Chapter-4

HOMING BEHAVIOUR

Most animals show specific adaptation to a particular habitat and if they are displaced fr their normal home range it will be important for them to be able to return. Homing is the inhe ability of an animal to navigate its return to its original location through unfamiliar areas. Th location may be either a home territory or a breeding spot. Homing animals exhibit a very per tent motivation to return home despite the obstacles and difficulties.

Homing occurs in a wide variety of species and ranges from the relatively simple ta of returning home after foraging to the complexities of a migration from one home another. Most authors however restrict homing Behaviour to relatively local movements of a mals. A well developed homing ability is particularly valuable in saving time and energy wh large distances have to be covered, and when the starting point is unfamiliar. The complexity a sophistication of the sensory mechanisms used in homing suggest that there has been consid able pressure of natural selection, and that homing is very important in the life of many animal

ROLE OF NAVIGATION AND ORIENTATION :

Navigation refers to the ability of planning and controlling one's movement from one pla to another. It requires knowing one's current location on earth, the location of the desired go and an ability to calculate travel directions to get from here to there. The distinct preferen shown by animals to depart in one particular direction is known as **orientation.** To return hom successfully across an ocean, or a mountain barrier, requires a considerable feat of navigatio The homing animal has not only to set off in the correct direction, but has also to maintai correct course despite changing weather conditions. Successful homing skill thus demands co siderable navigation and orientation abilities on part of the animals concerned.

EXAMPLES OF HOMING BEHAVIOR :

- Adelie penguins *(Pygoscelis adeliae)* may leave their young chicks for up to 2 weeks while they forage far out at sea. They are able to return to their nest even if displaced by storms.
- The green turtle *(Chelonia mydas)*, which breeds on Ascension Island, feeds off the coast of Brazil about 1500 km away. The adult female turtles visit the island, which is only 7.5 km wide and is in the middle of the Atlantic Ocean, and lays their eggs in the sand of the beaches. They then return to their feeding grounds where they remain for several years, before returning to the same beach to lay another clutch of eggs.
- Even more remarkable is the homing behavior of the Californian newt *(Taricha torosa)*. These newts spend the summer month's underground, forage widely in the forests in the autumn and winter, and migrate to their particular breeding grounds in the spring. They breed in pools in mountain streams, and return to the same pool each year. Of a group of newts that were taken 4.5 km to a deep canyon with a 300-m high ridge between them and their home pool, a number were found back home the following year.

CUES AND MECHANISMS USED FOR HOMING BY ANIMALS :

The key element to understanding homing behavior is determining which cues provide the directional information that allows animals to move between their home and other locations. Animals may utilize a variety of cues and mechanisms to determine the location of its home site. Different species may use these cues in different orders of priority, and some cues may always be used in preference to others. Also, animals may use environmental information hierarchically, so that one type of homing information is important when they are distant from their home, and others become more important as they come closer to their goal. Many sense organs are known to be implicated in navigation and homing, including electromagnetic senses, chemical senses, and various aspects of vision. A brief review of the cues used by animals for homing is presented as follows.

Topographic features

Topographic memory, memory of the contours surrounding the destination, is one common method used for homing by animals. Visual landmarks are used by a number of animals in locating the exact position of their home. This means in familiar areas they will use landmarks such as roads, rivers or mountains when flying, or islands and other landmarks while swimming. These topographic features may be particularly important for navigation to a precise breeding or wintering locality. Radar images show that migrating bird flocks drift off courses in a strong crosswind, except for flocks that travel along distinct landmarks, such as rivers, coast lines, or mountain ridges.

Tinbergen explored digger wasps' (*Philanthus triangulum*) ability to return to the entrance tunnel of a specific nest site containing a developing larva. The wasp catches bees on hunting trips and returns this food to the offspring. While the wasp was in the burrow, Tinbergen placed a circle of pine cones around the entrance. When the wasp,emerged it completed several circles around the entrance area before flying off. Tinbergen then moved the pine cones to the side of the nest and waited for the wasp to return from hunting. Upon return the wasp flew to the center of the pine cone circle even though that had been moved during her absence.

Chemical cues :

The life cycle of a salmon begins in a freshwater stream or river that dumps into the ocean. After spending four or five years in the ocean and reaching sexual maturity, many salmon return to the same streams they were born in to spawn. There are several hypotheses on how salmon are able to do this. One hypothesis states that salmon retain an imprint of the odor of their natal stream as they are migrating downstream. Using this memory of the odor, they are able to return to the same stream years later. Another smell-related hypothesis states that the young salmon release a pheromone as they migrate downstream, and are able to return the same stream years later by smelling the pheromone they released.

