a swarm of bees when the vibrations end (Carreck, 2016).

The primary aim of trembling dance is to warn other bees that there is a great deal of nectar in the hive for care. The honeybee walks and shocks her legs quickly in this dance so that her body trembles and terms (Seeley, 2009; Hrncir *et al.*, 2011). This was the first person to describe the message and the sense of a trembling step for working drones in and out of the hive. The frightening dance tends to draw more receivers and storage bees to help foragers unpolluted nectar. ' A bee runs on four legs and twitches and shakes tickle. He blows it up and pipes briefly as he sees a bee who wagtails (Bukovac *et al* ., 2017).

How bees calculate distance and direction: The waggle dance is used to decipher the dance language and predict distance and path to a food source by foraging bees. The waggle runs over 100 times, and the distance is compared with the run time, while information on the path to food is taken out from an angle of the cart, which gives the swarm an angle about the solar azimuth. The waggle runs are more than 100 times (Bukovac *et al.*, 2017; Kumari *et al.*, 2020). But how do these bees gain the dance information? There is an understanding of different processes providing information on the course of the food. Many signs, such as landmarks, can classify the direction (Barron and Plath, 2017) Sun's location, skylight (Le Moël and Wystrach, 2020) polarization pattern, and maybe even magnetic fields.. Bees can prefer one mechanism over another, depending on the environmental conditions. However, the methods used by foragers to define or measure the distance was not previously clear because Frish performed a variety of experiments and suggested 'energy theories' during the journey, which claimed that energy costs were the basis for estimating the distance (Von Frisch, 2014).

Esch said that when foragers gather food in a short narrow tunnel, they dance as if the food source were far farther away. Tänzers calculate the distance to their target through retinal image flow. The visually guided odometer misreads distance

because the narrow tunnel walls increase the optical flow(Esch *et al.*, 2001). Recruited bees look for the tunnel at exaggerated distances outside and not inside the tunnel through which the foragers came. Thus dances must provide the direction and the total quantity of image movement on the road to the food source, but not the absolute distance information. Esch and others also demonstrated that the same hive distances could be substantially different on different outdoor routes. In 2008, however, Dacke and Srinivasan (Dacke and Srinivasan, 2008) found that two kinds of tubes are helping to find a source of food, the 'community' odometer that is used to warn nestmates about dancing, and the 'private' odometer that an experienced tamper uses to return to the food supply formed already. (Grüter and Ratnieks, 2011). meanwhile, examined the most discussed problem regarding the relative use of waggle dance (social information) in resource location versus route memory (private information). They have tested the hypothesis that dance language is relevant if personal information is of low value. And they verified since secret knowledge does little to the foragers, they use the waggle dance's information.

Dance pattern in the dark hive: A remarkable example of a valid code that makes the social use of feeding sites is the honeybee waggle dance. During waggling dance, effective foragers generate thoracic pulsed vibrations that, putatively, provide information for hive bees who can't decode dances visually in the hive's darkness. Both these profitability variables increase the likelihood of thoracic vibration and several characteristics connected with its strength during the waggle process (pulse length, speed range, duty cycle) (Hrncir *et al.*, 2011). Species of honeybees like *A. mellifera* perform hive dances. Honeybees frequently shake their bodies with their wings from left to right during their dances (Lam *et al.*, 2017). Recommended the creation and release of several chemicals by dancing bees that activate foraging for followers. Floral odors were often considered a reference point to find a source of food for followers. However, because nestmates' food storage and operation created many different scents in the hive, it was still unknown if supporters could use odor signs to find the hive dancers (Bell *et al.*, 2019). Many experiments show that honeybees are heating their wings to emit an eruption of sounds. The sound involves pulses with a carrier frequency of 250-300 Hz and a pulse length of 20 msec (Tofilski, 2008; Hasegawa and Ikeno, 2011) established that honeybees use Johnston's organ in antennae for tuning themselves into this frequency (Kirchner *et al.*, 1991). Furthermore, honeybees could locate the sound source and distinguish the dance frequency from a different frequency in a Y-maze after associating a 265 Hz ton stimulus rewarding after operating conditioning. The proprioceptors on the bee's legs could sensitize these vibrational signals in the 200 to 1000 Hz range (Kilpinen and Storm, 1997).

Other scientists, including Hasegawa and Ikeno, have shown that honeybees could locate sound at 250 Hz and 265 Hz carrier frequencies and could not differentiate between flying and repetitive waggle dancing impulses. The trial with distinctive musical dance sounds showed that honeybees could discern cadenced sounds within a specific frequency range. They suggested that dancers attract followers even in their noisy environments using frequency and rhythmic components of dance sounds (Hasegawa and Ikeno, 2011). Some honeybee species conduct themselves visually obviously, walking inside their dark hives in a pattern eight. Sounds have been suggested to play an essential part in this dance language, while honeybee activity in packs produces a range of wing vibration sounds. Dance sounds have probably been created in a dim, noisy environment to exchange information(Hasegawa and Ikeno, 2011).

CONCLUSION: While dance does not save time to recruit, these different dance forms permit recruits to monopolize and exploit the rewarding food before other honeybees' colonies detect them. While the dance language provides detailed information regarding the food supply's amount, quality, and direction further research must better understand other useful information by code from different dance styles. Thus, only through the dance language can we provide details on profitability, wealth, and other qualities from the source.

CONFLICT OF INTEREST: All authors declare that they have no conflict of interest.

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