MSCZO-509

M. Sc. II Semester
ANIMAL BEHAVIOR

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SCHOOL OF SCIENCES
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UNIT 1: CONCEPT AND CLASSIFICATION

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1.1 OBJECTIVES

Study of Animal Behaviour has made significant contribution and play important role to the basic biological system and has considerably increases rapidly during the past few years. The importance of Animal Behavior is generally not recognized, as the ideas, concept and revelation have not adequately presented. The content of this chapter introduces various aspect of animal behavior like different kind of Behaviour, homing behavior, patterns of Animal Behaviour and parental care in Animal etc.

1.2 INTRODUCTION

The scientific study of the characteristic behavior patterns and the study of Animal behavior and social organization from a biological perspective are known as the Ethology, i.e. Ethology (ethos = habit, and logos = study, deals with the study of animal behaviour) is the branch of biology that analyzes the reaction of an animal to its environment, trying to determine specific cause and effect relationship between the animal action and events and condition experienced by the Animals. Thus behavior is the study of what animals do as they react to their environment with particular patterns of muscular and glandular activity. A scientific study of animal behavior involves a variety of approaches. It can be explained in term of its evolutionary history, in term of the benefits it brings to the animal and in term of physiological mechanism. The consideration of any one of the approaches depends upon aspect of animal behaviour which one wants to know about.

The Scientific study of animal behaviour has its origin in the work of **Gilbert White (**1720-1793) and **Charles Leroy** (1723-1789). The most significant starting point in understanding animal behaviour came from the work of **Charles Darwin (**1809-1832), "Father of scientific study of Animal behaviour". Darwin wrote two books: i.e. **descent of Man and selection in relation to sex** (1871) and **The expression of emotions in Man and Animals** (1873). His theory of natural selection set the stage for consideration of animal behaviour and he believed the the theory of evolutionary continuity of man and other animal.

The modern approaches to animal behavior includes many feature derived from both the behaviorist and the early ethological views. In addition, modern ethology draws upon the physiological tradition, with its emphasis on the explanation of behaviour in term of the activity

of the nervous system. Konrad Lorenz & Niko Tinbergen formulated a number of concept on which the study of animal behavior has been based.

1.3 ETHOLOGY AS A BRANCH OF BIOLOGY

Ethology is a branch of biology that focuses on animal behavior. It originated in European zoology in the 1930s and revolved around the study of instinctive and fixed-action patterns of behavior. Ethologists study the animal's behavior in its natural environment rather than in a laboratory.

Ethology is the scientific study of animal behaviour, usually with a focus on behaviour under natural conditions, and viewing behaviour as an evolutionarily adaptive trait. Behaviourism as a term also describes the scientific and objective study of animal behaviour, usually referring to measured responses to stimuli or to trained behavioural responses in a laboratory context, without a particular emphasis on evolutionary adaptivity. Throughout history, different naturalists have studied aspects of animal behaviour. Ethology has its scientific roots in the work of Charles Darwin (1809–1882) and of American and German ornithologists of the late 19th and early 20^{th} century, including Charles O. Whitman, Oskar Heinroth (1871–1945), and Wallace Craig. The modern discipline of ethology is generally considered to have begun during the 1930s with the work of Dutch biologist Nikolaas Tinbergen (1907–1988) and of Austrian biologists Konrad Lorenz and Karl von Frisch (1886–1982), the three recipients of the 1973 Nobel Prize in Physiology or Medicine. Ethology combines laboratory and field science, with a strong relation to some other disciplines such as neuroanatomy, ecology, and evolutionary biology. Ethologists typically show interest in a behavioural process rather than in a particular animal group, and often study one type of behaviour, such as aggression, in a number of unrelated species.

Ethology is a rapidly growing field. Since the dawn of the 21^{st} century researchers have re-examined and reached new conclusions in many aspects of animal communication, emotions, culture, learning and sexuality that the scientific community long thought it understood. New fields, such as neuroethology, have developed.

Understanding ethology or animal behaviour can be important in animal training. Considering the natural behaviors' of different species or breeds enables trainers to select the individuals best

suited to perform the required task. It also enables trainers to encourage the performance of naturally occurring behaviours and the discontinuance of undesirable behaviours.

1.4 ANIMAL PSYCHOLOGY

Comparative psychology, or animal psychology, is **a multidisciplinary field designed to study the behaviors and cognitive processes of non-human animals**. The epistemology of this field draws from many related areas of inquiry, including but not limited to, ethology, general psychology, and evolutionary biology. The findings and inquiries related to this field potentially bear great significance not only on our general knowledge of behavior across species but also on human social sciences.

But animal psychology is not as widely known or understood by the general public as other areas of psychology. In this guide, we'll delve into the features of this unique field of psychological practice to give you a more informed understanding of what it is, why it's important, and what you can expect to experience as an animal psychologist.

The main goal of this field of inquiry is to examine differences (or lack thereof) in observed behaviors across many different species. This includes how animals interact with one another, how they interact with their environment, and how they interact with human beings.

This analysis can ultimately come from many different angles. For example, disparities across species in terms of behavioral traits can be used to assess what may or may not be considered "normal" animal behavior.

By establishing a norm in terms of animal behavioral traits, we can then pose the question of whether or not certain traits persist as evolutionarily-stable strategies. If this is in fact the case for a given trait, the genes associated with that trait are more likely to survive the "battle" of natural selection than those associated with less viable traits.

1.4.1 CLASSIFICATION OF BEHAVIORAL PATTERNS

The following points highlight the three categories of behavioural pattern of animals. The categories are:

1. Instinctive Behaviours or Fixed Action Pattern (FAP)

2. Learning Behaviour

3. Complex Behaviour

1. Instinctive Behaviours or Fixed Action Pattern (FAP)

Instinctive Behaviours are genetically inherited characteristics that impel animals to behave in a certain fixed way. It is also referred to as Fixed Action Pattern (FAP) or Innate Behaviour or Inborn Behaviour or Inherent Behaviour. Instinct is generally described as patterns of inherited pre-set behavioural responses which develop along with the developing nervous system.

It is a familiar behaviour which evolves gradually over the generations by selection, to match an animal's behaviour to its environment. It may be defined as a behaviour which does not require learning or practice, but which appears spontaneously at the first instance of its need.

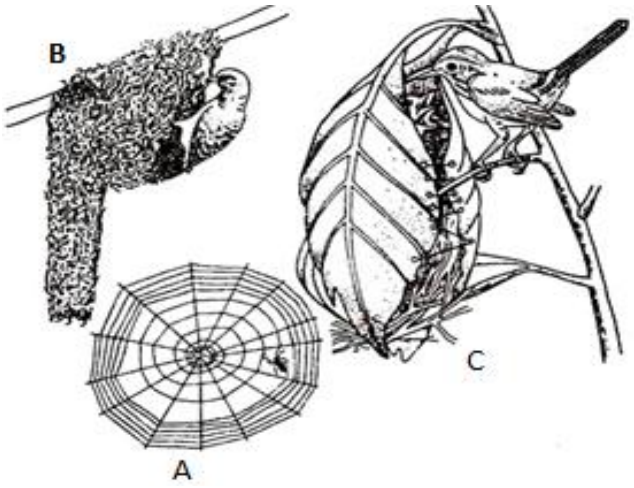

Fig 1.1 Nest Construction (a) Web formation by spider (b) Construction birds by weaver birds (c) Nest construction by tailer birds

Although this definition is of a negative kind, it emphasizes the other familiar way in which behaviour can become matched to circumstances. In the latter case, animals do not have any present responsiveness, but are able to modify their behaviour in the light of individual experience. The terms Inherited Adaptations and Acquired Adaptations are sometime used to emphasize the source.

In the animal kingdom, there are a number of behavioural patterns which are depicted in the genes. To name a few — the courtship display and mating in most animals, feeding patterns, nest building, parental care, singing, wings cleaning, territoriality and aggression, construction of web by spiders construction of nest by birds etc.

An instinct is a complex pattern of innate behavior. Spinning a web like the one in -----is complicated, yet spiders spin webs correctly on the first try. Unlike reflexes, instinctive behaviors can take weeks to complete. Instinctive behavior begins when the animal recognizes a stimulus and continues until all parts of the behavior have been performed.
Early ethologists regarded instinct as the natural origin of the biologically important motives. Thus, Thomas Aquinas believed that animal judgments are not free but implanted by nature. Descartes regarded instinct as the source of the forces that govern behaviour, being designed by God in such a way as to make the behaviour adaptable.

The idea of instinct as a prime mover was taken up by Psychologists such as Freud (1915) and McDougall (1908.) Sigmund Freud developed a motivational theory of neurosis and psychosis that emphasized the irrational forces in human nature. He saw, behaviour as the outcome of the two basic energies, a life force underlying life-maintaining and life-continuing human activities and a death force underlying aggressive and destructive human activities. Freud thought of the life and death forces as instincts whose energy required expression or discharge.

Darwin (1859) was the first to propose an objective definition of instincts in terms of animal behavior. He treated instincts as a complex reflexes made up of units compatible with the mechanisms of inheritance, and thus, a product of natural selection that had evolved together with the other aspects of the animal's life. Darwin's concept of instinct is then similar to that of Descartes, with evolution replacing the role of God.

Criteria for instinctive behavior

There are three criteria for instinctive behaviour:

(1) They are unlearned, (2) They are adaptive and (3) They are the characteristic of the species.

Exceptions are always there and in higher animals learning by individual life experiences cannot be ruled out, For example cats are carnivorous and instinctively kill rates, but not cats kill rats,

for it turns out that kittens often must see adult cats killing rats before they do so themselves. Kittens brought up with mice rarely become mouse killers. Illustrations of innate behaviour in Animal kingdom innate behaviour are often stereotyped and occur in all animals but are more significant in lower forms. In higher animals, innate responses occur along with learned ones and are often modified by learning. Few important patterns as an example of innate behavior are illustrated as under:

1 st example: When a toad sees a long thin object such as a garden snake, it characteristically reacts by filling its lungs to capacity and rising up from the ground while at the same time tilting towards the object. The increased size and changed attitude is effective in preventing it from being swallowed by the snake, but the toad probably does not known that, it is just reacting "instinctively" to the stimulus.

2 nd example: many calm species characteristically react to contact with starfish by flapping their shells in such a manner that they are propelled upwards and away from the predator.

III rd example: Mammals also show complex patterns of innate behaviour. The curiosity of a young kitten, it playful pouncing on its mother's body, its persistent searching for an available nipple are examples of unlearned behaviour patterns that characterize normal young kittens.

IV th example: Mammals also show complex patterns of innate behaviour. The curiosity of a young kitten, its playful pouncing on its mother's body. Its persistent searching for an available nipple is examples of unlearned behaviour patterns that characterize normal young kittens.

V th example: In many meat eating mammals (carnivores), it is usual for the mother to be the only parent to protect and provide food for the offspring. The male parent is often likely to eat its own young, if the opportunity arises. Nevertheless, it is innate behaviour of males of many species, such as courgars, wolves and foxes, to provide food and protection by the mother. Especially in mammals, however innate behaviour is modified and improved by learning, so that it is difficult to tell how much of a particular behaviour pattern is innate and how much is learned.

2. LEARNING BEHAVIOUR

All animals have innate and learned behaviors. Learned behavior develops during an animal's life time. Animals with more complex brains exhibit more behaviors that are the result of learning. However, the behavior of insects, spiders, and other arthropods is mostly instinctive behavior. Fish, reptiles, amphibians, birds, and mammals all learn. Learning is the result of experience or practice. Learning is important for animals because it allows them to respond to changing situations. In changing environments, animals that have the ability to learn a new behavior are more likely to survive. This is especially important for animals with long life spans. The longer an animal lives, the more likely it is that the environment in which it lives will change.

Fig 1.2 grouse and quail chicks

Learning also can modify instincts. For example, grouse and quail chicks, shown in fig 10.4 leave their nests the day they hatch. They can run and find food, but they can't fly. When something moves above them, they instantly crouch and keep perfectly still until the danger has passed. They will crouch without moving even if the falling object is only a leaf. Older birds have learned that leaves will not harm them, but they freeze when a hawk moves overhead. Learning is the modification of stereotyped behaviour or the acquisition of new behavioural patterns based upon past experiences. Therefore, learnt behaviour is also called Modifiable Behaviour or Acquired behaviour. Two criteria are used to distinguish learning from other modification of stereotyped behaviour.

1. Learning must be permanent and not the result of fatigue or fluctuation in motivation, and
2. Learning must not the simply a permanent change in behaviour resulting from maturation.

It is practically impossible to say that any behaviour is completely learnt in that it depends in no way on inherited mechanism. One might say that nothing is more obviously learned than human language. But the real point about linguistic behaviour is that its mechanism is innate, and is highly modifiable. The ability to talk is innate, but the particular language we talk is not. Simply put, learning is a process that causes changes in behaviour as result of experience. In contrast to innate behaviour patterns that depend on the genetic makeup of the individual, learned behaviour patterns depend on the animal's environment and prior experience. An animal's ability to learn is a function of the complexity of its nervous system.

Kinds of learning behaviour

The various levels of learning found in the animal kingdom have been classified ethologically in several ways which are recognized by animal psychologists.

1. Habituation
2. Imprinting
3. Conditioned Reflexes or Associative learning
4. Trial-and-error learning
5. Latent learning
6. Insight learning
7. Reasoning

1. Habituation

Habituation is actually the simplest kind of learning. It is a form of non-associative learning. Habituation is a process in which an animal learns to inhibit a response and is considered to be the most primitive and widespread from of learning. In other works, it is the general suppression of a stereotyped behavior pattern as the result of a repeated stimulus that is not followed by an adverse effect. In simple terms, it is a learning to ignore stimuli in the environment and not associated with any reward or punishment. For example, if a garden snail is allowed to crawl across a surface and the surface is trapped sharply, the snail will rapidly withdraw into its shell. After a few moments, it will come out again and continue moving. Tapping the surface again will cause it to stop, withdraw, wait, and then reemerge. This response will continue for while, but gradually the time taken to remerge diminishes, and ultimately the snail will not respond to the tapping at all.

2. Imprinting

Imprinting is actually a specialized form of learning that is seen clearly in many kinds of birds during their early period of life (Hess, 1958.) When the early period over's, the birds are unable to learn. For example, young ducks will normally follow their mother around soon after they hatch. This following behaviour is the result of hatching. Apparently imprinting will occur only for a short time after the bird is hatched. If imprinting is prevented from occurring by hatching the egg in an incubator and not exposing the young bird to an adult bird for some days, it never occurs. Experiments have been performed with ducks and other birds hatched in incubators. In the case of many, the first large moving object seen by the newly hatched animal (bird) will be the stimulus for imprinting. If the first such object seen is a man, the young birds will follow the man about. In simple form, if the young duckling are hatched artificially and then exoposed early to some moving object other than their true mother, they will behave towards the object as they normally would to their mother duck, following the object wherever it goes. Such a "substitute mother" might be a ball bicycle, an electric train engine, or even a human.

3. Conditioned Reflexes or Associative learning or Learned Reflexes

Do you have an aquarium in your school or home? If you put your hand above the tank, the fish probably will swim to the top of the tank, expecting to be fed. They have learned that a hand shake above them means food. What would happen if you tapped on the glass right before you fed them? Soon the fish probably will swim to the top of the tank if you just tap on the glass. Because they are used to being fed after you tap on the glass, they associate the tap with food.

Actually a conditioned reflex is substituting one stimulus for another in bringing about a type of response. In other words, where nerve impulse travels in a reflex and which involves brain association neurons to decide on what response is to be made to the original stimulus, the response is called a conditioned reflex .Saliva secretion occurs by simple reflex caused by the touch of food inside the mouth affecting the receptors which stimulate the salivary gland effectors, via sensory and motor neurons.

Food touch → receptors → Sensory neuron

↓

Salivary gland secretes saliva ← Effectors ← Motor neurons

The sight and smell of food can cause salivation. Similar a dinner gong sound can produce salivation. Associative learning or learned reflex is of two types: A-classical conditioning and B-Instrumental conditioning.

3. Trial and Error learning

It is also called as "Selective Learning". Trial and error learning results when instrumental conditioning is made more complex by introducing several variables. Various types of mazes i.e. problem apparatus as weel as other multiple choice situations have been developed to measure learning ability in various animals.

Attempts have been made to show that various protozoans, expecially paramaecia, can lern. Even experiments designed to illustrate habitation learning have not been entriley successful. In fact, learning has not yet been successfully demonstrated in the simple multicellular animals or in any of the radially symmetrical animals (Coelenterata, Ctenophora, and Echinodermeta).

4. Latent learning

Latent learning is acquired even when there is no particular reward or punishment associated with an animal's activity. Many animals appear to be naturally "curious", exploring their surroundings in great detail. When finches are relased into an aviary for example, they will investigate every nook and cranny until they are thoroughly familiar with their new home. When a hive of honeybees is closed up, moved to a new location, and then reopened, many of the emerging bees appear to perform short orientation flights, lasting only a minute or two. They emerge and fly in ever widening circles around the hive, apparently learning to recognize the surroundings sufficiently to find there, way back from a longer flight.

5. Insight learning

The most sophisticated kind of learning is called insight learning, the ability to use knowledge obtained in one context to solve a problem in a different context. The chimpanzee, who pokes a stick into an ant nest, allows the ants to climb on the stick and then licks them off, is using insight learning if it has "reasoned" beforehand that the stick would make a suitable tool for capturing the ants. Insight learning may also be termed as "intelligence."

Insight learning differs from trial-and-error leaning because it involves the sudden production of anew response. In the human species insight learning is most highly developed. However, birds, such as crow also possess this type of learning.

Actually human behaviour contains many learned responses and depends especially on insight learning.

6. Reasoning

With increasing complexity of the nervous system in the higher vertebrates', for instance, mammals and especially the primates, the behavioural pattern many not always be innate or acquired from past experiences but a complex of one more ability of reasoning. Reasoning is of the top of all modes of adaptive behaviour. Reasoning capacity includes the ability to solve complex problems with something more than simple trail-and-error habit or stimulus-response modification. In other words, reasoning is the ability to use past experience and logical deductions to solve some new complex problem.

3. COMPLEX BEHAVIOUR:

The simplest unit of behaviour is the reflex. Behavioural patterns were initially thought to have been brought about by long and complex chain of reflexes. But behaviour is not all about external stimuli; it is also based on internal physiological conditions and spontaneous reactions controlled by nervous, hormonal and muscular systems.

However, one can learn some of the basic features of behavioural mechanisms through the study of properties which reflexes share with more complex patterns and which can be clearly related to the properties of individual nerve cells. On the operation of the nerve cells, all behaviour depends.

It is difficult to draw a firm line between reflexes and complex behaviour. Complex behaviour can incorporate many reflexes. For example, the swallowing reflex is the culmination of elaborate food-seeking behaviour. Complex behaviour, thus, is the product of an integrated series of changes in cell chemistry; initiated by receptor cells and carried on by sensory interneurons and motor cells and muscles.

For example, singing in a cricket or a bird, where the body works due to the coordination of nerves, muscles and sense organs. The nervous system is remarkable in the sense that it not only responds to stimuli but also possesses a remarkable ability to preserve the effect of previous stimuli for a shorter or longer period.

The properties of reflexes and complex behaviour are:

(a) Latency:

Latency is the delay between giving a stimulus and seeing its effect. Latency in response is exhibited by both reflexes and complex behaviour. When a dog encountering a painful stimulus, the latency between the encountering of the stimulus and showing of flexion reflex (that is, withdrawal of the leg), lies between 60 and 200 milliseconds.

Of this delay, a small fraction of time is taken for nerve impulses to be conducted along axons while the majority of the delay is due to the synapses (the term coined by Sherrington) between one neuron and the next. Thus, the delays between stimulus and response in complex behaviour are due to the fact that, in the chain between receptors and effectors, there are often dozens of synapses to cross.

