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Editorial

Honeybees as One of the Best Model Organisms to Study Social Behavior and to Use IEGs as Starting Tool for Finding the Underlying Regulatory Pathways

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The role of honeybees is indispensable in human lives since time immoral. A large of part of crop pollination is done by honeybees. Honey is a delicious food which is used as ingredient as well as medicinal by humans from ancient days, is manufactured inside the body of honeybees. Besides, there are many humans can learn from honeybees, their well-disciplined and systemically organized behavior is the most astonishing one. A colony of honeybee is just like a small human kingdom, ruled by a queen. Many of the astonishing correctors of honeybees can be seen while they are foraging. During foraging, honeybees search for food (usually nectar/pollen), they identify and taste the food and memorize the food location, they interact and communicate among each other and systematically carry out the task of food collection and stored in the hive. Highly systematic and precisely coordinated interaction and communication among the honeybees is the unique and special behavior that are easily observable during the foraging of honeybees. Honeybees foraging has been extensively studied for understanding their specific behaviors such as learning of time-space, direction and distance, remembering and memorizing using landmarking concepts and techniques of learning. It may be noted that Karl von Frisch was awarded Nobel Prize in Physiology or Medicine 1973 for his extraordinary contribution in the field of behavioral patterns of animals, by interpretating of honeybee dance language as means to communication. However, only few studies have been carried out for understanding these astonishing behaviors in the molecular and cellular level. What amazed me was, during foraging, before landing to the artificial feeder (sugar water solution), honeybees made few round flights then landed to the feeder, tasted the food quality, then drank, and they made few round flights around feeder and flew back to the hive; these round flights was not performed after 3 or 4 times they return to the same feeder [1]. It appears that honeybees used these round flights as a devise for memorizing the food source location and food identification, a pretty much like of human behavior and other higher animals. This can be related to the daily practices of lifestyles in humans, in that humans used various kinds of concepts to learn and memorized things and places. Anyone can closely view this beautiful astonishing scene of honeybee behavior (European species *Apis mellifera* in this case) by feeding them in a specific place without disturbing them while feeding and flying [1].

Few recent studies have beautifully demonstrated that immediate early genes (IEGs) can be used as a tool to begin the hunt for underlying regulatory cellular and molecular pathways that regulate such dynamic behaviors of honeybees [1-5]. In fact, these studies promptly highlight the benefit of using immediate early genes in the further studies of regulatory pathways of social behavior in general. It has been considered that IEGs are activated first following a stimulus that subsequently link to events on the cellular membranes and the nucleus participating in phenotypic changes of the neurons. And these genes have been used as markers for the neurons in the study of brain functions regulating behaviors in honeybees. Moreover, depending on the types of stimuli, proteins encoded by an immediate early gene can be independently regulated in different parts of the brain. Singh., *et al*. [2-4] demonstrated transient overexpression of three IEGs

such as *Egr-1*, *Hr-38* and *Kakusei* during daily foraging of honeybees in a semi national environment and their potential involvement in learning and memory. The findings from these studies are also closure to the real phenomena as the study was carried out in the semi natural environment allowing the honeybees to fly back and forth freely from the hive to the feeder, in a bee house with 12m in length, 5m in height, and 2.5m in width. The method of these studies is described in detail in the study by Singh and Talhellambam [4]. The authors also found upregulation of the *Egr-1* downstream genes, such as ecdysone receptor, dopamine decarboxylase, dopamine receptor 2, that involved in ecdysteroid and dopaminergic signaling pathways. These studies open a way giving a direction in the further studies to investigate the regulatory pathways of the genes/proteins linking to specific neurons and regions of the brains that regulate a specific social behavior including identification of daily used objects, learning and memory, the way/means of communication and interaction by using IEGs as search tool. As these are common behaviors of social animals as well as humans, the research findings on honeybees on this area can be translated to other higher animals and humans. Moreover, honeybee foraging behavior consists of repetitive nature in that they fly back and forth repeatedly from the feeder to the hive, a well-disciplined and systematically organized communication and interaction among the bees during foraging, noting that repetitive behaviors and lack of social interaction and communication of autistic individuals; understanding regulatory pathways of honeybees foraging can help in providing better directions in the research for behavioral abnormalities in humans.

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