Limpets fit their shell to one specific spot on a rock. A close fit is critical to withstand the impact of waves when submerged and prevent desiccation when exposed. Scraping algae from the rock surface, they travel from their home site, leaving behind a chemical trail. By reversing direction on this trail they are able to return to the very site they came from.

Earth's magnetic field :

Many animals use magnetic orientation based on the Earth's magnetic field to find their way home. It is believed that animals imprint on the unique magnetic field that exists in their natal area and then use this information to return years later. This idea is known as the "*geomagnetic imprinting hypothesis*". Important aspects of the process include the following: (1) the learning occurs during a particular, critical period, usually early in the life of the animal; (2) the effects last a long time; and (3) the effects cannot be easily modified. For natal homing, the concept is that animals like sea turtles and salmon imprint on the magnetic field of their home area when young, and then use this information to return years later. Sea turtles have a well-developed magnetic sense and can detect both the intensity (strength) of the Earth's field as well as the inclination angle (angle at which the field lines intersect the earth's surface. The concept was developed to explain how sea turtles and salmon can return to their home areas after migrating hundreds or thousands of kilometers away.

Celestial objects :

Many animals are known to use the location of the sun and stars to navigate and find their way home. Displaced marbled newts, for example, can only home when stars are visible. Another example comes from the Sahara desert ants (*Cataglyphis*) which are scavengers. They forage for the corpses of insects and other arthropods which have succumbed to the heat stress of their desert environment. While no known land animal can live permanently at a temperature over 50°C, Sahara desert ants can sustain a body temperature well above 50°C with surface temperatures of up to 70°C. This ant ventures far from its burrow in the Sahara desert, which has almost no identifiable features. While venturing out it periodically takes measurements of its angle in respect to the Sun. By doing this the ant can venture far from its nest in search of food. Because of the blistering heat, it can only do this for about 3–5 minutes/day (the hottest time of the day, when all its predators are in hiding from the sun). In addition to obtaining information on outwards, directional angles, the ant appears to measure distances using an internal pedometer to count its steps. When the ant finds a dead insect it calculates the shortest route back to the nest through vector averaging. Honey-bees *(Apis mellifera)* too use the position of the sun as a navigational aid. When the sky is overcast they obtain equivalent information from the pattern of polarization of the light in the sky.

Homing behavior in bees :

Honeybees (*Apis mellifera*), like many other animals, forage from a fixed location, the hive. This type of foraging, often termed "central-place foraging" imposes a requirement for good navigation abilities; the animal must be able to find its way back home after a foraging bout which may take it away from visual or auditory contact with the nest and its residents. Honeybees may forage several kilometers from their hive, making them a good model species for studying navigation in central-place foragers.

Information used in home-based navigation can be divided into two categories.

- **Egocentric** information is generated internally by the animal and is independent of its immediate surroundings. Internal calculations of the distance and direction travelled, which are used in path integration, are examples of egocentric information.
- **Geocentric** information includes landmarks and any map information available to the animal.

Honeybees primarily use path integration in making their way to and from foraging sites. Dance information provides outgoing bees with a distance and direction to be travelled. Flight direction is determined by a sun compass orientation and distance of flight by an internal "odometer" that measures the rate at which visual images flow past the eyes. Other inputs, such as odors, provide supplementary information. Once a route is learned, bees incorporate visual landmarks when they make repeat trips to a foraging site. The return trip is governed by path integration as well, but also may be informed by landmarks.

To explain how bees incorporate landmarks into their orientation two basic models have been proposed.

- **Snapshot memory :** This model proposes that the bee remembers a series of visual images ("snapshots") of the landscape as it passes. The bee also remembers images of particularly prominent landscape features. These images can then be compared with the actual landscape surrounding the bee at any given moment. Ultimately, the bee may be able to use the landmark snapshot information, projecting its position when it is displaced to an unfamiliar location but still in view of an array of familiar landmarks (i.e. viewing them from a novel angle).
- **Cognitive maps :** More complex is the "cognitive map" model, which states that the bee constructs a relatively complete neural representation of the landscape based on its experiences while flying. Tests of the cognitive map model require that displaced bees calculate a novel route home, based on their memory of the landscape map (as humans might). While claims have been made for experimental support of the cognitive map explanation of bee navigation, critics have found simpler explanations for findings which seem to support these claims.