Another example of latency can be cited from the toad's tongue flip to the escape of a cockroach. Slowed-down film shows that just before the toad's tongue flips out of its mouth and strikes, the cockroach can sense it and would run out of reach. The important cue is the tiny gusts of wind produced by the toad's movement which is picked up by the cockroach through many tiny wind-sensitive hairs on its cerci.

The critical gust of wind occurred, on average, 41 ms (milliseconds) before the tongue starts emerging from the mouth. The latency period between the puffs of air and the cockroach's reaction (escape behaviour) is 44ms, which is sufficient for it to escape.

(b) Summation:

It has been observed that sometimes individual neurons respond only after they have received several post-synaptic potentials and, thus, are able to summate (add up) excitation coming either at different times (temporal summation) or from different places (spatial summation). An

example of summation at the level of reflex is provided by Sherrington (1906), through the scratch reflex of the dog.

(d) Inhibition:

Within the nervous system, nerve cells actively inhibit each other's transmission of information. At the behavioural level, prevention of one's activity occurrence, while another is in progress, constitutes inhibition. Muscles are generally arranged in antagonistic (a muscle contracts and limits the action of another) pairs, such that, when one flexes, the other extends it.

Sherrington showed that, when in one member of a muscle pair, excitation occurs; it is accompanied by inhibition of its antagonistic pair. However, such inhibition is not absolute. Once a muscle is stretched by its antagonistic pair, then its own 'stretch reflex' will tend to make it contract. Mutual inhibition allows them to take the lead in turn during the limb movements and to alternate flexion and extension of the limbs.

In complex behaviour, the role of inhibition is less obvious than that of excitation. When an animal is stimulated, the obvious result is that the it makes a response. Sherrington showed that the muscles, whose action is common to several different reflexes, compete with each other for the final common pathway.

The different controlling patterns of complex behaviour like fighting, feeding and sleeping compete for the control of the animal's musculature. However, only one behaviour can occur at a time. The nervous system will allocate priorities since there will often be conflicts as to which stimuli should an animal respond to. Thus, inhibition of action would be as crucial as excitation.

To substantiate the above let us take a very common example where many animals require taking in food and water over the same time in order that digestion can proceed normally. McFarland & Lloyd (1973), experimenting on doves, gave food and water to birds who had previously been deprived of both.

1.4.2 ANALYSIS OF BEHAVIOR (ETHOGRAM)

An ethogram is **a catalogue or inventory of behaviours or actions exhibited by an animal used** in ethology. The behaviours in an ethogram are usually defined to be mutually exclusive and objective, avoiding subjectivity and functional inference as to their possible purpose. For example, a species may use a putative threat display, which in the ethogram is given a descriptive name such as "head forward" or "chest-beating display", and not "head forward threat" or "chest-beating threat". This degree of objectivity is required because what looks like "courtship" might have a completely different function, and in addition, the same motor patterns in different species can have very different functions (e.g. tail wagging in cats and dogs). Objectivity and clarity in the definitions of behaviours also improve inter-observer reliability.

Often, ethograms are hierarchical in presentation. The defined behaviours are recorded under broader categories of behaviour which may allow functional inference such that "head forward" is recorded under "Aggression". In ethograms of social behaviour, the ethogram may also indicate the "Giver" and "Receiver" of activities.

Sometimes, the definition of behaviour in an ethogram may have arbitrary components. For example, "Stereotyped licking" might be defined as "licking the bars of the cage more than 5 times in 30 seconds". The definition may be arguable, but if it is stated clearly, it fulfills the requirements of scientific repeatability and clarity of reporting and data recording.

Some ethograms are given in pictorial form and not only catalogue the behaviours but indicate the frequency of their occurrence and the probability has that one behaviour followed another.

1.5 Innate Behavior

A behavior that an organism is born with is called an innate behavior. These types of behaviors are inherited. They don’t have to be learned. Innate behavior is commonly called Inborn or Inherited behavior. Innate behaviour is stereotyped behaviour; therefore it is termed as stereo typed innate behaviour. Some behaviour is probably completely innate (built in) e.g. tropism in plants. In birds not only the ability to sing but also a particular song is innate. A simplest form of behavior consists of a given response to a given type of stimulus. Since such response is always associated with a specific given stimulus, this type of behavior is known as stereotyped. Furthermore, such behaviour is innate, in that it is not learned but is present prior to any teaching

or experience. In other words, the simplest type of behaviour is that where the responses to stimulus is governed by the hereditary properties.

Fig.1.3 Birds building nest (Innate behavior)

In other words, the behaviour that develops without obvious environmental influence is known as stereotyped or unchanging or innate behaviour. The animal in this category responds to a stimulus in a definite manner which is independent of all other factors except the nature of the stimulus. Thus stereotyped behaviour is that simple behaviour which is essentially stimulus dependent. Therefore, in this type of behaviour the nature of the stimulus determines the nature of the response. Reflex, Taxis, Kinesis, instincts etc. are the examples of this behaviour. Some ethologists have directly interpreted that stereotyped behaviour is a taxis (plural=taxes), if the whole organism changes its position in relation to some environmental stimulus. Taxes are usually named in terms of the guiding stimulus. Protozoan's react to light (Photo taxis); touch (Thigmotaxis); chemicals (Chemo taxis); gravity (Geotaxis); weak electrical currents (Galvanotaxis), and temperature (Thermotaxis). In general taxis refer to an idea about orientation. However, not all orientations are taxis. In general orientation may be defined as the reactions which guide the locomotors responses of the animals. The normal position of the animal which is the basic position, from which other reactions start, is known as primary Orientation. The locomotory behaviour of animals in response to various stimuli like temperature, light, humidity etc. is called secondary Orientation.

DIFFERENT TYPE OF INNATE BEHAVIOR

Secondary Orientation is basically of three main types which are regarded as kinds of innate behavior:-

1. Taxis

2. Kinesis

3. Transverse Orientation.

Besides the aforestated type of orientation, there three more types of innate behaviors' which are as follows:-

1. Instinctive
2. Reflexes and
3. Motivation.

1. Taxis

When the animals either move towards or away from the stimuli and their general course of movement is the straight line joining them with the source of stimulus, such orientation is called as 'taxis'. If the movement of Animal towards the source of stimulus than this is called as positive taxis and if it is opposite to this direction than it is known as negative taxis.

Types of Taxis: -

Taxis are of three types.

1. Klinotaxis 2. Tropotaxis 3. Telotaxis

1. Klinotaxis:-

This is the simplest form of orientation & undirected. Orientation by successive comparison of stimulus intensity requires turning movements. Usually it is called klinotaxis. Many animals show Klinotaxis in response to gradients of chemical stimulation.

2. Tropotaxis:

Tropotaxis is shown by those animals which possess receptors. With the help of receptors, they can compare the intensity of stimulus in all sites simultaneously. Tropotaxis enables the animal to steer a course directly towards or away from the source of stimulation. Usually the receptors are arranged in a bilaterally symmetrical fashion.

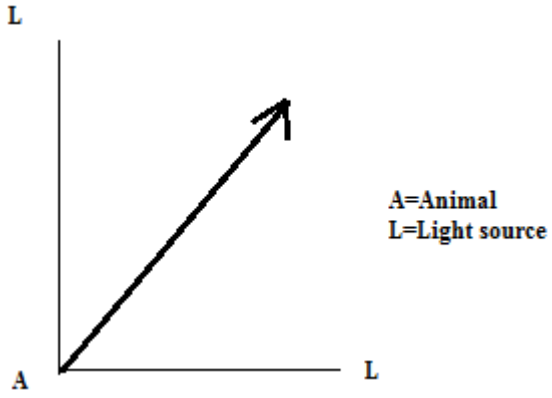

Fig.1.4 Topotaxis

It has been observed that if the receptors of one side are put out of action then the animals are unable to decide the course and move almost aimlessly. Such type of movement of the animal is called as “Circus movement”.

3. Telotaxis:

In this type of axis the balance does not exist and orientation of animal to light is not altered. The animal at one time may orientate to one light source and at the other time to the other light source. Thus it is capable of ignoring one or more light sources at a particular time. It shows that the bilateral arrangement of the stimulus is not a necessary factor for orientation of this type. In other words, eyes that are capable of providing information about the direction of light by virtue of their structure are capable of Telotaxis.

KINESIS:

The orientation of the whole animal in space may be based on very simple principles but may also involve very complex mechanism. The simple principles can be seen most easily in certain

invertebrate species. The simplest form of spatial orientation in kinesis, in which the animal's response is proportional to the intensity of stimulation but is independent of the spatial properties of the stimulus. For example, common woodlice (porcellion scaber) tend to aggregate in damp places beneath rocks and fallen logs. They move about actively at low humidity levels but are less active when the humidity is high. They consequently spend more time in damp conditions but their enhanced activity in dry conditions increases the chance of discoveries of a damp place. It may be inferred that when the speed of movement and the frequency of turning of animals are affected by the stimulus then such orientation is called kinesis. Kinesis is directed movement of animals in relation to the sense of stimulus and is of two types:

A. Orthokinesis

B. Klinokinesis

A. Orthogenesis:-

When a relationship exists between the speed of locomotion and the intensity of stimulation then it is called Orthokinesis. Such kinesis may be seen in Porcellion scaber (Woodlice), in which the linear velocity of its movement is affected by the intensity of stimulus. As referred above, the woodlice move faster in dry condition than the humid condition. The result is that when the woodlice are kept in a chamber with graded humidity, then they aggregate in the humid zone. Actually this is not because they prefer humidity but because of the fact that they move quickly through the non-humid areas (i.e. dry areas) to humid ones.

A. Klinokinesis:-

In this type of kinesis the rate of change of direction increases with the increased light intensity (According to Fraenkel and Gunn, 1940, Hinde, 1970.) The flatworm *Dendrocoelum lacteum* does not move in a linear fashion but shows a twisted course of movement which includes turning in various direction of linear movement are random and take place even in uniform environmental condition. The rate of random turning or angular velocity is called as **'rate of change in direction'** (R.C.D.) and is represented in degress/Unit time.

1.7 *SUMMARY*

The modern approaches to animal behavior includes many feature derived from both the behaviorist and the early ethological views. In addition, modern ethology draws upon the physiological tradition, with its emphasis on the explanation of behaviour in term of the activity of the nervous system. Konrad Lorenz & Niko Tinbergen formulated a number of concept on which the study of animal behavior has been based. All animals have innate and learned behaviors. Learned behavior develops during an animal's life time. Animals with more complex brains exhibit more behaviors that are the result of learning. However, the behavior of insects, spiders, and other arthropods is mostly instinctive behavior. Fish, reptiles, amphibians, birds, and mammals all learn. Learning is the result of experience or practice. Innate behaviour is stereotyped behaviour; therefore it is termed as stereo typed innate behaviour. Some behaviour is probably completely innate (built in) e.g. tropism in plants. In birds not only the ability to sing but also a particular song is innate. A simplest form of behavior consists of a given response to a given type of stimulus.

1.7 TERMINAL QUESTIONS AND ANSWERS

Question No.1 what do understand by the Learning behavior of Animal?

Question No.2 Explain the different type of innate behavior.

Question No.3 Explain the Classification of behavior patterns.

Question No.4 Write a short note on complex behavior.

UNIT 2: CONTROL OF BEHAVIOR

CONTENT

2.1 Objectives

2.2 Introduction

2.3 Neural behavior

2.4 Hormonal behavior

2.5 Summary

2.6 Terminal Questions and Answers

2.1 OBJECTIVES

The study of Neural behavior and Hormonal behavior.

2.2 INTRODUCTION

Internal mechanism of control of behavior is composed of nervous system and the endocrine system. It regulates animal behavior. These systems receive information from the external environment through sensory organs. Brain and endocrine glands process this information. Brain and glands initiate responses by motor neuron. Or they show the response by changing the operations of inter I organs. The nervous system control more specific and rapid responses. But the endocrine system monitors slower and general responses.

2.3 NEURAL BEHAVIOR

Internal mechanism of control of behavior is composed of nervous system and the endocrine system. It regulates animal behavior. These systems receive information from the external environment through sensory organs. Brain and endocrine glands process this information. Brain and glands initiate responses by motor neuron. Or they show the response by changing the operations of inter I organs. The nervous system control more specific and rapid responses. But t e endocrine system monitors slower and general responses.

NERVOUS SYSTEM

Nervous-system plays an important role in the control of behavior. The nervous system acts as a **stimulus filter.** Each organism receives stimuli from many sources continuously. The sensory organs and central nervous system block unimportant or irrelevant incoming stimuli. Thus information passes through the sense Dry filters. This information are then sorted and processed within the nervous system for appropriate responses.

Behavior is **chiefly controlled by the central nervous system** (i.e. brain and spinal cord). ... Reflex behavior is common to all the organisms, while complex behaviors are unique to the animal kingdom and denote their intellectual ability and hierarchy in the living system. Complex behaviors can be innate or learned.

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Fig.2.1Control of behavior

Example of blowflies

1. Feeding behaviour of blow flies: The behaviour of the blow flies is controlled by nervous System. The blowfly has special sensory receptors on its feet. The fly moves around. It encounters different substrates. Their

Receptors can detect the presence of certain sugars. The receptors of the feet send information to nervous system. The nervous system processes this information. The blowfly shows response by extending their proboscis. It also mutates the oral taste receptors. Thus the fly starts feeding. Some f feedback mechanism stops feeding. The foregpt of blowfly swells sufficiently after feeding. Receptors in the foregut send a message to the brain. The message sends to the nerves that control the feeding response. It stops the further intake of the sugar solution.

2. Control of aggressive behavior in Rhesus monkey: The nervous system regulates the control of aggressive behavior in rhesus• monkeys. Some researchers identified the dominant male monkey. They were present in a group of four to six animals. They surgically implanted electrodes into the special regions of brains monkeys. This region produces or inhibits the

aggressive behavior. They give mild electrical stimulation to the brain of the monkey. It produced aggressive or passive behaviors. This behavior depends on which electrode sent the message.

The researcher trained the other monkeys in the group to press a lever when the dominant monkey became aggressive. Pressing of the lever sent a message to the brain of the dominant male. It inhibits his aggression.

ENDOCRINE SYSTEM

The endocrine system is closely interrelated with the nervous system. Many receptors located on neurons in the brain or central nervous systems. These receptors are specialized for receiving input from hormones. The brain communicates with the endocrine system through neurons. Such types of connections are between the hypothalamus and pituitary gland of vertebrates. Other endocrine glands are located throughout the body of the organism. These endocrine glands produce hormones. The hormones affect the behavior in two major ways: organizational effects and antirational effects.

1. **Organizational effects of hormones**

It occurs during Development of the animals. It is particularly important for sex differentiation. These effects detect the presence of hormones and critical time periods. These effects influence the developmental pathways for specific brain regions. They also influence the developing gonadal tissues. These tissues become female or male like. The major effect takes place in the middle of gestation in most male mammalian embryos (e.g., guinea pigs, monkeys). The testes produce a large amount of male hormone (testosterone). This organizes other developing tissues and certain regions of the brain. The female embryos develop in the absence of testosterone. Thus female like characteristics develop in the external anatomy and brain. These brain regions are important for sex differentiation. Genes normally turn on the production and release of testosterone. But sometimes, the testosterone comes from an external source.

• Sometimes, cattle develop twin in the uterus. One member of the twin is male and other is female. A male fetus masculinized a female fetus. The system of male fetus turns on and releases testosterone during gestation. Some of that hormone crosses over and affect the developing female fetus. It produces a **freemartin.** It is a sterile heifer (offspring of cow). It shows a number of male like behavior patterns.

Some pregnant human females are in danger of losing their fetus. They are given, some hormone treatments. This hormone is converted and acts like testosterone within the female embryo. Thus it causes masculinization of female embryos.

2. **Activational effects of hormones**

An external stimulus starts a hormonally mediated response. It is called activational effects of hormone.

- Many male fishes develop territory boundary. Sometimes, their territory is threatened. Therefore, these males change color patterns. This change of colour pattern is stimulated by hormones. The color change is an indication of aggressive behavior to defend the territory.
- Many animals like domestic cats, roosters, and mice are castrated (removal of tie gonads). They lose their aggressive fighting ability. The gonads are the sauce of testosterone. It stimulates particular brain receptors to produce aggression.

2.4 HORMONAL BEHAVIOR

The goal of this topic is to introduce you to the topic of hormones and behavior. This field of study is also called behavioral endocrinology, which is the scientific study of the interaction between hormones and behavior. This interaction is bidirectional: hormones can influence behavior, and behavior can sometimes influence hormone concentrations. Hormones are chemical messengers released from endocrine glands that travel through the blood system to influence the nervous system to regulate behaviors such as aggression, mating, and parenting of individuals.

To understand the hormone-behavior relationship, it is important briefly to describe hormones. Hormones are organic chemical messengers produced and released by specialized glands called endocrine glands. Hormones are released from these glands into the blood, where they may travel to act on target structures at some distance from their origin. Hormones are similar in function to neurotransmitters, the chemicals used by the nervous system in coordinating animals' activities. However, hormones can operate over a greater distance and over a much greater temporal range than neurotransmitters. Examples of hormones that influence behavior include steroid hormones such as testosterone (a common type of androgen), estradiol (a common type of estrogen), progesterone (a common type of progestin), and cortisol (a common type of

glucocorticoid). Several types of protein or peptide (small protein) hormones also influence behavior, including oxytocin, vasopressin, prolactin, and leptin.

Hormones coordinate the physiology and behavior of individuals by regulating, integrating, and controlling bodily functions. Over evolutionary time, hormones have often been co-opted by the nervous system to influence behavior to ensure reproductive success. For example, the same hormones, testosterone and estradiol, that cause gamete (egg or sperm) maturation also promote mating behavior. This dual hormonal function ensures that mating behavior occurs when animals have mature gametes available for fertilization. Another example of endocrine regulation of physiological and behavioral function is provided by pregnancy. Estrogens and progesterone concentrations are elevated during pregnancy, and these hormones are often involved in mediating maternal behavior in the mothers.

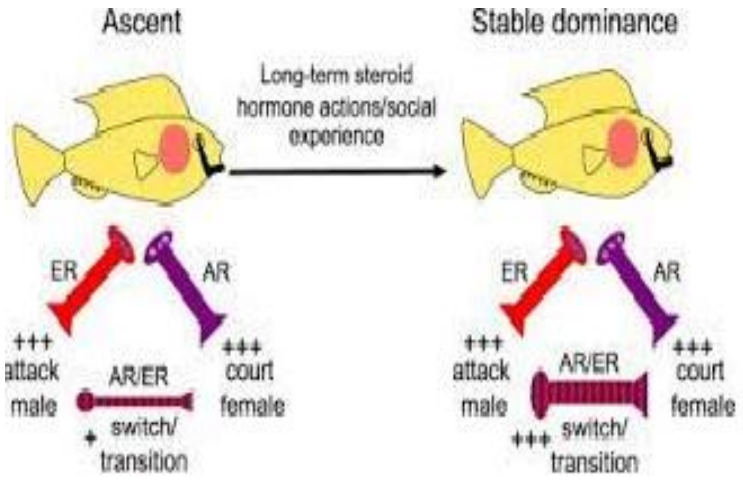

Fig.2.2 Hormonal Regulation of social ascent & temporal pattern of behaviour

Not all cells are influenced by each and every hormone. Rather, any given hormone can directly influence only cells that have specific hormone receptors for that particular hormone. Cells that have these specific receptors are called target cells for the hormone. The interaction of a hormone with its receptor begins a series of cellular events that eventually lead to activation of enzymatic pathways or, alternatively, turns on or turns off gene activation that regulates protein synthesis. The newly synthesized proteins may activate or deactivate other genes, causing yet another cascade of cellular events. Importantly, sufficient numbers of appropriate hormone

receptors must be available for a specific hormone to produce any effects. For example, testosterone is important for male sexual behavior. If men have too little testosterone, then sexual motivation may be low, and it can be restored by testosterone treatment. However, if men have normal or even elevated levels of testosterone yet display low sexual drive, then it might be possible for a lack of receptors to be the cause and treatment with additional hormones will not be effective.

