**BIO 414: Behavioural Biology**

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Quiz - I  
Solution

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# Question 1:

In the experiments set up by Karl von Frisch he noticed two anomalies:

1. Although the bees used the sun to navigate, they could navigate also on cloudy days. How did the bees do this? Describe the physics behind this briefly. (max 300 words, 2 marks)
2. Although the bees are very smart and accurate in their navigation and communication of information, when the plane of the hives was altered significantly, the communication system failed. Please expound on this as to what might or is happening? (max 300 words, 2 marks)

## Solution (217 words + 262 words):

1. The air column in the skies above our head varies greatly in density and distance. Under uniform NTP circumstances, the air column at the zenith is usually of the least height and increases in length as the azimuthal angle increases towards the horizon. As a result, the sun’s rays scatter variably (Rayleigh Scattering) and get polarized in multiple directions throughout the sky (least at the zenith; most at the horizon), giving the appearance of a plethora of shades of blue across the celestial sphere. Thus, every part of the sky has a distinct direction of vibration of polarised light and therefore a distinct shade of blue.

Bees can perceive this polarized light. Hence, when a bee views a part of the sky, its brain reverse-engineers the process mentioned above to accurately deduce the position of the sun at that particular time. This also means that only a fragment of the sky (and not the whole sky) needs to be exposed to the bee for it to be able to find the sun’s position. Therefore, even on occasions of dense cloud cover, a single patch of disclosed sky can help bees locate the sun and reorient themselves to perform their routine activities such as commutation & hive-dances. However, on days of complete cloud cover, the bees become disoriented.

1. According to Karl von Frisch’s experiment on altering hive planes, no significant difference in bee behaviour was observed. Mr. Frisch's explanation to this observation was that the bee communication and group navigation occurred through the bee dances in the hive. It was initially thought that these dances were spatially, temporally and directionally oriented and the directional orientationality depended on the bee’s gravitational orientation and the sun’s dynamic position. However, it was later observed that although vertically rotating the hive changed the bee’s gravitational orientation, they could still maneuver themselves either directly or indirectly (with the help of the polarised light of the blue sky) using the sun’s location. Hence, gravity as a means of perceiving directional orientationality was eliminated.

With that being said, the bees were disoriented when the sky was not at all visible and the hive was vertically rotated, proving the importance of the solar-based navigation cum communication as well.

An evolutionary argument is also stated by Mr. Frisch in his paper, where he mentions that a more primitive strain of honeybee (the Small Honeybee) from India also performs the hive dances on a horizontal platform in its hive. This could mean that the vertical dances of modern honeybees could be evolutionary successors of the primitive horizontal dances, and ability to perform the latter is still genetically or developmentally expressed. Moreover, Mr. Frisch also mentions that it is not an uncommon sight to see the bee dances of the modern honeybee to be performed on the horizontal ledge of the hive if it finds an appealing audience there as well.

# Question 2:

Explain in 3 bulleted points why you think behavioral biology in itself is important and 2 bulleted points on why behavior is an important part of evolutionary biology? (5 marks)

## Solution (259 words):

Why Behavioural Biology in itself is important?

* Minimize Human-Animal Conflict: Behavioural patterns of both humans and their surrounding animals can be studied and understood to mitigate their conflicting interactions (majorly enveloping overlap of food sources, shelter opportunities, reproductive urgencies as well as predation and poaching).
* Strengthen Conservation Efforts: By studying behavioural patterns, anomalies as well as their changes, a safer & sustainable habitat can be created/preserved for non-human animals which can lead to a growth in the biodiversity.
* Human-Animal Behavioural Analogies: As subtly explored by Nikolaas Tinbergen in his Nobel Speech, studying ethology provides a bridge to correlate human behaviour with non-human animal behaviour, which can help humans in exploring and improving their natural evolutionary adaptability as well as gather solutions to new health problems and diseases by incorporating (either partly or wholly) other mutually beneficial animal habits within us.

Why behaviour is an important part of Evolutionary Biology?

* Key Moderator to Reproductive Success: An individual animal’s or a species’ mating behaviour is crucial for the survival of the species or the individual. Male aggression, female choice, polygamy and fecundity are all examples of behaviours that directly affect the reproductive success of the species while foraging efficiencies, sheltering habits and communicational behaviour serve as indirect influences on the reproductive success. Moreover, reproductive success is a key milestone in understanding the evolutionary history of an organism.
* Understanding Evolution of Behaviour: Animal behaviour, like any other trait can be genetically or reinforceably transferred. Thus, behaviour can change (advantageously or deleteriously selected) according to the changes in the intra- and inter-species’ environments.

# Question 3:

In 100 words or less (use point form if needed), explain how you would experimentally quantify if a bird is predisposed to learn its own species' song. (2.5 marks).

## Solution (100 words):

* Isolate the eggs of a social bird and rear the chicks without the influence of any other bird sounds. Test the songs of the adult offspring and compare them with others of the same species (more specifically with their parents).
* Isolate and rear another batch of eggs along with other members of the same species (or a recording of the same) but isolated from the interaction with other species. Test and compare the songs of the adult offspring.
* Observe the rearing of another batch of eggs with full interaction with all species present in their habitat. Test, compare the songs.

# Question 4:

In 250 words or less, take a field of biology of your choice (that is NOT eco-evo-animal behavior, you could pick cell biology, molecular biology, biochemistry...your choice) and illustrate how Tinbergen's four questions are applicable to other biological disciplines. (5 marks).

## Solution (223 words):

Topic: Variability in DNA sequences

Proximate Question: What is the cause of variability in DNA sequences?

Ontogenic Question: Is the variation hereditary or random?

Explanation: Variation can be both hereditary as well as random. Recombinant DNA strands are formed due to hereditary genetic variations whereas occurrences of SNPs are the most common examples of random genetic variability.

Mechanistic Question: What controls the production of variation?

Explanation: Several processes such as mutations, meiosis, recombination and replication errors can cause this variation.

Ultimate Questions: Why, how many times, how and when did the variations evolve?

Phylogenetic Question: How many times and when did the variations evolve?

Explanation: The phylogenetic question can only be addressed for the hereditary variations as the random variations can evolve at any time and innumerable times. Hereditary variations such as the meiotic variation occurs with the frequency of mating and was developed as a concept with the evolution of the first sexually reproducing common ancestor 1.2 billion years ago.

Adaptive Significance Question: Why did the variation evolve?

Explanation: There is no specific motive for random genetic variations to occur, but their occurrence can be selected for and even made hereditary if the variation is beneficial to the reproductive success of the organism. Hereditary variation, on the other hand is caused solely for the purpose to further the cause of reproductive fitness.