The allocentric model for snapshot use begins to converge with the cognitive map model, but remains a simpler explanation for orientation and homing in honey bees.

Homing in Pigeons :

Homing behavior in pigeons, *Columba livia*, is interesting because for thousands of years humans have used homing pigeons to return messages back to home base by attaching them to the bird's legs. The homing pigeon has been selectively bred to be able to return to its home over extremely long distances. As a pigeon generally returns to its own nest and its own mate, human handlers have selectively bred subsets of birds that were particularly good at this task. Homing flights from as far as 1000 kilometers have been recorded by exceptional birds at average flying speeds of around 50km/h.

How do pigeons find their way home when deposited in an unfamiliar location? To do this, they must have two kinds of information. The first, called "map sense" is their geographic location. The second, "compass sense" is the bearing they need to fly from their new location in order to reach their home. If either information source is disrupted, then homing fails or is delayed.

- **The map sense :** In familiar surroundings - locations from which pigeons have previously homed or landscapes through which they have flown - landmarks play a predominant role in homing. Pigeons learn visual features of the landscape and use these visual features to determine their current position (map location) relative to their roost. When released in completely unfamiliar environments, pigeons are known to use olfactory cues however. It is now known that in their roost, they associate odors with wind directions. When released, they assess the odor of their new location and extrapolate the map location from their roost-gained knowledge of winds and odors. Pigeons in visually unfamiliar territory whose sense of smell has been disrupted (by cutting olfactory nerves or treatment of the nasal passages with zinc sulfate solution) have a great deal of difficulty homing. Similarly, if the roost is blocked from winds and provided with filtered air, homing fails. Pigeons in fact home better if they have some time to olfactory experience their new surroundings prior to release.

- **The compass sense :** The primary compass information of pigeons comes from the position of the sun in the sky. By integrating their internal clock with the sun's position, they compensate for the apparent movement of the sun across the sky. Pigeons whose time sense is shifted by keeping then under artificial lights display incorrect orientations when released. For example, if "sunrise" comes for the pigeon 6 hours prior to actual sunrise, then their orientation is shifted counterclockwise. If their "sunrise" is later than the actual sunrise, then their orientation shifts clockwise. Like migrating birds, the pigeon's sun compass also interacts with a magnetic compass. Under some conditions, experimental modification of the magnetic field around pigeons causes problems in homing. Experiments with clock shifts and magnetic disruption however do not interfere as much as expected with homing. This is because the olfactory and landscape information used in establishing their map sense can be used to correct for compass misinformation.

PRACTICE QUESTIONS :

- ***Multiple choices :***

1. Homing animals exhibit a tendency to return to
   a. a particular habitat   b. a breeding spot
   c. a home territory   d. all of the above
2. Successful homing demands good
   a. navigation   b. Orientation
   c. Neither a nor b   d. Both a and b

3. Which of the following cues is a hindrance in homing?
   - a. Position of the sun
   - b. Mountains
   - c. Rivers
   - d. Wind
4. One animal which uses pheromones for homing is
   - a. Salmon
   - b. Digger wasp
   - c. Pigeon
   - d. Penguin
5. Which animal uses position of the sun as a navigational aid?
   - a. Sahara desert ant
   - b. Pigeon
   - c. Digger wasp
   - d. All
6. For homing pigeons are known to take help of
   - a. Position of sun
   - b. Smell
   - c. Magnetic field
   - d. All
7. Which of the following is known to count its steps for homing?
   - a. Sahara desert ant
   - b. Penguin
   - c. Digger wasp
   - d. All
8. Natal homing is shown by
   - a. Sea turtles
   - b. Salmon
   - c. Both a and b
   - d. Neither a nor b
9. Which of the following is not true for geomagnetic imprinting?
   - a. The effects are short lived
   - b. It occurs during a critical period
   - c. It occurs during early life
   - d. The effects cannot be easily modified.
10. Map sense of animals provides them information relating to
   - a. Climate and weather
   - b. Their present location
   - c. Earth's magnetic fieldd. Direction of movement

- ***Write short notes on***

1. Write a note on geomagnetic imprinting hypothesis.
2. Explain how chemical cues help orgasms in their homing behavior.
3. How does snapshot memory help a bee in locating its colony?
4. What sorts of information is utilized for home based navigation by animals?
5. Describe how animals use celestial bodies for navigation.

- ***Long answer type :***

1. What is meant by homing behavior? What abilities are required by animals for successful homing? Describe with examples the different cues used by animals for homing.
2. Describe the process of homing in pigeons.