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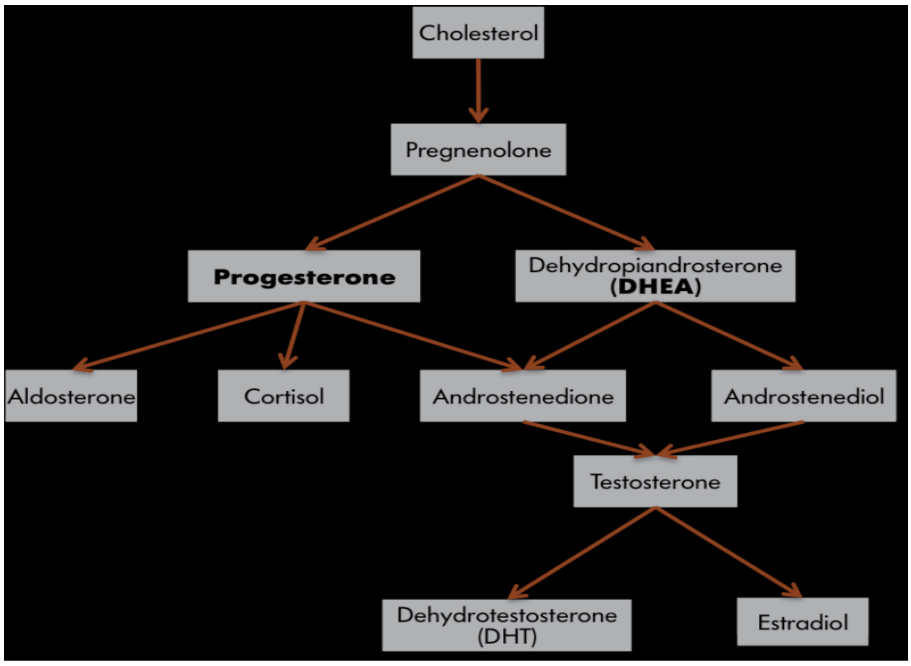

Fig 2.3 Hormones & Behaviour

Hormones coordinate the physiology and behavior of individuals by **regulating, integrating, and controlling bodily functions**. Over evolutionary time, hormones have often been co-opted by the nervous system to influence behavior to ensure reproductive success. In psychology, **control** is a person's ability or perception of their ability to affect themselves, others, their conditions, their environment or some other circumstance. Control over oneself or others can extend to the regulation of emotions, thoughts, actions, impulses, memory, attention or experiences. There are several types of control, including:

- Perceived control (a person's perception of their own control and abilities to achieve outcomes)
- Desired control (the amount of control one seeks within a relationship or other circumstance)
- Cognitive control (the ability to select one's thoughts and actions)
- **Emotional control** (the ability to regulate one's feelings or attitudes toward something)
- Motivational control (one's ability to act on prescribed behaviors)
- Inhibitory control (the ability to inhibit thoughts or actions in favor of others)
- Social control (selecting one's environment for personal benefit)
- Ego control (the attempt to regulate impulses or attention processes)
- Effortful control (the ability to regulate how much effort one invests into a goal)

Perceived control

Perceived control in psychology is a “person’s belief that they are capable of obtaining desired outcomes, avoiding undesired outcomes, and achieving goals.” High perceived control is often associated with better health, relationships, and adjustment. Strategies for restoring perceived control are called 'compensatory control strategies'. One's perception of perceived control is influenced by the past and future as well as what the desired outcome of an event may be. Perceived control is often associated with the term locus of control. Perceived control can be affected by two processes: primary and secondary control. Primary control consists of attempting to change the environment to align with one's own wishes, whereas secondary perceived refers to

the act of attempting to gain control by changing one's wishes to reflect what exists or is achievable within the environment

Desired control

Desired control is the degree of influence that an individual desires over any subject, circumstance, or relationship. This can apply to romantic, non-romantic, professional, and sales contexts. Desired control is often associated with perceived control, and studies focused on individuals with a lower desire for control show a correlation with greater psychological problems

Cognitive control

Cognitive control is "the ability to control one's thoughts and actions. It is also known as controlled processing, executive attention, and supervisory attention. Controlled behaviors - behaviors over which one has cognitive control - are guided by maintenance, updating, and representing task goals, and inhibiting information irrelevant to the task goal. Cognitive control is often developed through reinforcement as well as learning from previous experiences. Increased cognitive control allows individuals to have increased flexibility in their ability to choose between conflicting stimuli. Cognitive control is commonly tested using the Stroop color-word task as well as the Eriksen flanker task.

There are certain quirks of cognitive control, such as ironic rebound, in which attempts to keep a particular thought out of consciousness result in that thought becoming increasingly prevalent. In social psychology experiments conducted by Daniel M. Wegner, Ralph Erber and R.E. Bowman, male and female subjects were instructed to complete some sentences related to sexism. Some participants were given guidance to avoid being sexist, whereas some were not given such instructions. Additionally, for some sentence completions, time pressure was either applied by asking for immediate responses or reduced by giving subjects ten seconds to respond. Under low-pressure conditions with guidance to avoid being sexist, the number of sexist completions were lower than the much higher number of sexist completions that resulted when subjects were under time pressure along with guidance to avoid being sexist. Furthermore, these results were consistent among both male and female subjects. This highlights the effect of ironic rebound:

when the individuals attempted not to be sexist under a significant time constraint, their resulting actions were counter to their attempts at cognitive control.

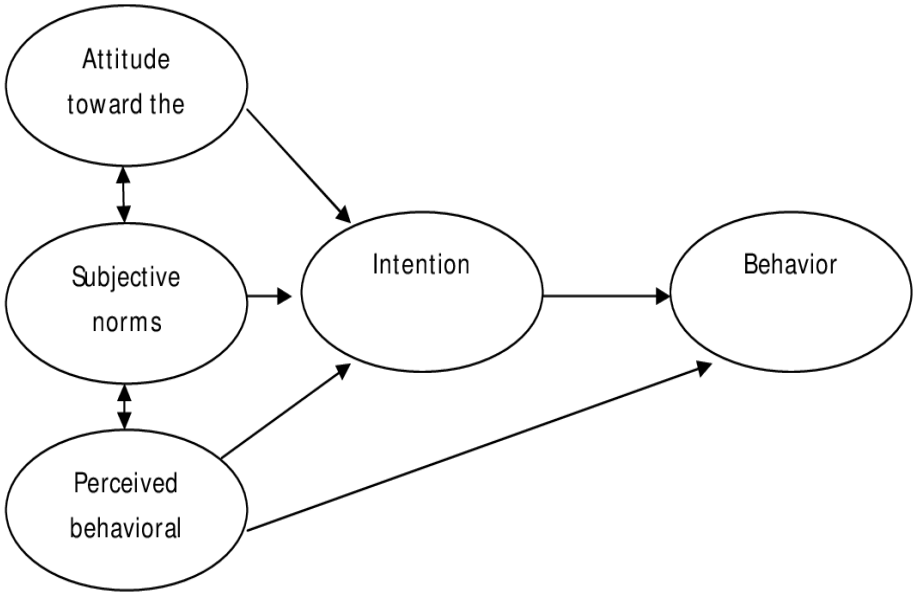

Fig.2.4Pereceived behavioral Control

Emotional control

Is a term from literature on self-regulatory psychology and refers to "the ability to self-manage or regulate attitudes and feelings that directly affect participant receptiveness to, and implementation of, training activities." Emotional control is often referred to as emotional regulation and is the process the brain undergoes to regulate and control emotional responses throughout the day. Emotional control manages and balances the physiological as well as psychological response to an emotion. The opposite of emotion regulation is emotional dysregulation which occurs when problems arise in the emotional control process those results in the inability to process emotions in a healthy manner. Emotional control contains several emotional regulation strategies including distraction, cognitive reappraisal, and emotional action control.

Motivational control

Motivational control is “the self-regulatory mechanism by which individuals are able to act on prescribed behaviors to implement activities.”In other words, it is the capability of an individual to act on intentional reasoning, rather than out of emotion or impulse. For example, a student may study for an hour each morning for two months before a test, despite not enjoying studying, in order to improve their results.

Inhibitory control (IC) is another type of self-regulation: “the ability to inhibit prepotent thoughts or actions flexibly, often in favor of a subdominant action, typically in goal-directed behavior”. There are two types of inhibitory control: hot and cold. Hot IC involves activities or tasks related to emotional regulation, and cold IC involves abstract activities or tasks. A lack of inhibitory control can lead to difficulties in motor, attentional, and behavioral control. Inhibitory control is also involved in the process of helping humans correct, react, and improve social behavior.

A lack of inhibitory control can be connected with several mental disorders including behavioral inhibition, attention deficit hyperactivity disorder (ADHD), and obsessive-compulsive disorder (OCD). Alcohol and drugs also influence one's inhibitory control.

Social control

In learning psychology, social control refers to "an individual’s skills in engaging the social environment in ways that help to support and reinforce his or her learning activities.”Social control can be influenced by several factors including the control that society places on individual actions and behaviors as well as the control an individual can exert over their own behaviors in public. The definition of social control has changed over time to include the social control groups of people have in addition to individuals.

Social control

'Ego control' describes the efforts of an individual to control "thoughts, emotions, impulses or appetites… task performances and attentional processes.” Failure of ego control is seen as a central problem in individuals who suffer from substance abuse disorders.

2.5 SUMMARY

Although neural and hormonal communication both relies on chemical signals, several prominent differences exist. Communication in the nervous system is analogous to traveling on a train. You can use the train in your travel plans as long as tracks exist between your proposed origin and destination. Likewise, neural messages can travel only to destinations along existing nerve tracts. Hormonal communication, on the other hand, is like traveling in a car. You can drive to many more destinations than train travel allows because there are many more roads than railroad tracks. Similarly, hormonal messages can travel anywhere in the body via the circulatory system; any cell receiving blood is potentially able to receive a hormonal message.

Neural and hormonal communication differs in other ways as well. To illustrate them, consider the differences between digital and analog technologies. Neural messages are digital, all-or-none events that have rapid onset and offset: neural signals can take place in milliseconds. Accordingly, the nervous system mediates changes in the body that are relatively rapid. For example, the nervous system regulates immediate food intake and directs body movement. In contrast, hormonal messages are analog, graded events that may take seconds, minutes, or even hours to occur. Hormones can mediate long-term processes, such as growth, development, reproduction, and metabolism.

Hormonal and neural messages are both chemical in nature, and they are released and received by cells in a similar manner; however, there are important differences as well. Neurotransmitters, the chemical messengers used by neurons, travel a distance of only 20–30 nanometers (30 X 10–9 m)—to the membrane of the postsynaptic neuron, where they bind with receptors. Hormones enter the circulatory system and may travel from 1 millimeter to >2 meters before arriving at a target cell, where they bind with specific receptors.

Another distinction between neural and hormonal communication is the degree of voluntary control that can be exerted over their functioning. In general, there is more voluntary control of neural than of hormonal signals. It is virtually impossible to will a change in your thyroid hormone levels, for example, whereas moving your limbs on command is easy.

Although these are significant differences, the division between the nervous system and the endocrine system is becoming more blurred as we learn more about how the nervous system regulates hormonal communication. A better understanding of the interface between the endocrine system and the nervous system, called neuroendocrinology, is likely to yield important advances in the future study of the interaction between hormones and behavior.

This module describes the relationship between hormones and behavior. Many readers are likely already familiar with the general idea those hormones can affect behavior. Students are generally familiar with the idea that sex-hormone concentrations increase in the blood during puberty and decrease as we age, especially after about 50 years of age. Sexual behavior shows a similar pattern. Most people also know about the relationship between aggression and anabolic steroid hormones, and they know that administration of artificial steroid hormones sometimes results in uncontrollable, violent behavior called "roid rage." Many different hormones can influence several types of behavior, but for the purpose of this module, we will restrict our discussion to just a few examples of hormones and behaviors. For example, are behavioral sex differences the result of hormones, the environment, or some combination of factors? Why are men much more likely than women to commit aggressive acts? Are hormones involved in mediating the so-called maternal "instinct"? Behavioral endocrinologists are interested in how the general physiological effects of hormones alter the development and expression of behavior and how behavior may influence the effects of hormones. This module describes, both phenomenologically and functionally, how hormones affect behavior.

2.6 TERMINAL QUESTIONS AND ANSWERS

Question No.1 What is the Difference between Hormonal and neural Controlled behavior?

Question No.2Explain in detail the Neural controlled behavior.

Question No.3 Explain in detail the Hormonal Controlled behavior.

Question no.4 Write a short note on Motivational and emotional controlled behavior.

2.7 REFERENCES

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UNIT 3: DEVELOPMENTAL BEHAVIOR

CONTENT

3.1 Objectives

3.2 Introduction

3.3 Genetic components

3.4 Environmental components

3.5 Summary

3.6 Terminal Questions and Answers

3.1 OBJECTIVES

In this topic you learn about the Developmental behavior of Animal and the Genetic components of Developmental behavior & Environmental components of Developmental behavior.

3.2 INTRODUCTION

The development of animal behaviour, therefore, involves many factors. Animals are subject to a series of permanent and constant changes, which are the result of continuous interactions between phenotype, genotype and environment, and which will modify and shape the behaviour of individuals. It has been shown that patterns and models of animal behaviour depend to a large extent on genes. However, genetics is not the only driver of individual behaviour. Patterns can undergo multiple modifications and transformations depending on the environment.The development of animal behaviour, therefore, involve many factors.Animals are subject to a series of permanent and constant changes, which are the result of continuous interactions between phenotype, genotype and environment, and which will modify and shape the behaviour of individuals. These interactions can be considered as highly predictable processes, especially in the earliest stages of an organism's development.

3.3 GENETIC COMPONENTS

Genes, via their influences on morphology and physiology, creates a framework within which the environment acts to shape the behavior of an individual animal. The environment can affect morphological and physiological development; in turn behavior develops as a result of that animal's shape and internal workings.

Genetic characteristics are those that are to a large extent determined by genes. Although genes may play a role in many behaviors, they never determine them. There are no genes that directly code for a behavior - genes only code for proteins. However, it is clear that a change in a single protein can cause a host of downstream effects and may even bring about a distinct phenotype. The external environment exerts a strong influence on how all genes are expressed in behavior via a development of nervous and hormonal mechanisms. The **Phenotype** (i.e., the observable

characteristics of an organism) emerges from an interaction of its **Genotype** (i.e., the organism's genetic composition) with environmental factors. A **Gene** is the smallest functional unit of heredity and is composed of DNA. It specifies the codes for amino acid chains that make up individual proteins (e.g., serum albumin). A **Locus** is a section on a chromosome that relates in a meaningful way to a function. **Monomorphic** loci are loci with a single common segment of code, and which is present in 95-99% of individuals. In contrast, **polymorphic** loci exist in form of two or more **alleles** (i.e., versions of the same position of the chromosome) with a combined frequency>0.05. Diploid organisms carry two copies of each gene, one derived from each parent. **Homozygous** is the condition in which both of these copies for that gene are identical (i.e., the same allele). If the chromosomes contain two different alleles of the gene, it is called **heterozygous**. In some cases the phenotype of heterozygous individuals follows one allele (i.e., the **dominant** one) and not the other (i.e., the **recessive** allele). Recessive phenotypes will only be expressed in cases where the individual is homozygous for that allele. If one gene pattern is well established and common in a particular organism, it is referred to as the **wild type** allele. In contrast, a **mutant** allele usually represents a relatively new and less common modification.

CLASSICAL GENETICS

Classical (or Mendelian) genetics examines the distribution of hereditary characteristics of behaviors from one generation to the next. With selective breeding, the presence/absence of specific behaviors can be tracked through the outcomes of sexual reproduction. From such work came the realization that genes existed, that individuals are diploid with one half of the genes contributed by each parents, and that some genes dominate the phenotype over others. The genetics of many diseases follows simple Mendelian rules while examples of behavior in this category are generally few. Rather than in a small number of discrete states, most morphological/behavioral traits (body size, intelligence, boldness) occur across a continuous phenotypic range.

Hygienic bees: Hygienic behavior in honey bees involves the ability to detect and remove diseased, larval and pupal brood from the nest before the pathogen becomes infectious. Forming a mechanism of resistance to bee diseases and parasitic mites, it consists of two distinct task-components: uncapping a cells and removing its content. Rothenbuhler (1964) suggested that these two traits were controlled in a simple Mendelian manner by two recessive loci. More recent

molecular evidence from **quantitative trait loci** (QTL) linkage mapping has identified multiple specific stretches of DNA with genes that underly variation in this trait. This work suggests that the genetic basis of hygienic behavior is considerably more complex, and that seven QTLs are associated with hygienic behavior, each controlling only 9-15% of the observed phenotypic variance.

DEVELOPMENTAL GENETICS

Developmental genetics explores how genetics interfaces with ontogenetic processes in behavior. Genetics plays an integral role in the control of cell growth and differentiation, formation of tissues, organs and hormone systems, as well as in the emergence and critical timing of learning opportunities, cognitive abilities, and emotional systems.

Microarray technology is able to characterize levels of activity for many genes simultaneously. This technique measures how many copies of different mRNAs are made when genes are turned on.

EPIGENETICS

Epigenetics refers to changes in behavior as a result of alterations in gene expression, rather than changes in the nucleotide sequence itself. Modifications over an individual's lifespan, such as **DNA methylation**, acetylation, and changes in histones, alter the way in which specific genes are expressed. DNA methylation is a large contributor to epigenetic changes and gene expression. When methylation occurs in the promoter region of the genome sequence, the gene transcription is repressed, turning off that particular gene. Causing different responses to their surrounding environment, these changes may be heritable. Morphological differences in identical twins result when two distinct copies of the same genome diverge as different paths and experiences modify the expression of the basic genetic blueprint, and resulting in differences in morphological traits, personalities, and behavioral responses. While '''Behavioral Genetics''' considers observable inter-individual differences in behavior due to genotype, '''Behavioral Epigenetics''' bridges genetic mechanisms to the significance of environmental impacts.

3.4 ENVIRONMENTAL COMPONENTS

The physical environment provides young animals with expectations for behavior. When educators are mindful of the aesthetics, organization, and function of each area in the space, challenging behavior is likely to decrease while constructive, cooperative behavior increases.

A program's vision for learning and philosophy of care dictate how an environment is designed. For example, if the curriculum is based on the view that children are competent directors of their own learning, educators develop a physical setting and activities that reflect children's emerging interests and provide easy access to meaningful play materials. Shelves for manipulative and other materials are near the floor where children can easily reach them. Special areas in the room are designed for individual, small-group, and larger-group interactions. Play materials and other materials are carefully selected to reflect children's emerging interests, as observed in the context of play and conversation. In this environment, adult-child interactions can expand children's questions and comments.

High-quality learning environments set the stage for social-emotional exploration and growth. When children are presented with a warm, inviting, and culturally familiar environment, they feel comfortable and secure. The attractive spaces adults prepare for children communicate expectations of responsibility and cooperative care (we all play in and care for this beautiful place together).

Preparing a variety of learning areas with open-ended materials encourages each child to participate in meaningful play experiences that match their individual temperaments and abilities. Incorporating elements from the home creates an atmosphere of community while simultaneously acknowledging the presence of individuals.

A physical environment that supports social-emotional learning has the following characteristics:

- Challenging and developmentally appropriate materials
- Ample supply of materials
- Appropriately sized small-group activities
- A variety of small-group activities within a range of adult supervision

- Aesthetically appealing
- Spaces to be with others *and* spaces to be alone
- Furnishings and materials accessible to children
- Displays of children's work
- Space for children's belongings
- Reflective of diversity
- Space for arrivals and departures
- Supportive of children's active engagement
- Outdoor areas supportive of social-emotional development

3.5 SUMMARY

Animal Behavior is the scientific study of the wild and wonderful ways in which animals interact with each other, with other living beings, and with the environment. It explores how animals relate to their physical environment as well as to other organisms, and includes topics such as how animals find and defend resources, avoid predators, choose mates, reproduce, and care for their young-ones.

Previous lesser definitions of Animal Behavior include:

- "Behavior is motion". "Movement, not necessarily movement of the whole animal... muscular contractions" or "The whole function of the nervous system can be summed up in one word, conduction." In Sherrington's view, the basic elements of behavior were formed in a reflex-arc, where receptor organs receive sensory stimuli and are conducted to an effector organ. This highly reductionist position has received criticism from many angles, specifically, from arguments that it fails to account for spontaneous behaviors, behaviors that are characterized by a lack of motion, as well as disregarding the complexity of emergent properties in behavior.
- "What a plant or animal does, in the course of an individual's lifetime, in response to some event or change in its environment." This definition reduces behavior to phenotypic plasticity and is thus not specific enough.

- "Behavior is all observable or otherwise measurable muscular and secretory responses (or lack thereof) and related phenomena in response to changes in an animal's internal or external environment." Behavior may include components which do not lend themselves to simple quantification.
- "Behavior is characterized by entropic and energetic transductions by an organism, in which the long-term averages convert high entropic and low energetic sensory inputs into low entropic and high energetic outputs."

3.5 TERMINAL QUESTIONS AND ANSWERS

Question no.1 What are the different environmental component of developmental behavior?

Question no.2 What are the different Genetic component of developmental behavior?

Question no.3 What do you understand by the developmental genetics?

Question no.4 What do you understand by the classical genetics?

3.6 REFERENCES

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UNIT 4: COMMUNICATION

CONTENT

4.1 Objectives

4.2 Introduction

4.3 Chemical

4.4 Visual

4.5 Light

4.6 Audio

4.7 Specific specificity of Songs

4.8 Evolution of Language (primates)

4.9 Summary

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4.11 References

4.1 OBJECTIVES

In this topic you will learn about the communication behavior of the animal (Transfer of information from a signaler to a receiver) and specific specificity of Songs Evolution of Language (primates).

4.2 INTRODUCTION

Animals communicate with each other **using stimuli known as signals**. These signals are chemical (pheromones), aural (sound), visual (courtship and aggressive displays), or tactile (touch). These types of communication may be instinctual, learned, or a combination of both.

Animal communication is the transfer of information from one or a group of animals (sender or senders) to one or more other animals (receiver or receivers) that affect the current or future behavior of the receivers. Information may be sent intentionally, as in a courtship display, or unintentionally, as in the transfer of scent from predator to prey. Information may be transferred to an "audience" of several receivers. Animal communication is a rapidly growing area of study in disciplines including animal behavior, sociology, neurology and animal cognition. Many aspects of animal behavior, such as symbolic name use, emotional expression, learning and sexual behavior, are being understood in new ways.

When the information from the sender changes the behavior of a receiver, the information is referred to as a "signal". Signaling theory predicts that for a signal to be maintained in the population, both the sender and receiver should usually receive some benefit from the interaction. Signal production by senders and the perception and subsequent response of receivers are thought to coevolve. Signals often involve multiple mechanisms, e.g. both visual and auditory, and for a signal to be understood the coordinated behaviour of both sender and receiver require careful study.

4.3 CHEMICAL

Despite being the oldest method of communication, chemical communication is one of the least understood forms due in part to the sheer abundance of chemicals in our environment and the difficulty of detecting and measuring all the chemicals in a sample. The ability to detect chemicals in the environment serves many functions, a crucial one being the detection of food, a function that first arose in single-celled organisms (bacteria) living in the oceans during the early days of life on Earth as this function evolved, organisms began to differentiate between chemicals compounds emanating from resources, conspecifics (same species; i.e., mates and kin), and heterospecifics (different species; i.e., competitors and predators).

For instance, a small minnow species may do well to avoid habitat with a detectable concentration of chemical cue associated with a predator species such as northern pike. Minnows with the ability to perceive the presence of predators before they are close enough to be seen and then respond with adaptive behavior (such as hiding) are more likely to survive and reproduce. Atlantic salmon go a step further than detecting a predator's cue: when an individual is damaged by a predator, it releases a chemical cue to its conspecifics as also been observed in other species, acidification and changes in pH physically disrupt these chemical cues, which have various implications for behavior. Scent and scent rubbing are common forms of olfactory communication in mammals. An example of scent rubbing by an animal can be seen from bears, bears do this as a way to mark territory or let others know they are there and to stay away

4.4 VISUAL

Gestures: Most animals understand communication through a visual display of distinctive body parts or bodily movements. Animals will reveal or accentuate a body part to relay certain information. The parent herring gull displays its bright yellow bill on the ground next over its chick when it has returned to the nest with food. The chicks exhibit a begging response by tapping the red spot on the lower mandible of the parent herring gull's bill. This signal stimulates the parent to regurgitate food and completes the feeding signal. The distinctive morphological feature accentuated in this communication is the parent's red-spotted bill, while the tapping towards the ground makes the red spot visible to the chick, demonstrating a distinctive

movement. Frans de Waal studied bonobos and chimps to understand if language was somehow evolved by gestures. He found that both apes and humans only use intentional gestures to communicate.

Facial expression: Another important signal of emotion in animal communication are facial gestures. Blue and Yellow Macaws were studied to understand how they reacted to interactions with a familiar animal care taker. Studies show that Blue and Yellow Macaws demonstrated a significant amount of blushing frequently during mutual interactions with a caretaker. In another experiment, Jeffrey Mogil studied facial expression in mice in response to increments of increasing pain. He found that mice exhibited five recognizable face expressions: orbital tightening, nose and cheek bulge, and changes in ear and whisker carriage.

Gaze-following: Social animals, both human and nonhuman, use gaze-following as a form of communication through monitoring head and eye orientation in other mammals. Studies have been conducted on apes, monkeys, dogs, birds, wolves and tortoises, and have focused on two different tasks: "following another's gaze into distant space" and "following another's gaze geometrically around a visual barrier e.g. by repositioning themselves to follow a gaze cue when faced with a barrier blocking their view". A broad range of animals have been proven to exhibit the latter, however only apes, dogs, wolves, and corvids (ravens) have been able to follow another's gaze into distant space. Marmosets and ibis were unable to demonstrate "geometric gaze following". Researchers do not yet have a clear picture of the cognitive basis of gaze following, but developmental evidence indicates that "simple" gaze following and "geometric" gaze following probably rely on different cognitive mechanisms.

Color change: Color change can be separated into changes that occur during growth and development, and those triggered by mood, social context, or abiotic factors such as temperature. The latter are seen in many taxa. Some cephalopods, such as the octopus and the cuttlefish, have specialized skin cells (chromatophores) that can change the apparent colour, opacity, and reflectiveness of their skin. In addition to their use for camouflage, rapid changes in skin color are used while hunting and in courtship rituals.[11] Cuttlefish may display two entirely different signals simultaneously from opposite sides of their body. When a male cuttlefish courts a female in the presence of other males, he displays a male pattern facing the female and a female pattern

facing away, to deceive other males. Some color signals occur in cycles. For example, when a female olive baboon begins to ovulate, her anogenital area swells and turns a bright red/pink. This signals to males that she is ready to mate. Humboldt squid are bioluminescent and thus capable of communicating visually in dark ocean environment.

Bioluminescent communication: Communication by the production of light occurs commonly in vertebrates and invertebrates in the oceans, particularly at depths (e.g. angler fish). Two well known forms of land bioluminescence occur in fireflies and glow worms. Other insects, insect larvae, annelids, arachnids and even species of fungi possess bioluminescent abilities. Some bioluminescent animals produce the light themselves whereas others have a symbiotic relationship with bioluminescent bacteria Animals exhibit bioluminescent light to lure in prey, attract a mate, or protect themselves from potential predators.

4.5 LIGHT

So cameras equipped with circular polarizing sensors may detect cancer cells long before the human eye can see them. Another study involving Professor Marshall, published in the same edition of Current Biology, showed that linear polarized light is used as a form of communication by fiddler crabs.

Light that is produced by a living organism's body is called bioluminescence (say: by-oh-loo-muh-nes-ens). Depending on the species, they may use their glow to attract prey, warn off other animals, scare predators, or to communicate with each other.

4.6 AUDIO

Many animals communicate through vocalization. Vocal communication serves many purposes, including mating rituals, warning calls, conveying location of food sources, and social learning. In a number of species, males perform calls during mating rituals as a form of competition against other males and to signal females. Examples include frogs, hammer-headed bats, red deer, humpback whales, elephant seals, and songbirds. Other instances of vocal communication include the alarm calls of the monkey, the territorial calls of gibbons, and the use of frequency in greater spear-nosed bats to distinguish between groups. The vervet monkey gives a distinct alarm call for

each of its four different predators, and the reactions of other monkeys vary appropriately according to the call. For example, if an alarm call signals a python, the monkeys climb into the trees, whereas the "eagle" alarm causes monkeys to seek a hiding place on the ground. Prairie dogs also use complex calls that signal predator differences.

Not all animals use vocalization as a means of auditory communication. Many arthropods rub specialized body parts together to produce sound. This is known as stridulation. Crickets and grasshoppers are well known for this, but many others use stridulation as well, including crustaceans, spiders, scorpions, wasps, ants, beetles, butterflies, moths, millipedes, and centipedes. Another means of auditory communication is the vibration of swim bladders in bony fish. The structure of swim bladders and the attached sonic muscles varies greatly across bony fish families, resulting in a wide variety of sounds. Striking body parts together can also produce auditory signals. A well-known example of this is the tail tip vibration of rattlesnakes as a warning signal. Other examples include bill clacking in birds, wing clapping in manakin courtship displays, and chest beating in gorillas

Burrowing animal's species are known to whistle to communicate threats, and sometimes mood. Species such as the marmot species including the groundhog (woodchuck) the alpine marmot show this trait. Whistling is used by animals such as prairie dogs to communicate threats, with prairie dogs having one the most complex communication systems in the animal kingdom. Prairie dogs are able to communicate an animal's speed, shape, size, species, and for humans specific attire and if the human is carrying a gun. This method of communication is usually done by having a sentry stand on two feet surveying for potential threats while the rest of the pack finds food. Once a threat has been identified the sentry sounds a whistle alarm, (sometimes describing the threat) at which point the pack retreats to their burrows. The intensity of the threat is usually determined by how long the sentry whistles. The sentry continues to whistle the alarm until the entirety of the pack has gone to safety at which point the sentry returns to the burrow.

4.7 SPECIFIC SPECIFICITY OF SONGS

Animal song is not a well-defined term in scientific literature, and the use of the more broadly defined term 'vocalizations' is in more common use. Song generally consists of several successive vocal sounds incorporating multiple syllables. Some sources distinguish between simpler

vocalizations, termed “calls”, reserving the term “song” for more complex productions. Song-like productions have been identified in several groups of animals, including cetaceans (whales and dolphins), avian (birds), anurans (frogs), and humans. Social transmission of song has been found in groups including birds and cetaceans.

Functions of vocalizations

Vocalizations can play a wide variety of different roles. In groups such as anurans and birds, several distinct types of notes are incorporated to form songs, which are sung in different situations and serve distinct functions. For example, many frogs may use trilling notes in mate attraction, but switch to different vocal patterns in aggressive territorial displays. In some species, a single song incorporates several note types which serve different purposes, with one type of note eliciting responses from females, and another note of the same song responsible for warning competitor males of aggression.

Mating and courtship

Vocalizations play an important role in the mating behaviour of many animals. In many groups (birds, frogs, crickets, whales etc.), song production is more common in males of the species, and is often used to attract females.

Bird song is thought to have evolved through sexual selection. Female songbirds often assess potential mates using song, based on qualities such as high song output, complexity and difficulty of songs, as well as presence of local dialect. Song output serves as a fitness indicator of males, since vocalizations require both energy and time to produce, and thus males capable of producing high song output for long durations may have higher fitness than less vocal males. It is thought that song complexity may serve as an indicator of male fitness by providing an indication of successful brain development despite potential early-life stressors, such as lack of food. Social transmission of songs allows for development of local dialects of song, and female songbirds also typically prefer to choose mates producing local song dialects. One hypothesis for this phenomenon is that selecting local mates allows the female to choose genes specially adapted to suit local conditions.

Frog song also plays a prominent role in courtship. In tungara frogs (*Engystomops pustulosus*), male frogs increase the complexity of their calls, adding additional note types when greater numbers of competitor males are present, which has been found to attract greater numbers of female frogs. Some species change their courtship calls when females are especially nearby. In male glass frogs (*Hyalinobatachium fleichmanni*), a long frequency-modulated vocalization is produced upon noticing another nearby frog, but is changed to a short chirping song when a female approaches.Several species (e.g. dendrobatid frogs (*Mannophryne trinitatis*), ornate frogs (*Cophixalus ornatus*), splendid poison frogs (*Dendrobates speciosus*)), switch from long-range loud trilling sounds to short-range quieter chirps when females move closer, which is thought to allow mate attraction without alerting competitor males to female locations.

Although highly complex song-like production has been identified in whales, the function is still somewhat elusive. It is thought to be involved in courtship behaviour and sexual selection, and singing behaviour becomes more common during the breeding season.

Aggression and territorial defense

Another major function of song output is to indicate aggression among males during breeding seasons. Both anurans and birds use singing in territorial displays to confer aggressive intent. For Eastern smooth frogs (*Geocrinia victoriana*), for example, courtship songs involve shorter notes to attract potential mates, and are followed by longer tones to repel males.Frequency of sounds produced generally negatively correlates with body size both within and among species, and allows competing males to assess body size of vocalizing neighbouring frogs. Male frogs typically approach higher frequency sounds more readily than lower frequencies, likely because the frog producing the sound is assessed to be a smaller, less dangerous competitor.

In territorial birds, males increase song production rate when neighbouring males encroach on their territory. In great tits (*Parus major*), nightingales (*Luscinia megarhynchos*), blackbirds (*Turdus merula*) and sparrows (family Passeridae), playing song recordings slows the rate at which males establish territories in an unoccupied region, suggesting these birds rely on song output in establishing territorial boundaries.Experimentally muted Scott's seaside sparrow

(*Ammodramus maritimus*) lose control of their territories to other males. Thus, territorial birds often rely on song production to repel conspecific males.

Individual recognition

Like the human voice, bird song typically contains sufficient individual variability to allow discrimination of individual vocal patterns by conspecifics. Such discrimination is important to mate recognition of many monogamous species. Seabirds, for example, often use vocalization patterns to recognize their mate upon reunion during the breeding season.In many colonial nesting birds, parent-offspring recognition is critical to allow parents to locate their own offspring upon return to nesting sites. Cliff swallows (*Petrochelidon pyrrhonota*) have been demonstrated to preferentially respond to parental songs at a young age, providing a means of vocalization-based offspring recognition.

4.8 EVOLUTION OF LANGUAGE (PRIMATES)

Animal languages are forms of non-human animal communication that show similarities to human language. Animals communicate by using a variety of signs such as sounds or movements. Such signing may be considered complex enough to be called a form of language if the inventory of signs is large, the signs are relatively arbitrary, and the animals seem to produce them with a degree of volition (as opposed to relatively automatic conditioned behaviors or unconditioned instincts, usually including facial expressions). In experimental tests, animal communication may also be evidenced through the use of lexigrams (as used by chimpanzees and bonobos).

Many researchers argue that animal communication lacks a key aspect of human language, that is, the creation of new patterns of signs under varied circumstances. (In contrast, for example, humans routinely produce entirely new combinations of words.) Some researchers, including the linguist Charles Hockett, argue that human language and animal communication differ so much that the underlying principles are unrelated.

Primate:

Humans are able to distinguish real words from fake words based on the phonological order of the word itself. In a 2013 study, baboons have been shown to have this skill, as well. The discovery has led researchers to believe that reading is not as advanced a skill as previously believed, but instead based on the ability to recognize and distinguish letters from one another. The experimental setup consisted of six young adult baboons, and results were measured by allowing the animals to use a touch screen and selecting whether or not the displayed word was indeed a real word, or a nonword such as "dran" or "telk." The study lasted for six weeks, with approximately 50,000 tests completed in that time. The experimenters explain the use of bigrams, which are combinations of two (usually different) letters. They tell us that the bigrams used in nonwords are rare, while the bigrams used in real words are more common. Further studies will attempt to teach baboons how to use an artificial alphabet.

4.9 SUMMARY

Animals communicate **using signals, which can include visual; auditory, or sound-based; chemical, involving pheromones; or tactile, touch-based, cues**. Communication behaviors can help animals find mates, establish dominance, defend territory, coordinate group behavior, and care for young.

Animal communication, process by which one animal provides information that other animals can incorporate into their decision making. The vehicle for the provision of this information is called a signal. The signal may be a sound, colour pattern, posture, movement, electrical discharge, touch, release of an odorant, or some combination of these mediums.

Animals face daily decisions about how to behave. Choices can be as simple as a sea anemone deciding when to expand its tentacles or as complex as a male lion deciding whether to approach a reluctant mate. The decision, which may be reflexive or conscious, is guided by evolutionary biases based on alternative outcomes of choice, recent experience about likely conditions, and sensory information. An animal with access to complete information can always choose correctly. However, life is rarely so accommodating, and inputs often fail to provide complete information. Thus, communication is an important source of additional information that is incorporated into the decision-making process.

4.10 TERMINAL QUESTIONS AND ANSWERS

Question No.1 What do you understand by the animal communication. Explain in detail?

Question No.2 What are the different function of vocalization, explain in detail?

Question No.3What is differences between visual and chemical communication?

Question No.4 What is the difference between light and audio communication?

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UNIT 5: ECOLOGICAL ASPECT OF BEHAVIOR

5.1 Objectives

5.2 Introduction

5.3 Habitat selection

5.4 Food selection

5.5 Optimal forage theory

5.6 Anti predation defenses

5.7 Aggression

5.8 Homing

5.9 Territoriality

5.10 Dispersal

5.11 Host parasite relations

5.12 Summary

5.13 Terminal Questions and Answers

5.1 OBJECTIVES

In this topic you will learn about different Ecological aspect of animal behavior like Habitat selection, Food selection, Optimal forage theory, Anti predation defenses, Aggression, Homing, Territoriality, Dispersal, Host parasite relations etc.

5.2 INTRODUCTION

Behavioral ecology, also spelled **behavioural ecology**, is the study of the evolutionary basis for animal behavior due to ecological pressures. Behavioral ecology emerged from ethology after Niko Tinbergen outlined four questions to address when studying animal behaviors: What are the proximate causes, ontogeny, survival value, and phylogeny of a behavior?

If an organism has a trait that provides a selective advantage (i.e., has adaptive significance) in its environment, then natural selection favors it. Adaptive significance refers to the expression of a trait that affects fitness, measured by an individual's reproductive success. Adaptive traits are those that produce more copies of the individual's genes in future generations. Maladaptive traits are those that leave fewer. For example, if a bird that can call more loudly attracts more mates, then a loud call is an adaptive trait for that species because a louder bird mates more frequently than less loud birds—thus sending more loud-calling genes into future generations. Conversely, loud calling birds may attract the attention of predators more often, decreasing their presence in the gene pool.

Individuals are always in competition with others for limited resources, including food, territories, and mates. Conflict occurs between predators and prey, between rivals for mates, between siblings, mates, and even between parents and offspring.

5.3 HABITAT SELECTION

Habitat selection refers to the set of rules individuals use to choose among patches that differ in some way. The outcome of habitat selection is the spatial distribution of populations. The ideal free distribution (IFD) models habitat use when individuals have perfect information about relative fitness payoffs and can move freely. Later models incorporate different forms of

competition and other influences on fitness into the IFD and related models. How these rules shape populations and communities can also be determined through curves that specify when to be selective (isolegs) and which habitat to use (isodars).

Habitat selection is the process by which organisms actively select habitats (natural environment) to live. Eg. Mayfly nymphs inhabit the underside of stones in fast-flowing streams and burrow in sediments in still water.

Habitat is the natural environment where an animal usually lives. Habitat provides shelter; food, protection, mates and space for breeding, feeding, resting, roosting, courtship, grooming, sleeping, etc. Rich habitats give higher fitness" to the organisms living there. Poor habitats give lower fitness.

The quality of the habitat consists of the following variables:

➢ Food availability

➢ Predator occurrence

➢ Ease of defense

➢ Likelihood of offspring survival

➢ Microclimate changes

➢ Distance to human settlements.

Habitats are heterogeneous. There are many factors that are involved in the organism's choice of habitat. Animals must be able to tolerate two kinds of factors in the habitat, namely:

1. Abiotic factors

2. Biotic factors

Abiotic factors are non-biological factor:

Abiotic factors include temperature, humidity, salinity and pH. Biotic factors include competition, predation and disease. If both abiotic and biotic factors can be tolerated, the animal

able to find the resources that it needs to survive. Habitat selection is a hierarchical process. Habitat selection is generated by foraging decisions. Foraging is the only process of driving habitat selection.

Heredity and experience play a role in determining selection It involves a series of innate and learned behavioural decisions made by an animal. It is an active behavioural process that may vary across spatial and temporal scales. It is more complex.

A species actively prefers or avoids certain types of habitat Evaluation of habitat selection is a hierarchical process coined by Johnson in 1980. It may result in the disproportionate use of habitats to influence survival and fitness of individuals. Habitat may be selected for the following purposes: Cover availability Forage quality and quantity. Resting or denning sites. Each of these may vary seasonally. If an individual or species demonstrates disproportional use of any factor, then selection is inferred for those criteria. Hilden structured his ideas on habitat selection by categorizing the differences between proximate and ultimate factors.

5.4 FOOD SELECTION

Food selection is the ability of animals to select the beneficial food. Food is a source of energy. Food is required for movement, migration, courtship, performing various activities etc. All animals select specific food in their natural habitat. Food selection implies food ingestion. Food ingestion implies the presence of food.

Food selection includes food search process. The food search process is searching images and mechanisms for finding appropriate food stimuli in the environment.

Honey bees have highly developed food search system. Food selection also implies the ability to capture food and to assimilate it. Food ingestion depends on an internal state indicating a need for the particular food. It also depends on the recognition of the potential food as the required food. Omnivores, such as rats and humans, face with an enormous number of potential foods. They are always cautious of eating something harmful or eating too much of a good thing.

Types:

- ❖ Carnivores
- ❖ Scavengers
- ❖ Herbivores
- ❖ Saprophytes
- ❖ Omnivores

Frugivores eat mainly fruit.Browsers eat mostly leaves. Animals that eat mostly grass are grazing animals. Eg. Goat, elephant, cows, horses, deer, rhinoceros, wildebeest, monkey, sheep, rabbit, panda, koala, etc.

3. Omnivores

An omnivore is an animal that eats both plants and animals. The food may include eggs, insects, fungi and algae. Many omnivores are opportunistic feeders. Eg. Cassowary, chickens, crows, rooks, emus, hummingbirds, ostriches, robins.

4. Scavengers

A scavenger is an organism that mostly consumes decaying biomass, such as meat or rotting plant material. Many scavengers are carnivores.

5.5 OPTIMAL FORAGE THEORY

Optimal foraging theory (OFT) is a model that helps to predict an animal behaves when searching for food. Optimal foraging theory was first formulated by Robert MacArthur, JMEnilen and Eric Pianka in 1966. It is an ecological application of the optimality model. Optimal foraging illustrates that the organisms forage in such a way to maximize their net energy intake per unit time. Although the animal obtains energy from the food, searching for and

capturing the food require both energy and time. This theory is based on a number of assumptions. This theory assumes that the most economically advantageous foraging pattern will be selected by a species through natural selection. The theory was devised in an attempt to explain, why animals often restrict themselves to a few preferred food types, even though there is an availability of wide ranges of food. The prediction is that an animal strikes a balance between two contrasting strategies: Predators are categorized into two types, namely:

1. Searching predator

2. Sit-and-wait predator

Assumptions behind optimal foraging theory are as given during foraging.
1. There should be a heritable component of foraging behavior
2. The relationship between foraging behaviour and fitness is known.
3. Evolution of foraging behaviour is subject to functional not prevented by genetic
4. Evolution of foraging behaviour is subject to " functional', stants that have been realistically determined.

1. Searching Predator

A searching predator moves throughout its habitat and finds its Searching predators encounter and consume non-movingprey populatim The prey density must be low. The predator's energy requirements must be high.

2. Sit-and-wait Predator

A sit-and-wait predator waits for its prey to come close to its point of observation. It mostly relies on moving preys or that have high prey mobility. The prey density must be relatively high. The predator's energy requirements must be low. The sit-and-wait foraging mode is less common during periods of prey scarcity.

Building an Optimal Foraging Model An optimal foraging model generates quantitative predictions of how, animals maximize their fitness while they forage. The model building process involves identifying the following factors:

1. Currency
2. Constraints
3. Optimal decision rule

1. Currency is defined as the net energy gain that is optimized by the animal per unit time.

2. Constraints are hypotheses about the limitations that are placed on an animal. It can be due to features of the environment or plassilogy of the animal. Feeding Systems and Classes of Predators Optimal foraging theory is applicable tofeeding systems throughout the animal kingdom. The optimization of these different foraging and predation strategies can be explained by the optimal foraging theory. There are different classes of predators. They are the following:

1. True predators attack large numbers of prey throughout their life.

They kill their prey either immediately or shortly after the attack.

• They may eat all or only part of their prey.

• It includes tigers, lions, whales, sharks, seed-eating birds, ants and humans.

2. Grazers eat only a portion of their prey. They harm the prey, but rarely kill it. It includes antelope, cattle and mosquitoes.

3. Parasites eat only a part of their prey (host), but rarely the entire organism.

5.6 ANTI PREDATION DEFENSES

Ant predator defence is the behaviour which provides protection the prey against the predator. Defenses are the acts of animals that reduce the chances of it being harmed by another animal. Animals have a wide range of defences against predators. Defense mechanisms are very important in the life of all animals. The most common system of defence is adaptation against predators. Animals may also have defences against parasites and other members their own species. Defence against predators is of two types, namely:

1. Primary defences

2. Secondary defences

Primary Defences

Primary defences are the protective mechanisms found in prey animals,which operate before a predator starts to catch the prey It is also a defense mechanism which operates, whether a predator is nearby or not. It reduces the probability that a predator.
It reduces the probability that a predator will encounter the prey. It includes the following methods:

- Hiding away
- Mimicry
- Crypsis
- Warning sounds
- Warning colouration
- Mimesis

Hiding away is the primary defense mechanism, in which prey animals stay out of the sight of predator. Animals hide themselves by living in holes or crevices, ground or by being nocturnal. Nocturnality is an animal behaviour, in which an animal is active only during night and sleeps during day time.

This is a behavioral form of detection avoidance. They cannot be seen unless the predator searches carefully by animals. The hidden animal however has to come out into the open from their hidden place, but while hidden, it is relatively safe. E.g. Fruit bats forage during night, evening time emergence in echoloc bats, kangaroo rats exhibit moonlight avoidance to avoid predators. Crypsis is the ability of a prey animal to conceal itself from its predator by having a

colour, pattern and shape that allows, it to blend to its surroundings. It is also called cryptic coloration.

It is a tactic that organisms use to disguise their appearance Mimicry is the close external resemble mimic, to some different organism, the model. It is the similarity of one species to an odler which one It is a situation in which one species called the mimic, resembles in colour, form and behaviour of another species, called the rnodel The model and the mimic are not always closely related.

5.7 AGGRESSION

Aggression sometimes occurs when parents defend their young from attack by members of their own species. Female mice, for example, defend their pups against hostile neighbours, while male stickleback fish defend eggs and fry against cannibalistic attack. More frequently, however, animals fight over resources such as food and shelter e.g., vultures fight over access to carcasses, and hermit crabs fight over empty shells. Another important resource over which fighting commonly occurs is potential mates. In this case the biology of gamete production has an influence on aggressive behaviour: because a female's eggs are larger, are fewer in number, and require more energy to produce than a male's sperm, competition among males over females is usually more frequent and intense than competition among females over males. As a result, the most spectacular fights among animals, whether they are crickets, salmon, tree frogs, chaffinches, or stags, occur between males over fertile females.

Aggressive behaviour, animal behaviour that involves actual or potential harm to another animal. Biologists commonly distinguish between two types of aggressive behaviour: predatory or antipredatory aggression, in which animals prey upon or defend themselves from other animals of different species, and intraspecific aggression, in which animals attack members of their own species. Intraspecific aggression is widespread across the animal kingdom, being seen in creatures as diverse as sea anemones, rag worms, wolf spiders, field crickets, lobsters, salmon, tree frogs, lizards, songbirds, rats, and chimpanzees.

5.8 HOMING

Homing, ability of certain animals to return to a given place when displaced from it, often over great distances. The major navigational clues used by homing animals seem to be the same as those used in migration (Sun angle, star patterns, Earth's magnetic field, etc.), but homing may occur in any compass direction and at any season. Most of the best-known examples of strong homing ability are among birds, particularly racing, or homing, pigeons. Many other birds, especially seabirds and also swallows, are known to have equal or better homing abilities. A Manx shearwater (Puffinus puffinus), transported in a closed container to a point about 5,500 km (3,400 miles) from its nest, returned to the nest in 12 1/2 days. Non-avian animals that have homing abilities include some species of reptiles and fishes. When female loggerhead sea turtles (Caretta caretta) emerge from their shells, they imprint on the unique magnetic field signature of the beach on which they hatched and can navigate back to it as adults to lay eggs of their own. In addition, experimental studies have shown that several species of salmon can navigate back to their spawning streams by using their olfactory senses to find the unique chemical signature of the waterway, and juvenile sockeye salmon (Oncorhynchus nerka), like loggerhead sea turtles, also appear to navigate using magnetic fields, from the ocean back to their spawning streams

5.9 TERRITORIALITY

Territorial behaviour, in zoology, the methods by which an animal, or group of animals, protects its territory from incursions by others of its species. Territorial boundaries may be marked by sounds such as bird song, or scents such as pheromones secreted by the skin glands of many mammals. If such advertisement does not discourage intruders, chases and fighting follow.

Territorial behavior is adaptive in many ways; it may permit an animal to mate without interruption or to raise its young in an area where there will be little competition for food. It can also prevent overcrowding by maintaining an optimum distance among members of a population. Territories may be seasonal; in many songbirds the mated pair defends the nest and feeding area until after the young are fledged. In communally nesting birds such as gulls, the territory may simply consist of the nest itself.

Wolf packs maintain territories in which they hunt and live. These areas are aggressively defended from all non-pack members. The male cougar has a large territory that may overlap the territories of several females but is defended against other males. Responding to scent marks, the inhabitants of the overlapping ranges also avoid each other, except for breeding.

5.10 DISPERSAL

Biological dispersal refers to both the movement of individuals (animals, plants, fungi, bacteria, etc.) from their birth site to their breeding site ('natal dispersal'), as well as the movement from one breeding site to another ('breeding dispersal'). Dispersal is also used to describe the movement of propagules such as seeds and spores. Technically, dispersal is defined as any movement that has the potential to lead to gene flow. The act of dispersal involves three phases: departure, transfer, settlement and there are different fitness costs and benefits associated with each of these phases. Through simply moving from one habitat patch to another, the dispersal of an individual has consequences not only for individual fitness, but also for population dynamics, population genetics, and species distribution. Understanding dispersal and the consequences both for evolutionary strategies at a species level, and for processes at an ecosystem level, require understanding on the type of dispersal, the dispersal range of a given species, and the dispersal mechanisms involved.

Biological dispersal may be contrasted with geo-dispersal, which is the mixing of previously isolated populations (or whole biotas) following the erosion of geographic barriers to dispersal or gene flow (Lieberman, 2005; Albert and Reis, 2011).

Dispersal can be distinguished from animal migration (typically round-trip seasonal movement), although within the population genetics literature, the terms 'migration' and 'dispersal' are often used interchangeably.

Some organisms are motile throughout their lives, but others are adapted to move or be moved at precise, limited phases of their life cycles. This is commonly called the **dispersive phase** of the life cycle. The strategies of organisms' entire life cycles often are predicated on the nature and circumstances of their dispersive phases.

In general there are two basic types of dispersal:

DENSITY-INDEPENDENT DISPERSAL

Organisms have evolved adaptations for dispersal that take advantage of various forms of kinetic energy occurring naturally in the environment. This is referred to as density independent or passive dispersal and operates on many groups of organisms (some invertebrates, fish, insects and sessile organisms such as plants) that depend on animal vectors, wind, gravity or current for dispersal.

DENSITY-DEPENDENT DISPERSAL

Density dependent or active dispersal for many animals largely depends on factors such as local population size, resource competition, habitat quality, and habitat size. Due to population density, dispersal may relieve pressure for resources in an ecosystem, and competition for these resources may be a selection factor for dispersal mechanisms. Dispersal of organisms is a critical process for understanding both geographic isolation in evolution through gene flow and the broad patterns of current geographic distributions (biogeography).

A distinction is often made between **natal dispersal** where an individual (often a juvenile) moves away from the place it was born, and **breeding dispersal** where an individual (often an adult) moves away from one breeding location to breed elsewhere.

5.11 HOST PARASITE RELATIONS

PARASITOLOGY DEFINED:

Parasitological is defined as the study of parasites and their relationship to their host. It is one of the most fascinating and rewarding phase of biology. This discipline actually involves several approaches to the study of parasitic organisms.

PARASITISM DEFINED:

Parasitism is one of those aspects of biology and in particular ecology, which deals with the relationship of organisms to one another and to their habitat. Parasitism involves an association between animals of different species where one, the host, is indispensable to the other, the parasite; while the host can quite well do without

the parasite. In other words Parasitism is a heterospecific type of an association between two individuals in which one of the partners called parasite is metabolically dependent on another referred to as host.

The relationship may be permanent as in the case of tapeworms found in the intestines of mammals, or temporary, as during the feeding of mosquitoes, leeches, and ticks on their host's blood.

HOST PARASITE RELATIONSHIP INTRODUCTION:

When a parasite gains access to a host, the host has to compromise, and the parasite has to adopt itself in host environment. In this way host and parasite establish a sort of relationship which effects each other's growth, metabolism, etc.

In general the series of events that constitutes the relation of host and parasite may be considered as beginning with the transmission of parasite from one host to another, then follows the distribution and localization of parasite on or within the host, then growth or multiplication of parasite, the resistance of host to the parasite and the parasite to the host. The method of attack of parasite, changes in host brought about by parasite and those in parasite due to residence in host. Host parasite adjustments during the infection, the escape of infective stages of the parasite from the host and then the recovery or death of host.

HOST-PARASITE RELATIONSHIP STRATEGY

In the host-parasite relationship, we can identify two categories of bio-physiological function. These are:

1. Parasite invasiveness which is aimed to obtain entry into the host and continue its life within the host, and
2. Host resistance which tends to prevent the invasion of parasite and its colonization. In a host-parasite relation we can see that both these functions counter each other thereby acting as a check to maintain balance in the host parasite relationship.

- When a parasite is growing and multiplying within or in a host, the host is said to have an infection.

HOST PARASITE RELATIONSHIP DEFINED:

From the definition of parasitism it is clear that it involves 2 partners, a parasite and a host and also that parasitism effects both the partners. Host Parasite relationship is defined as the influence of each partner by the activities of the other. In general the host-parasite relationship can be studied under two heads:

A. EFFECTS ON THE PARASITE

B. EFFECTS ON THE HOST

A. EFFECTS ON THE PARASITE:

Effects of parasite on the host are more obvious than those which operate in the reverse direction, but the later are nonetheless important. The general constitution of the host may profoundly influence the host-parasite relationship. The parasite besides undergoing several modifications called parasitic adaptations to survive in the hostile atmosphere in the host has several specific effects on it as:

1. Effect of nutrition
2. Effect of hormones
3. Effect of age
4. Effect of immunity
5. Effect of host specificity
6. Effect of parasitic density
7. Effect of host sex

1. EFFECT OF NUTRITION:

The kind of nutritive material ingested by parasites effects their development. A diet consisting largely of milk has an adverse effect on intestinal helminths or protozoan fauna, because it lacks p-aminobenzoic acid which is necessary for the parasite growth. A high protein diet has been found to be unfavourable for the development of many intestinal Protozoa. On the other hand, a diet low in protein favours the appearance of symptoms of amoebiasis. It has also been shown

that carbohydrate rich diet favours the development of certain tapeworms. In fact the presence of carbohydrate in the diet is known to be essential for some of the worms.

The nutritional status is of an increased importance both in determining whether or not a particular infection will be accompanied by symptoms and in influencing their severity if present.

Nutritional disturbances may also influence resistance through its effects upon the immune mechanisms of the host.

2. EFFECT OF HORMONES:

Hosts hormones have direct effect on the growth and in many cases sexual maturity of parasites e.g., Ascaridia galli attains greater lengths in hyperthyroid chickens whereas Heterakis gallinae attains greater length in hypothyroid host, the two worms apparently respond differently to the hormone thyroxin. The dog nematode Toxocara canis develops into adult only in the female dogs i.e., bitches, during their pregnancy as hosts sex hormones are necessary for its maturity and growth.

3. EFFECT OF HOST AGE:

Human schistosomes usually infect young persons, and adults over thirty generally do not become infected on exposure. Age resistance does not appear to depend on immune reactions but rather to changes in the host tissues that render them as unsuitable environment for the parasite.

4. EFFECT OF IMMUNITY:

The host produces one or more substances known as antibodies that are chemically antagonistic to the parasite or its products. These antibodies may stunt the growth of the parasite or kill it or prevent its attachment to the host tissues or they may precipitate or neutralize parasitic products. Primary infection with Leishmania seems to confer a degree of immunity to reinfection while many protozoal and helminthic infections confer no long lasting immunity to reinfection. They do seem to stimulate resistance during the time that the parasites are still in the body. This resistance to hyperinfection is known as premonition.

5. EFFECT OF HOST SPECIFICITY:

The host specificity varies greatly among helminths. Even closely related helminths may exhibit great differences in host requirements. It is usually supposed that a helminth requires a very specific environment complex for its development and this is found only in proper hosts.

6. EFFECT OF PARASITE DENSITY:

When a number of helminths of one species is present in one host, the worms are usually stunted and of low reproductive capacity. This stunting effect seems to result not from insufficient food supply but from some action of the parasites on each other.

7. EFFECT OF HOST SEX:

An influence of host sex is evidenced in the development of some helminths e.g., Cysticercus fasciolaris is more frequent in male than in female rats, as a consequence of the action of sex hormones; gonadectomy lowers the resistance of females and increases that of males to infection, and injection of female hormones into males also increases the resistance of the latter, whereas injection of females with male hormones lowers their resistance to the Cysticercus.

5.12 SUMMARY

Ecology comprises many topics, but is conveniently divided in respect of the laws governing the physiology of animals, populations, and the communities or the interactions of populations. Behaviour is not restricted to individuals alone. It also extends to the behaviours between individuals of the same species as well as the behaviours between individuals and populations of different species. The primary behavioural categories are those relating to reproduction, sustenance, development and survival which involve intra- and inter-species competition as well as the influence of the abiotic and biotic environment.

Behaviour is a phenotypic expression of the interaction of the genotype (of individuals or species) with the environment. This expression evolves from the stimuli that motivate animals to an inborn activity, such as the sucking response of the calf upon contacting the teat of the cow, or a learned or practiced activity, such as coital attempts by inexperienced bulls and the competent performance of the experienced bulls.

Man observes behaviours of animals and infers a cause or reason. Such inference must derive from a full knowledge of the behaviour and of the variability of the behaviour of species — a knowledge that is gained after much work and over an extended time. Interestingly, man's observations and inferences are species-specific behaviours which also have variability in performance. Man's evolution from the hunter behaviours to the recent husbandry behaviours must have involved much change in concepts, namely a revolution in behaviour and perceptions. Man is presently in a state of evaluating again his relationship to other species of animals in respect of his perceptions of animal welfare and the ethology of animal life.

5.13 TERMINAL QUESTIONS AND ANSWERS

Question No.1 Explain in detail the Ecological aspect of the animal behavior.

Question No.2 What do you understand by the Homing Ecological aspect of the animal behavior?

Question No.3 What do you understand by the Food Selection Ecological aspect of the animal behavior?

Question No.4 Write a short note on the Host parasite relation.

Question No.5 Gives the difference between Territorial behavior and Dispersal behavior.

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UNIT 6: SOCIAL BEHAVIOUR

6.1 Objectives

6.2 Introduction

6.3 Aggression

6.3.1 Schooling in fishes

6.3.2 Flocking in birds

6.3.3 Herding in mammals

6.4 Group selection

6.4.1 Kin selection

6.5 Social organization in Insects and Primates

6.6 Summary

6.7 Terminal Questions and Answers

6.1 OBJECTIVES

Study of this unit will let the students to:

- What is the need of Aggression in Animals?
- How the Concept of Kin Selection is an extension of natural selection.
- What is the utility of Aggregation Behavior in Animals
- What is the various Zone for Fish during Schooling?
- Understanding the factor which affects Birds Flocking.
- How Objectives of Schooling, Flocking and Herding are similar.
- Understanding the rules of Birds Flocking.
- Understanding the various types of Herding.
- How Group Selection is affecting the Diversity.
- Understanding the concept of Kin Selection.
- Understanding the concept of social animal.
- Elucidate the various types of organization in insects.
- Understanding the various types of primates organization.

6.2 INTRODUCTION

During the process of their evolution Animals have undergone a drastic change in their behavior, traits etc. They have adapted themselves with their surrounding and evolved their social behavior based on their survivability. Animals started to learn that their survivability will be greater when they live in group. Fishes, Birds and Mammals adopted their group behavior for survivability, group selection, reproduction etc. Schooling, Flocking and Herding are those group behaviors where animals have shown their aggregation behavior. Animals started to learn that their social structure can only survive when the group members show altruism. Altruism further led to the development to Group selection and Kin selection. Individual were ready to contribute to their group without their gain. They were found to be doing altruism activities which have some similar gene. Every individual started to adopt a strategy where their genetic material can pass over the generation.

6.3 AGGRESSION

Aggression behavior refers to a set of harmful action which is directed to one individual or species. This behavior can be of one individual or a community. Aggression in Animals is one of behavior which has been most studied and analyzed. In Vertebrates Aggression has been the mode of communication. Aggression can be seen in various activities of animals like fight for food, territory, mating rights, maintaining dominance hierarchy, keeping their prey away, intra-community, intercommunity and courtship etc. Even aggression has been used by an individual to express its feeling in a group or community, or a group with another group. Even species communication is also seen happening by aggression.

Lorenz in 1966 defines aggression as "Aggression in animals is the result of an inherited spontaneous tendency whose properties are much the same as the biogenic drives to eat and drink".

Component of Aggression:

1. Intra and interspecies Aggression:

i. Intra species Aggression: Aggression behavior which occur within the species. Example: Flicker birds of North America

ii. Intra species Aggression: Aggression behavior which occur between the species. Example: Starling (Sturnus vulgaris) drove away woodpecker from hole of tree.

2. Hostility and Fear Component: Aggression is associated with hostility and fear. A animal show aggression towards other in its territory. But it is in fear when it goes into the other's territory.

6.3.1 SCHOOLING IN FISHES:

Fishes living in a group is called as shoaling. When the shoal moves in one direction, this behavior is known as Schooling. The activity in which all shoal starts to swim in one direction and started to behave as a single organism. The Fish shoal for variety of reason. They are safe in numbers, searching for food, reproduction etc. The Schooling also help the fishes in conserving their energy as they have to spent less energy to navigates through the water currents. Experiments have found that Obligate Schooler's becomes highly stresses when they are away from school. Nearly 50% of the fish species at least shoals ones in their life. Fish uses a combination of senses while swimming in a school. They use senses like vision, sight, smell,

lateral line and pheromones to stays in school or have a feel of happening in a school. Experiments have shown Organs which are sensitive to water displacement acts as Vision. It has been seen that Fish have school during the day time, but they just shoal in dark. This has led to an assumption that Fish eyes Vision have a big role in maintaining a safe distance while schooling.

School has two zones for each fish namely zone of repulsion and zone of orientation. The zone of repulsion guides the fishes to keep equidistance from other individual of school. The zone of orientation keeps a track of the neighbor's movement. Each fishes in school match its movement with its neighbor's. Early scientist used to belief that fish school use to have a regular structure like crystal lattice. But it has come to known that each Fish species school follows a unique structure i.e. Random Aggregation. The separation distances are not maintained strictly over a period of time. Each fish have a position in school. They adjust themselves according to traits required at that position. Each fish use a combination of its position, lateral movement and eyes to find the speed of its school. After sensing the movement, each individual fish match its movement with the school.

Schooling has been an important part of fish behavior. This had been an integral part of their evolution. Fish feed in loose group where each member of school manning different direction. Polarization happens when they are threatened or need to move. When the school is threatened thenthe individuals come closer to one another and align themselves to become uniform. This behavior is quite conforming to the adaptive advantages offered by schooling behavior.

The development of schooling behavior in fishes has been associated with apredatory lifestyle, increased quality of perception and size sorting mechanisms to avoid cannibalism.

Sardines are known to have greatest shoal and follows one of the largest migrations found on Earth. The Sardine Schooling has been seen spread over 17 miles with depth of 25 meters. Millions of fishes have been part of Schooling. They migrate from warm – temperate water of South Africa coast to sub -tropical waters of east coast.

Fig 6.1 Schooling in Sardine

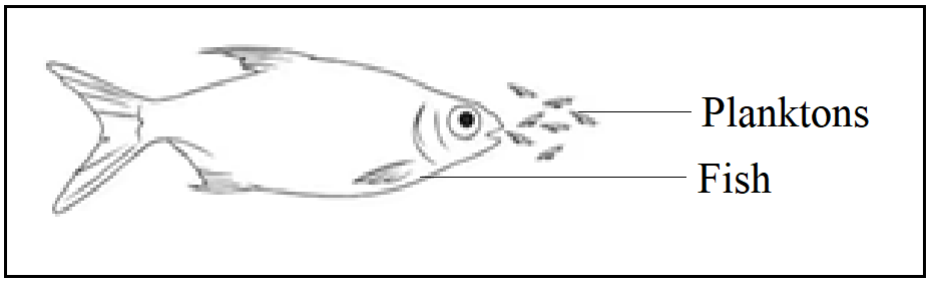

Fig 6.2 Feeding on planktons

Benefits of Fish Schooling:

1. Fish Schooling reduces the chance of been targeted by their predators.

2. Fish Schooling aids in finding foods and in finding mates within the group.

3. Fish Schooling aid to locate Fishes. Predators use these schooling for finding foods.

6.3.2 FLOCKING IN BIRDS:

Birds have a reputation of flying over a large distance in search of food, better climates etc. Siberian Crane fly from Siberia to India covering thousands of Kilometer to get away from adverse cold weather and to give birth of their young ones. This behavior of birds is done by Flocking. Flocking is a behavior where group of animals combined together and started to work as a group. This behavior is quite similar to schooling in fishes where birds forms a group and fly for a large distance displaying remarkable pattern in the sky. They flock to evade their predators, food searching and navigation. Birds flying in flocks are able to better manage the wind direction during their flight. A social structure is formed and a constant flow of communication happens within the group deciding on various set of resources, wind direction, Levels of Threats etc.

Hierarchy exists withinthe Flocks has been seen with a flock moving behind their Leader. Birds like Swans, Geese, Crane, and Flamingo are known to follows a migration over thousands of Kilo meter. They generally form a pattern of V during their flight. Each Birds Species have a different flock pattern during their flight. Some Birds prefers a large size flocks while others prefer a smaller size flocks. Some Birds don't stick with a strict pattern. They just wanted all birds move easily. Robins, Bluebirds etc. are an example of unrestricted patterns.

Fig 6.3 Flocking in Birds

Rules of Flocking Behavior:

Craig Reynolds in 1980's applied the principle of A Life to Flocking in Birds. He put forward a simulation program to stimulate the Flocking Behavior in birds. He put forward a model with the following assumption:

Assumption

1. Each individual has the ability to sense its mates in a flocking.

2. Each individual can sense the current environment.

3. Each individual calculates the current state and come up with the next decision to be taken.

Based on the above assumption Reynolds put forward 3 Rules which has been recognized and accepted.

They are

1. Alignment: Individuals try to match their velocity with their nearest one. The alignment angle is also checked from the velocity of its nearest one.

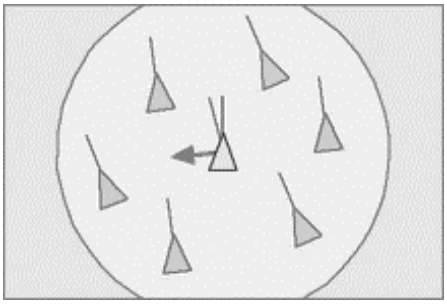

Fig 6.4 Alignment

2. Separation: Individuals always keep a fixed distance from its nearest one. Whenever the distance becomes less than the threshold value, suddenly they increase their distance.

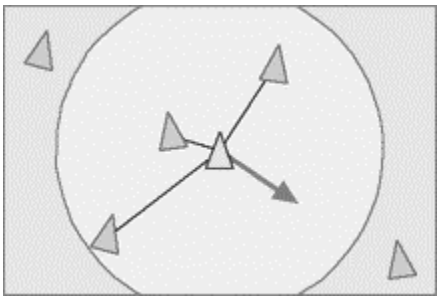

Fig 6.5Separation

3. Cohesion: Cohesion refers to the block structure. Individuals always try to move towards the center of mass of their neighbors.

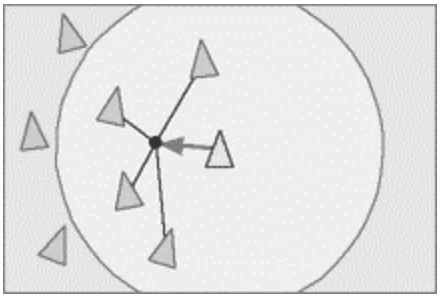

Fig 6.6 Cohesion

Each Flocking has the following measure to manage flock namely:

i) Leaders: Each Flock has a leader. It is the leader or the line leader which guides its line or an entire group. These leaders take the decision about a line or throughout a group. These leaders inform all the individuals under them about alignment, separation etc.

ii) Sick Birds: Each individual has a position in a flock. Some animals got injured during flocking. Then the sick birds will drop from the flock. A new individual take its positions until it recovers or dies.

iii)Replacement: Flock has to undergo a direction change due to any reason then the entire flock is led by a new leader.

iv)Fatigue: When the leader become tired, then they revert to the flock, a new individual bird becomes leader and take the lead role.

v) Resistance: Birds feel more resistance when they are out of the Flock. As soon as they feel more resistance, suddenly they realign and put up efforts to come up with the pattern of Flock.

Shapes of Birds Flocks:

1. Grounloar Shape: These birds form a flock's pattern which is like moving in circle in their flight.Example: Cheel

Fig 6.7: Flocking in Cheel

2. V Shaped:

Diagram: These birds form a flock pattern which is in the form of V shape in their flight. Example: Flamingo, Crane etc.

Fig 6.8: Flocking in Flamingo

3. Disperse: These are those set of birds which don't form any pattern. They just want to stay close to one another. Example: Pigeon

Fig 6.9 Flocking in Pigeon

Benefits of Flocking:

1. Flocking helps the group in searching food.

2. Flocking reduce the chance of falling to a prey.

3. Flocking helps in evolution of new species.

4. Flocking helps in mass migration.

5. Flocking helps to save energy during their flight.

6.3.3 Herding in Mammals:

Herding means a process where individual of the same species is combined into herds (Group). These herds can be of domestic animals like cow, buffalo, sheep, Goat etc. or wild animals like wolf, dogs. Herding has also been thought as the human interference in forming groups for its some benefits. Some animals like wolf, dogs have inherited the herds system of social behavior due to primitive hunting. Others like Deer, Wild beast, Wild Buffalo, Elephants have followed the herds system for their Safety, food and migration. The Herding group have a leader which take all decision for their group like availability of food, water, threats level, threats countering, navigation (migration) etc.

Reasons for Animals Herds:

1. Herds increase the chances to deceive their predators.

2. Herds provide them shelter, food and protection.

3. Herds allow them to grow in a secure environment.

4. Herds allows them to move over distances (migration).

5. Herds can provide a better security for themselves and their young ones.

6. Male don't have to go for a large distance to find mates.

Types of Herding:

Territorial Herding: In Territorial Herding, area is divided into several territories. All male and female of the same species living in area becomes a part of the Herds. Male fights among themselves to get their females. Example: Sheep's

Guarding Herding: In Guarding Herding, a Female controls the entire group. Male generally live a solace or in a group of male. Male can only enter with the permission of female. Group has all Females. Female Leader are responsible for its other members and young ones. Example: Elephants

Fig 6.10Diagram: Herds of Elephants

Social Herding: In social Herding all Female and Male lives under the dominating male and Female Mate called as Alpha Male and Female. Only Alpha male and female have the right to reproduce and mates. Others Members are responsible for their Herds. Example: Wild Dogs(*Lycaon pictus*), Meerkat(*Suricata suricatta*).

Fig 6.11Diagram: Herds of Meerkat

Name of Animals Herds:

Classes	Species	Herds Name
Fish	Bass	Shoal
	Herring	Army
	Sharks	Shiver
	Trout	Hover
	Bitterns	Sedge
Birds	Coots	Cover
	Cormorants	Gulp
	Cranes	Sedge
	Crows	murder, horde
	Dotterel	Trip
	Doves	Dule
	Eagles	Convocation
	Flamingos	Stand
	Geese	flock, gaggle, skein
	Parrots	Company

	Peacocks	muster, ostentation
	Turkeys	rafter, gang
Mammals	Bats	Colony
	Buffalo	gang, obstinancy, herd
	Cats	clowder, pounce
	Cattle	drove, herd
	Deer	herd, bevy
	Elephants	Herd
	Elk	Gang
	Ferrets	Business
	Fox	leash, skulk, earth
	Giraffes	Tower
	Goats	tribe, trip
	Gorillas	Band

Benefits Of herding system

1. Safety of Individual in groups

2. Chances of getting more mates.

3. Help in locating food resources.

Conclusion:

Animal exhibits a social behavior where they come together for need of some common resources like food, water, protection, mating etc. This coming together led to the formation of a social group which is known as Aggregation behavior. This is known by different names like Herding in mammals, Flocking in Birds Schooling in Fish. Their objectives are same, but a slight

variation has been observed in their aggregation behavior. This Aggregation Behavior is quite species based in Fish where as it has be uniform across bird and mammals.

6.4 GROUP SELECTION

Darwin postulated the theory of natural selection. This theory stated that an organisms success depends upon its reproductive success and its ability to transfer its genetic material to next generation. Evolutionists have extended natural selection into group selection. The group selection refers to application of natural selection at group level rather than at individual level. This is quite proximity to the theory which states that the fittest group will survive.

Natural selection is concern with the slight variation, in an individual adding the good one and rejecting the old one. Natural selection is silent and happens without making any one aware. Whereas Group selection involves an act of altruists where individuals have keep their interest at bay, but have taken an action which prove to be beneficial for a group of individuals. Group selection has led the individuals to show altruistic behavior. This altruist's behavior might be disadvantages to an individual but it cumulative advantage has benefited the entire group. Group selection has been conceived as inter group competition where an acts of altruist's at individuals level start to favors one group Example: Co-operative Hunting by Lions, Wild Dogs (Lycaon pictus), Co-operative monitoring of predators by Meerkat(Suricata Suricata),prairie dogs and ground squirrels , Co-operating raising of young ones by Elephants, System of predatory Alarm Calling by Monkey.

6.4.1 KIN SELECTION

Kin selection is an evolutionary process where the animal uses the altruism as a tool to enhance their chance of the gene transferring to their offspring's. This altruism is not a beneficial to the individual but for the whole group.

Kin selection is an extension of natural selection where altruism is not a beneficial for an individual but it is quite good from genetic perspective. When an individual is sharing the food with an individual or a group, they are carrying a part of his genes as they are closely related.

Thus, it ensures the better chance of survivability for its kin(relatives). Altruism act also increase the individual fitness as the resources will also be shared by others when it is needed.

Kin selection is not only limited with the behavior of altruism but has been able to explain the group behavior where it will co-operate, show more restraint and where it be aggressive. Kin selection theory states that the behavior towards the kin is more of co-operation whereas it been of aggression with the others.

Kin selection found in Nature

1. Tiger Salamanders, Ladybirds have shown cannibalism when subjected to food scarcity. They prefer to eat the non-relatives over their relatives.

2. Workers removed the eggs laid by other workers in social Insects like wasps, bees because they are related to queen genes.

3. The workers (Diploid, Sterile Females) living in bee colony shows the act of Kin Selection by taking care of the entire activity of the hive though they have no chance of carrying their gene to the next generation.

4. Squirrels give alarm calls to warm others of predators. It has been seen that Females are more likely to give a call.This is due to the fact that Female are more genetically related to each other as compared to males.

5. Mammals take care of their offspring. They invest their significant resources, time in their offspring.

6. Vampire Bats share the blood among their group members to increase their group survivability.

Hamilton's Ruleof Kin Selection:

J.B.S Haldane was first scientist to work on kin selection. He worked on the insects (bees) and stated that "if in a species hybrid only one sex is unviable or sterile, that sex is more likely to be the heterogametic sex".British Biologist William Hamilton carried the work of Haldane and comes up with a rule named Hamilton's Rule.

6.5 SOCIAL ORGANIZATION IN INSECTS AND PRIMATES

6.5.1 SOCIAL ORGANIZATION IN INSECTS:

All insects are not True social. True Social refers to having three conditions namely

1. Co-operative Caring of young Ones

2. Allowing offspring to assist their parents

3. Permission to all to reproduce.

Insects don't follow all conditions. So the Insects Social organization was first classified on the level of sociality by Michener in 1969.

He classified the Insects as-

a. Solitary: The Insects which don't follows any of the three condition. They remain their life in isolation. Majority of the insects lives their lives solitary. They just aggregate in groups for their mating. Once mating is done they parted away.

b. Sub-social: Insects whose parents care for their offspring for a short time. Example: Cockroach

c. Communal: Insects who share the same nest without co-operation only during brood care. Example: Digger Bees.

d. Quasisocial: Insects who share the same nest with co-operation only during brood care, Example: Euglossine Bees

e. Semi-social: Insects who share the same nest with co-operation and have a worker caste. Example: Halictid bees.

f. Eusocial: Insects who are semi social with young ones contributing with the parents. Example: Honey Bees. Eusocial is quite rare in insects. This is found in only in 2 orders namely Hymenoptera(Ants,bees,wasps) and Isoptera (Termites).Eusocial animals only make nest, lives in colonies and practice division of labor, social interaction.

Social Organization inOrder: Isoptera

Termites are the lone member in order Isoptera who exhibit a well- developed social structure. Termites are known as Deemak or white ant. They are known as common pest in our surrounding known for damaging woods based items.

Termites Characteristics:

- Pale, elongate body
- 2 pairs of membranous wings of equal length. Wings are present in reproductive castes only and they are shed after mating.
- Mandibulate (chewing) mouthparts
- Antennae about the same length as the head

Termites Colony are managed on division of labor based on caste differentiation. They exhibit polymorphism.

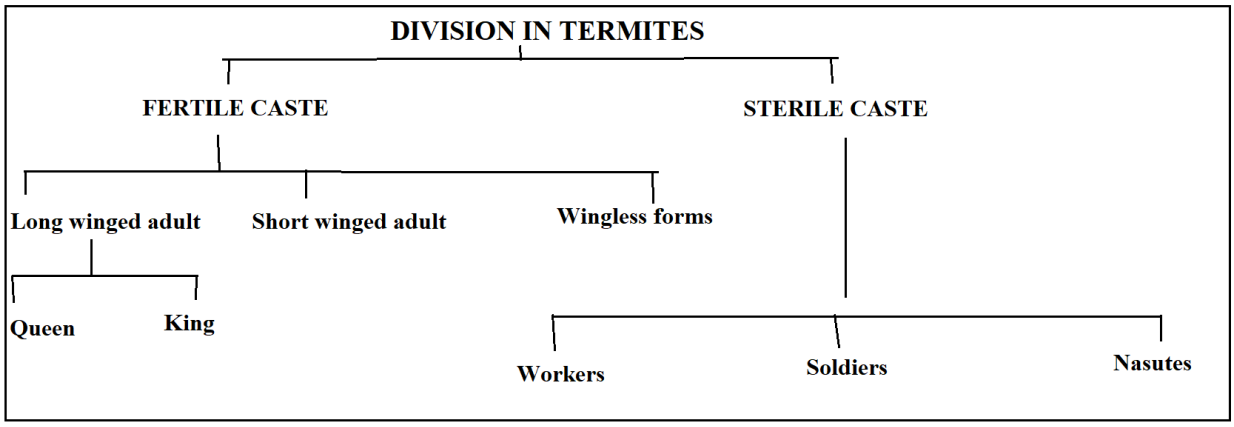

Fig 6.12Diagramof Division in Termites

Termites Colony has 2 major castes. A) Fertile Caste B) Sterile Caste

A) Fertile Caste: There are 3 Types of Fertile Caste namely

1. Long winged Adult: Long winged Adult (Both Male and Female) are produced during Rainy season. They copulated during night during their flight. After copulation Female settled for making a new colony. Female become a queen and Male settled as King.

a) Queen: They are 5 to 7.5 cm in length. Their sole role is to lay eggs. She lays nearly 70,000 to 80,000 eggs in 24 hrs. They stay in royal chambers with king and is served with royal jelly.

b) King: It is developed from unfertilized egg by feeding on royal jelly. Their sole role is to mate with queen so that queen can produce egg to developed winged male and female and Sterile Caste.

2. Short winged Adult: They are the substitute for the king and queen. They take their position in case of death.

3. Wingless Form: They are worker like substitute king and queen found in some primitive species.

B) Sterile Caste:

1. Workers: The workers perform all function of colony except reproduction.

2. Soldiers: These workers have the sole role of protection the nest from intruder.

3. Nasutes: These workers secrete a sticky substance to spray over their enemy in warfare. This sticky substance leads the enemy to abandon the attack and get away. They also dug tunnel or their movement.

In breeding season newly male and female winged flew for their flight. They do copulation at nights. Then they settled at a new place by digging a shallow depth and lay eggs. These egg produce workers which started to take function of all nest.

Social Organization In Order: Hymenoptera

Social Structure in Honey Bees:

Honey Bees exhibit a well- developed social structure. Honey bee are found in our surrounding visiting flowers, collecting the nectar and converting into honey.

Honey Bees Characteristics:

- Segmented body
- Size of worker (10-15 mm) , queen(18-20 mm), drone (15-17 mm)

- 2 pairs of membranous wings of equal length.
- Orange and black stripes

Honey Bees Colony are managed on division of labor.

Honey bee colony comprises of the following:

a) Queen: Queen is the lone fertile member in a hive of honey bee. She is also the biggest member in terms of its size. She secreted a chemical pheromone to control its workers. Generally one queen lives in a hive. Other Female fertile members (Young Queen or Queen Daughters) moves out of hive to sbuild their own hive.

b) Drone: They are male member of the hive whose sole purpose is to mate with the queen. There are 2- 3 dozen of male in a hive who pursues the queen. Queens collects sperm from drones and stores them to be fertilized later in their life. Queen collects sperm as she will do the mating act for few days and then settles permanently. Drones are driven out of hive once queen had collected enough of sperm. They die due to hunger.

c) Workers: They are sterile Female workers who do all the jobs of a hive like cleaning, maintaining, feeding the larva, secrete nectar, and water carriers. They die out of their work.

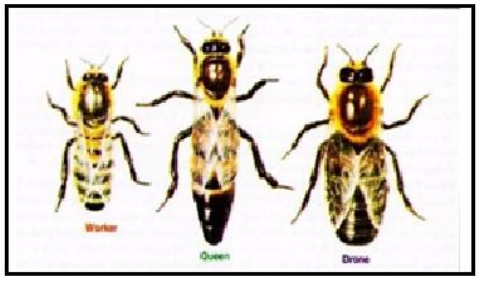

Fig 6.13 Diagram of composition of honey bee colony

Social Structure in Ants:

Ants are known to have highly developed socialized system in the animal kingdom. Ants are been seen in our surrounding visiting collecting their food and walking a large distance in a line.

Ant Characteristics:

Modified

- Segmented, Oval body
- Mostly Dark Brown , Black , Red color body
- 2 pairs of Antennas.

Ant Colony are managed on division of labour and exhibits polymorphism.

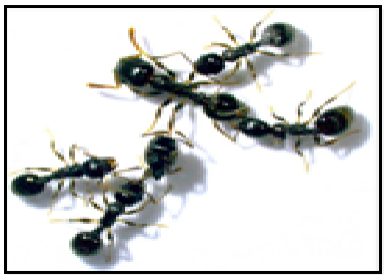

Fig 6.13 Division of LaborIn Ants

Ant Colony has 3 caste namely Queens, Workers and Males.

a. Queen: They are the fertile female in the Ant colony. Their antennae and legs are relatively shorter and stouter and the mandibles are well developed. An ant colony has multiple queens with some ants having a sole role of laying eggs. These ants become normal queens when the queens die.

b. Workers: They are sterile female who do all functions of their Nest. The workers are generally divided into 3 groups with small workers managing their eggs, middle one searching for food, and larger ones as soldiers. Ants are known to attack the colony of other ants. They take their eggs and larva to be used as slave after hatching.

c. Males: They are the fertile male members of Ant colony. They have smaller head, reduced mandibles, longer antennae and well developed reproductive organs.

Life Cycle of Ant:

Male and Queen mate during their flight. Queen lays their eggs. Eggs are hatched into larvae. Larvae are feed by the saliva of the queen till it pupa stage. Pupa stage is slowly transformed into a small insect. The first generation is of sterile Female who will manage the activity of their nest. Winged Male and Female are produced later. Generally Colony of ants is perennial and they grow over the years. Pheromones play a key role in managing the whole group and controlling the caste. These pheromones are subjected at various stages of their life cycle i.e. from larvae to full insects.

6.5.2 SOCIAL ORGANIZATION IN PRIMATES:

Primates are known to live in large groups. Primates are marked by large body size, large brain size and diurnal behavior. Primates social organization has been made to increase survival, cooperative predator avoidance, ready access to mates, kin selection, and thermoregulatory benefits. Their social organization structure is quite complex with female making up the center of organization. They are mother, sisters, and their child living in the same group. Primates have a polygamous structure with one dominating male controlling the all females. Male young ones have a high probability of leaving the group as they can begum a threat to alpha male. Generally Females stay in the same group. Their social structure is at disadvantage like competition for food, mates and space, predators.

Semi terrestrial species: These species lives in large groups. They live to protect themselves from their predators like Lions, Leopards, Hyena etc. and also protect their food which is generally scare. Example Baboons. Some Species like Langurs lives in a small group as they have little competition for food. Generally, they live a solitary life.

Most Primates have a closely knitted group with little or very little contact with other communities. They lives their entire lives in a certain area and rarely they moves to a new area. They are quite aggressive towards their other group. The aggression is due to the fact that increase of individuals will put the burden on the resources, which will eventually harm their own group.

Chimpanzee are quite friendly with another group. They have been seen to interact with other group with some interaction lasting for few hours. Even some female chimpanzee switches the group for matting purpose. Howler Monkey and Gibbons shows a territorial protection behavior by intimidating the members of other group by making exceptionally loud sounds. These group meet each other at a place where both group territorial meet.

There are different types of Social Organization found in Primates. They are as follows:

1. Solitary Primate System: This pattern is rare in Primates where Single Female and their offspring live together. The male generally comes only for matting purpose. In this structure male have a large area with many female living. Young Ones leaves their mother once they attain puberty. Their mode of communication is vocal and olfactory. Example: Loris, Lemurs, Tarsiers, Orangutan

2. Monogamous Family Group: This pattern has a one male and one female with their offspring. Once the young ones grow, they leaves the group to start their own family. This is quite analogue to Nuclear family of Human beings. Both the parents work and share their responsibility of taking care of young ones. This system is rare in primates, but is found in small Asian apes and in New world Monkey. Example: Gibbons.

3. Polyandrous Family Group: This pattern starts with a monogamous group with one male and female. Later a new male primate will join the group and assist in rearing of child. Both Males will mates with female. Generally, the second male is not capable of breeding, his role is just concerned with young ones care. This is also rarer in Primates. Example: Termarin& Marmoset

4. Polygamy Family Group: This pattern has one male with multiple female. Primates form a social group where the whole group is divided into multiple group. Male only mate with Female of alpha (Dominating) group. They form a distinct mating and child bearing group. Example: baboons, langurs, howler monkeys, and gorillas. In this Social group it is female which decides the hierarchy. Males are bigger, stronger and aggressive than the female. Female comprising of Mothers, aunt and sister club together and can rid of unwanted males. Female decides about their mates from their groups or from outside their group. Their relationship with the Male is of

temporary. Alpha Male can only be dominate till it shows a cordial and carrying attitude towards the female and is readiness to defend their territories.

5. Multi Male Multi Female Group: This pattern has no stable heterosexual bonds – both males and female have multiple partners. This is mostly found patterns in semi-terrestrial primates. This group has a hierarchical order for each member in both sexes. Each member knows to whom they have to submit. Primatologists have named the dominant male and female as Alpha Male and Alpha Female. Female Rank always stays in group throughout their life. Male also have a rank, but they have to leave their group after attaining puberty and join another group, Male start from lower rank and then gradually raise its rank in the newly joined group. Alpha Male will mate with multiple female partners. It has been seen that Female especially of Lower order in the group generally sneaked away and mate with lower order females. Thus in this Group It feels that it is Male dominant but it is the Female which manages the gene flow. Example: Rhesus Macaque, Baboons, Few Monkey species.

6. Fission-Fusion Society: This Class of animal have no Fixed size and no proper composition. It keeps on changing. Fission refers to individual been reduced where Fusion means the addition of new members.

Adult Male and Female occasionally wanders and align with others groups. Male can join other males coming from different group, can laugh, hunting exercise etc. together.Female can leave the group especially when they are in heat (Reproductive Active) for their mates. Their group interrelationship continuously change, group are regrouped etc. Example: Chimpanzee.

6.6 SUMMARY

Early Animal was mainly solitaire in nature. These use to live alone and breed unisexuality. As the animals evolved and get more refine. A set of specialization started which result in the development of sex. The sex reproduction brought more diversity in terms of fauna. This diversity led to more competition for the resources like food, water etc. Soon the animals start to realize that they have the best chance of survivability when they lives in group. This led to development of social behavior. Insect were the first animal to realize the importance of living in a society. Insect devises their adaptation in their social structure by having a division of labor. A particular set of animal were responsible for a particular set of work like queen for laying eggs, workers for feeding, searching for food etc. Insects belong to two order namelyHymenoptera

(Ants, bees, wasps) and Isoptera (Termites) only exhibit Eusocial organization. Insects are still not a complete social animal as they still don't follows all the traits of social animal. Higher Order animals like Fish, Birds and Mammals have shown a completed social behavior Schooling, Flocking and Herding are the aggregation(social behavior) shown by Fish, Birds and Mammals respectively. The level of social organization becomes more complex as we move up the ladder of evolution. Primates are known to have most complex structure in the animal world next to human beings. Animals have evolved a sense of responsibility to conserve the diversity by taking all the steps to pass their genetic material to their offspring. This responsibility led to the development of group selection and Kin selection. Kin selection is not only about altruism but has also explain the interaction between inter-species and where it show more restraint, where it be aggressive.

6.7 TERMINAL QUESTION AND ANSWER

6.7.1 MULTIPLE CHOICE QUESTIONS:

1. Termites are the only insects of _____ order who show social behavior.

a. Isoptera b. Hymenopterac. Depends on Species. d. None

2. A Queen just mate with the Male in one season and then it never mates for its entire life. Which insect species shows this behavior.

a. Wasp b. Ant c. Honey Bee d. Termites.

3. Workers in insect spend their entire life for the welfare of their group. This is an example of _____.

a. Group selection b. Kin Selection c. Altruism d. None of them.

4. There are _____ characteristics of social animal.

a. 1 b. 2 c. 3 d. 4

5. Reynolds put forward _____ Rules which has been recognized and accepted.

a. 1. b. 2 c.3 d. 4

6. Gorilla, Bonbon follows _____ system of Mating in their group.

a. Monogamy b. Promiscuity c. Polygynandry d. Polygyny

7._____ fish make a pattern of circles on the sea bed quite similar to crop circles.

a. Cat Fish b. Sea Horse c. Featherfin cichlid Processing d. Japanese Puffer

8.Michener in 1969 classified the Insects Social organization into _____ groups.

a. 5 b. 6 c. 7 d. 8

9. Rhesus Macaque Monkey follows _____ social structure.

a. Monogamous Family Group b. Polyandrous Family Group c. Polygamy Family Group d. MutiMale- MultiFemale.

10. Which group of animalshave the most complex social structure.

a. Fish b.Birdsc. Mammals d. Reptile

11. Kin Selection Theory was given by _____ .

a. Halton b.Weismann c. Muller d. Hamilton

12. Insects are _____ social animals.

a. Pure b. Partial c. Not d. None

13. Which group of animals follows the schooling social structure

a. Fish b.Birdsc. Mammals d.Reptile

14. Each Fish in Schooling has_____ zones for each fish.

a. 1 b. 2 c. 3 d. 4

Answer

6.7.1

1(a) 2(c) 3(b) 4(c) 5(c) 6(d) 7(d) 8(c) 9(d) 10(c) 11(d) 12(b) 13(a) 14(b)

6.7.2 Very Short Question:

1. Discuss the Hamilton Rule of Kin Selection.

2. How Schooling is different from Herding.

3. Name the factor which affects Birds Flocking Behavior.

4. Name the order of insect which are called as social animals.

5. Write the advantage to an animal living in groups.

6. Name the rule applied in Kin Selection.

7. What is altruism? Write its one example.

8. Differentiate between intra and inter species aggression.

9. What is the learning effect of aggression?

10. Name the aggression which is shown by flicker birds of North America.

11. Write the Salient Feature of Kin Selection.

6.7.3 TERMINAL AND MODEL QUESTIONS

1. Explain the concept of Group Selection. Explain how it had explain the reason for having some species.

2. Describe the concept of sperm competition. How it has led to increased diversity.

3. Discuss the need to have an aggregate behavior in Animals.

4. How the social structure of Ant is similar and different from Termites.

5. Explain the social structure in Termites.

6. Discuss about social organization in primates.

7. Discuss Reynolds 3 Rules of Birds Flocking.

6.8 REFRENCES

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6.10 GLOSSARY

Aggression: Forceful action or procedure.

Fertile: Sexual Active or one who can produce its offspring.

Flocking: Flockingis a behavior where group of animals combined together and started to work as a group.

Herding: Herding means a process where individual of the same species are combined into herds (Group).

Intercommunity: Between the community**.**

Intra-community: within the community**.**

Monogamous: A family with one female and one male with or without their young ones**.**

Polyandrous: A family group with one female and many males but only one male is sexually active**.**

Polygamy: A family group with one male and multiple female**.**

Shoaling: Fishes living in a group is called as shoaling.

Sterile: One who cannot produce its offspring

Unisexuality: Animal having both sexes.

UNIT 7: REPRODUCTIVE BIOLOGOY

CONTENT

7.1 Objective

7.2 Introduction

7.3 Evolution of sex and reproductive strategies

7.4 Mating system

7.5 Courtship

7.6 Sperm Competition

7.7 Sexual Selection

7.8 Summary

7.9 Terminal Question and Answer

7.1 OBJECTIVES

Study of this unit will let the students to:

- What is the need of Sex?
- How the Sex have evolved.
- What are the various Sex Strategies?
- Understanding the factor which affects Sex Strategies.
- How K selection sex strategies is different from R selection sex strategies.
- Understanding the process of Mating in different animals.
- Understanding the difference between Sex Strategies.
- How Male dominating Mating System are different from Female dominating Mating system.
- How Sex Strategies affect their behavior.
- Understanding the concept of intrasex and intersex.
- Elucidate the concept of sperm competition.
- Understanding how sperm competition acts as natural selection.
- Explain the concept of Sexual Selection.
- How Sexual Selection Theory has been modified.
- How Females are controlling the natural selection process.
- Why we have so much diversity at species, interspecies level.

7.2 INTRODUCTION

Early Life inhabitants originated without sex. They were using asexual reproduction like binary fission etc. Sexual reproduction and sex have evolved in due course of evolution. Sex had evolved around 2 billion years ago after 1.3 billion years of early life. Eukaryotes were the first to resort to sexual reproduction. The reason of resorting is still unclear but it is assumed that it was due to DNA repair. Over due course of time animal learn how to evolve and maintain their genetic material. Life started to evolve and getting complex and new sets of functionality (Specialization) were included. This Specialization leads an animal to become bisexual from unisexual.

Unisexuality bring a set of new challenges for an animal to maintains their genetic material in due course of evolution. This challenges lead to the development of different sex strategies, Courtship and mating behavior. Darwin also highlighted the above facts in its theory of Sexual Selection.Theory of sexual selection becomes the main stay for understanding the evolution of diversity at species and interspecies level.

7.3 EVOLUTION OF SEX AND REPRODUCTIVE STRATEGIES

7.3.1 Evolution of Sex:

Sex refers to two individuals having two different set of functionality (Specialization). They were refers to as Male (Having Spermatozoa) and Female (ability to release ovum). There are two aspect of sex namely origins of sexual reproduction and how it is been evolved and maintained. Origin of Sex is assumed to have evolved as a means to repair the genetic material. It was thought that the Eukaryotes started to have sexual reproduction some 2 billion years ago. Research have found that sexual reproduction is beneficial for larger size population, so sex might have originated once an optimum size of population have been attained. Sex is a combination of recombination, reproduction and gender. Recombination is how offspring differs from parents. Sexual Reproduction is the result of recombination. Gender is production of gametes.

Traditional view was given by Weismann in 1886, Muller in 1932 and by Crow & Kimura in 1965. It stated that Recombination increase the rate of evolution by bring two good mutations together and controlling bad mutation. This decreases their chance of extinction.

It was contracted by the following facts

Species or group selection is not strong enough to protect from mutation.

So, two hypotheses of origin of sex have been put forward:

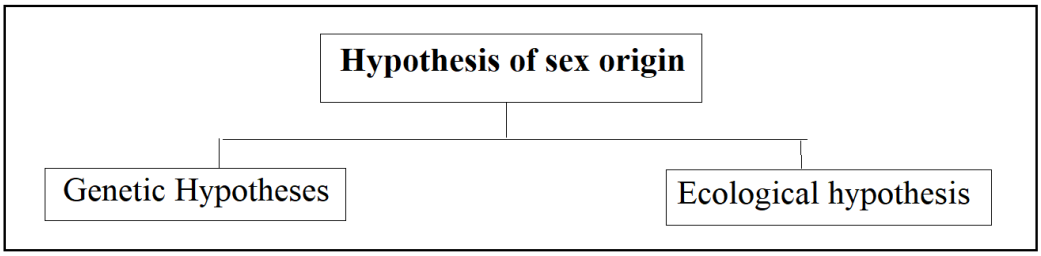

Fig 7.1 Hypothesis of sex origin

i) **Genetic Hypotheses:** This Hypothesis talk about repair and mutation. This can be done by proofreading by DNA polymerase, excision repair and Double stranded DNA.

ii) **Ecological hypothesis:** This hypothesis stated that each organism is the race between host and parasites. It states that both host and Parasites are evolving at their pace, but not increasing nor decreasing their existence. Still they are at the same stage. It is on accounts that both Parasite and pathogen are co-evolving and keeping up with them.

7.3.2 Reproductive Strategies:

Reproductive Strategies involves the various approach used by the animals to produce their offspring. It includes behavioral, morphological, and physiological adaptations used to attract their opposite sex. It also includes the various infant survival techniques and the way by which chance of fertilization can be improved.

Reproduction are of 2 Types namely Asexual and sexual. Asexual reproduction involves no fusion of gamete or change in chromosomes. They are just a replication copy of their parents with the same set of chromosomes. Asexual reproduction can be of unicellular or multicellular organism. Further Asexual reproduction involves only one individual so there is no question of reproductive strategies.

It is the sexual reproduction where there is more than one individual, fusion of gametes or change in chromosomes takes place. These individual can be living in group, communities. It involves competition among individual within the group or inter group. The animals have evolved separate strategies to conserve their genes and increase their survivability chances.

Reproductive Strategies are been broadly divided into 2 Types namely K Selection and R Selection.

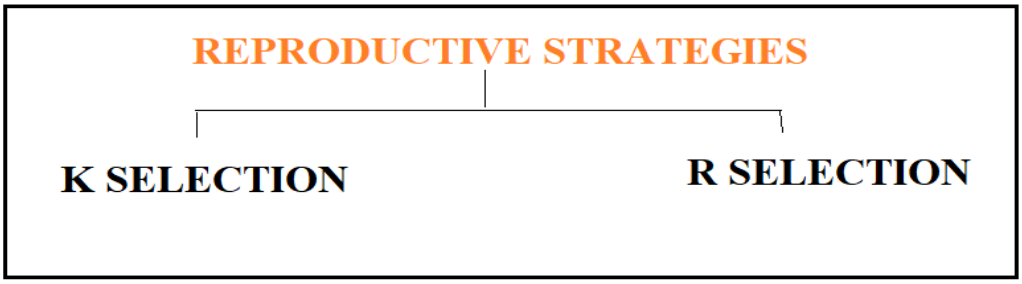

Fig 7.2 Types of Reproductive Biology

- **K Selection:**

  K strategies are generally used by animals who have a stable, resource rich environment. Their Young ones are prone to predators. In this approach parents invests a significant amount of resources in their young ones upbringing. The number of offspring's is quite less. Their lifespan is generally greater. The strategies decide their reproductive behavior. K selection strategies animal involves a significant time in selecting the gene. To ensure the longevity of their offspring and better resources a various set of mating rituals have evolved during their process of evolution. Body size is typically large. They take a significant long time to become a juvenile. Their population size generally remains stable. The survivability changes are quite high. Example: Humans, Elephant, Dolphin, Zebra etc. Elephants are large in size. They have a long gestation period of 18 months. They attain their maturity by the age of 20 years. Parental Care is provided for first few years living in the group community. The chance of survivability of young one is quite high.

- **R Selection:**

  R strategies are generally used by animals that have an unstable, slant resource environment. Their Young ones are less prone to predators as compared with K approach. In this approach parents don't or invests a very less significant amount of resources in their young ones upbringing. The number of offspring's is quite large. Their lifespan is generally shorter. R selection strategies animal don't invest their time in selecting the gene. So they generally lack various set of mating rituals. Body size is typically small.

They become a juvenile in a shorter time. Juvenile mortality is quite high. Their population size varies with the life cycle. Example: Fish, Rodent, Insects, Bacteria, Oyster etc. Oysters produce thousands of eggs. Each egg is own their own. No parental care is available. Only few of them will be able to hatch. Only 1 in 10,000 egg will be able to become an adult.

Characteristics of R and K selection Animals:

Point Of Difference	**R Selection Organism**	**K Selection Organism**
Size	Small	Large
Strength	Weak	Strong
Energy Wastage	Large	Quite Less
I.Q	Less	More
Having Multiple Baby at the same time	Yes	One or Two
Life Longevity	Small	Longer
Sex Frequency	Small	Larger
Off spring Care	No or very Little	Yes
Maturation Time	Fast	Slow
Number of Reproductive Cycle	Only One	Many

7.4 MATING SYSTEM

Animal Worlds have shown a lot of sex diversity among themselves. The Mating system has been divided based on the basics of sex who makes the mates choices. They are Female Mating system and Male Mating System. Besides them in some animals either of the sex can make a choice.

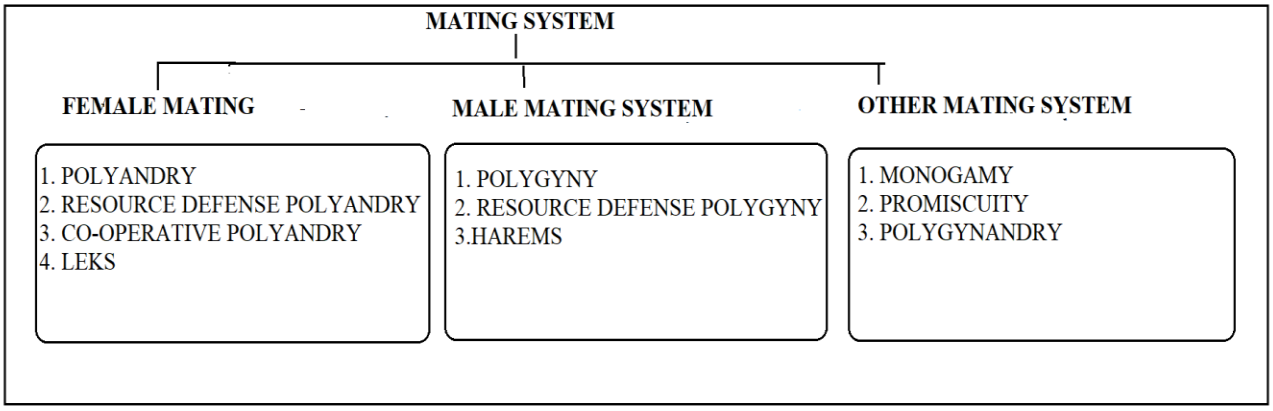

Fig 7.3 Types of Mating System

7.4.1. Female Mating System:

Female are quite choosier while deciding their male mates. Female make their based on some unique traits like plumage, color, tail, hair etc. Female ensures that their mate have a superior gene traits or have a resources which will ensure their offspring a better survivability.

i. Polyandry: Polyandry exists in some bird species especially sea birds, some insects, reptiles, snake etc. In this behavior a female mate with multiple male partners. Parental Care is generally done by male. Example: Sea Horse

ii. Resource Defense Polyandry: Female controls a resource which attract the male. Female ensures which set of male can use those resources. In the entire process Female controls the mating association. Example: Spotted Sand Piper, African cichlid fish, Lamprologuscallipterus.

iii. Co-operative Polyandry: Female mate with more than one male mate. Parental Care is done Co-operative by Female and all male mates. Example: Acorn Woodpecker

iv. Leks: Multiple Male forms a group exhibit some courtship behavior. Generally an area is chosen where male co-operates and performs acts to attract females. Female visits those areas and chose their mates. Relationship is limited to mating. Leks behavior is also known as Arena Behavior. This behavior is found in a number of insects, birds, fishes and mammals. Example: Great Snipe, Manikin, Prairie Chicken, Sharp-tailed Grouse, Musk Duck, Hermit Hummingbird, and Peacocks

7.4.2. Male Mating System:

Males have been found to have an attained for multiple patterns. Male Mate strategies are based on the facts their success is based on their copulation frequency and the number of partners.

i. Polygyny: Male mates with multiple females. This is found in some birds, insects, reptiles but most common in higher order animals like mammals.

ii. Resource Defense Polygyny: Male controls a resource which attract the Females. Males fight among themselves for those resources. Male ensures the resources needed for copulation. In the entire process Males controls the mating association. Example: damselflies.

iii. Harems: A group of females looking for a resource gets associated with one male. Male ensure those set of resources get availability for their female mate. Male is constantly under a threat of losing its control. Male are constantly in a fight among themselves with sole aim of controlling harems. Harems are a quite complex organization handled by females. This behavior is generally shown by mammals. Example: Crocodiles, Deer, Lion.

Besides this it has been seen that in some species it is neither of the sex who dominates, it is mutual.

7.4.3 Other Mating System:

i. Monogamy: Both Male and female remains loyal to each other for their entire lifespan. Parental Care is done by both the partners. This behavior is been seen mostly in birds rarely in other animals. Example: Blue Footed Boobies, beavers, otters, wolves, bats and foxes.

ii. Promiscuity: In this organization both male and female have multiple partners at the same time. There is no bond between them. This is one of rarest found organization. This organization occurs when the environment is unpredictable. The sole objective is to carry the gene to the next generation irrespective of the approach as judging of gene can't be done. Example: snowshoe hare, Lepus americanus.

iii. Polygynandry: In this organization both males and female can mates with multiple partners. Parental Care is provided by the whole group of organization. This organization is quite

beneficial as female have multiple male around to protect their young ones. Their kids are quite protected from infanticides. Example: Gorilla, Bonbon

7.5 COURTSHIP

Different species of animals select their mates by showing the behavior of Courtship. Courtship is a behavior where male try to attract their female mates by showing their behavior attires. Female decides with which male will be its partner from several individuals. It finally leads to a mating and lastly reproduction. Courtship is a set of complex behaviors which reveals the species, gender and physical conditions of the individuals. This behavior shown also varies from species to species. All species have pre-mating sequence. This sequence is fixed for a species but vary across the different species. This behavior includes ritualized movement ("dances"), vocalizations, mechanical sound production, or displays of beauty, strength, or agonistic ability. Energetic displays and striking appearance indicate good health. Attractiveness depends on the intensity of secondary sex characteristics, like colorful plumage and long tails. Agonistic behaviors are seen in species which have resources like food, shelter, and mates are often limited. Few Example of Agonistic behaviors are Mice, Rats, Elephants, Lion etc.

7.5.1 Courtship in Birds:

Birds are generally known to be as one of Finest Courtship in Nature. Birds have shown most varied and fascinating courtship rituals. Birds show different type of courtship behavior such as songs, display and dances. Courtship in begins moves in the following ways:

Step 1: Start with territorial defense and song.

Step 2: Mate attraction displays.

Step 3: Courtship feeding.

Step 4: Finally, selection of a nest site.

Courtship in **Song birds** is one of most amazing courtship to watch. It follows the following approach:

Step 1: Male songbird first marks his territory by singing from different corner of its area.

Step 2: Female birds are attracted by the male qualities.

Step 3: After Female bird make a choice for its mates. Then they both make a song signaling their relationship for other comparators.

Step 4: Finally, they settle for a nest site.

Fig 7.4 Picture of Song Birds

Courtship in peacocks is quite complex, but it uses a spectacular display to attract a mate. Courtship in Peacock uses dance as a tool to instigate the Female. It follows the following approach:

Step 1: All Male Peacocks looking for female gather's in groups called parties.
Step 2: Male Peacock use Physical movements, to intricate sequences including wing flaps, head dips, bill rubbing, or different steps.
Step 3: Female Peacock just observe the male from a distance. Dance steps are a sign of experience, weakness or hesitancy. Based on the Dance step sequence Females make a choice of their mates.

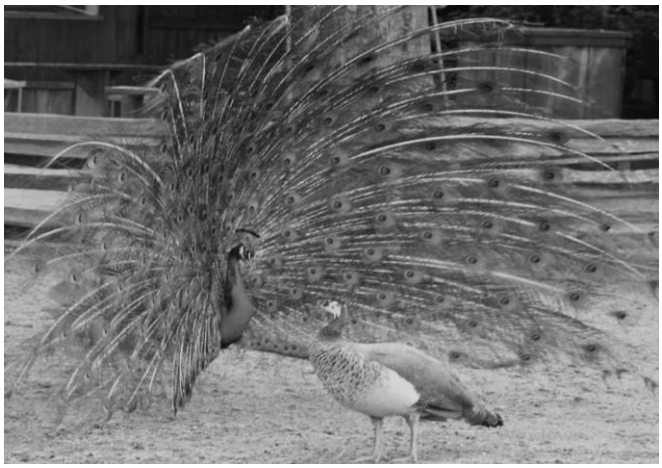

Fig 7.5 Picture: Indian Peacock

Besides this other bird uses other techniques like Preening, Feeding and Building to attract their mates.

Preening: Birds uses to touch each other either by lightly preen each other, beautifying their feathers. These are part of courtship to resolve their boundary and aggression.

Example: Pigeon, Avocet Birds

Fig 7.6 Picture of Pigeon (Touching)

Feeding: This Courtship allows a male to share its food with the female counterpart. In this process male shows its affection and care. This process also gives a feeling that male is ready to share its food with female mate and their young ones. Example: Cardinals

Fig 7.7 Feeding in Cardinals

Building: In these types of courtship male make a nest to show off their architectural skills. Female come to their nest then make an evaluation. Based on evaluation female decides about the mate.

Example: Baya Weaver Birds, Great Blue Heron

Fig 7.8Baya Weaver Birds Courtship

7.5.2 Courtship in Fishes: Fishes also exhibit courtship behavior. Fish Courtship is generally short. Male generally comes near the female, simulates them and copulation occurs. Courtships are generally found in fishes of bony fish, shark group found in marine.

i) Puffer Fish:

Japanese Puffer Fish make a pattern of circles on the sea bed quite similar to crop circles. Female Puffer Fish examines the pattern and take a decision on which pattern egg will be laid. Male externally fertilize the egg after being laid. Male also take care of the eggs for some days. This behavior is also shown by featherfin cichlid (Cyathopharynxfurcifer) residing in Tanganyika Lake (Africa). They create a mound of sand on the lake surface.

Fig 7.9 Picture of Japanese Puffer Fish Drawing

ii. Sea Horses

Sea Horses are monogamous. Sea Horses courtship has caresses, hugs and changes of colour, even dance. They dance for hours and follow a sequence where they swim side by side. Female lays egg in male bag. The eggs are fertilized in male bag. Child birth and Parental care is been done by male.

Fig 7.10 Picture of Sea Horse

7.5.3 Courtship in Amphibian: Amphibian uses vocalization and visual cues as a tool to attract their female mates. Their General approach is

Step 1: Male locates a female.

Step 2: Male uses vocalization as a tool to attract.

Step 3: Male blocks the path of female or instigates their female by touch.

Step 4: Female release their eggs after being instigates.

Step 5: Male releases their spermatophore on the eggs.

Step 6: External Fertilization occurs.

Example: Frog, Salamander

Fig 7.11 Picture of Frog Mating

7.5.4 Courtship in Insects:

Insects use different set of tools to attract their female mates. They include serenades, dances, nuptial gifts, physical touch, and even aphrodisiacs. Insect species have designed their unique set of dance patterns which vary from species. Female are stroked by use of legs or antennae by male insects. Dance pattern are fluttered, move in circle or short flights. Cricket uses songs to attract their female. Fruit Fly uses his wings in pulsing, rhythmic patterns. Mosquitos uses

harmonic duets in their courtship. Spider uses a linear dance, a zigzag dance or aerial dance in their courtship. Hanging fly uses a gift as a tool to call their female. They hunt an arthropod then release a chemical signal to lure the female mate.

Fig 7.12 Spider Dance Courtship

7.5.5 Courtship in Reptiles:

Reptiles have developed series of behavior to courts the female. Male assess the readiness and receptivity of their female mate before initiating the courtship. Crocodile uses a combination of water vibration and sprays to courts their sexual active females. Flying Lizard uses throat fans as a tool to attract their female. Turtle use a combination of visual and olfactory display in their courtship. Snake and some lizard use pheromones as a tool to attract their female.

Fig 7.13 Flying Lizard Courtship

7.5.6 Courtship in Mammals:

Mammals also show courtship in their behavior. A mammal usespheromones as a tool to attract their mate. Mammals are found to have Agonistic behavior in their reproductive strategies. Mammals Courtship follows the following process.

Step 1:Identification of sex partner- it involves the various sense like auditory, olfactory, optic and tactile. Male animal search by identifying oestrual signs of female.

Step 2:Courtship: Pheromones secreted attracts the several mates. Mammals have shown agonistic behavior during courtship. This behavior sometime results in hurts or loss of life.Male performs sniffing of vulva of urination by the female. Pheromones can be secreted by both sexes.

Step 3:Copulation: Mammals performs copulation by mounting on the female.

Example: Lions, Elephants, Dog, Cats etc.

Fig 7.14: Cats Courtship (Mounting)

7.6 SPERM COMPETITION

Sperm Competition refers to "Competition to fertilize an egg between sperms of two or more males". It is a form of post- copulatory sexual selection where female mates with multiple males. Malefollows a sperm competition theory where they produce millions of sperms, mates with multiple partners in a hope that they genes will be carried to the next generation. The more the number of sperms, better the chance of fertilization. So the sperm competition theory states that males should produce more sperms and ejaculate frequently whenever they are in danger or threats.Strategy has evolved around Threats and ejaculation. It further state that reducing the threats level reduce the frequency of ejaculation in male.

Advantage of sperm competition:

1. Sperm competition has led to increased diversity.

2. Sperm competition has led to developed of various strategies to increase paternity.

3. Sperm competition is prime source of various adaptations like larger testes, improving quality of spermatozoa or its structure to increase the longevity of spermatozoa.

4. Sperm competition ensures that fittest sperm fertilize the ovum.

5. Sperm competition ensures that female gets their offspring of superior genetic quality,

6. Sperm competition also ensures that offspring are quite variable.

Example of Sperm Competition:

1. Females Leopard mates with multiple male living in their surroundings. Female leopard has a unique adaptation where they can store the sperms of male. It is the Female who decides whose sperms will be used to fertilize the egg. It is the way in which leopard are ensuring their sexual selection and security from its young ones. No harm will be made to young ones as all male will be treating them as their young ones.

Fig 7.15: Leopards Mating

2. The cobalt milkweed beetle (*Chrysochuscobaltinus*) shows a unique strategy where the male rides on the back of the female for several hours. Male do this behavior to prevent the female from copulating with another male.

Fig 7.16 Cobalt Milkweed Beetle

7.7 SEXUAL SELECTION

Sexual Selection Theory was given by Charles Darwin.It states that traits like coloration, pigmentation, physical size etc. increase or decrease the attractiveness of the individual. The

levels of attractiveness define the success in obtaining opposite sex mates. He mentioned that traits improve its acceptance in opposite sex but it reduces its survival. Darwin noted that Sexual selection is a struggle among the male to access female. He found that two mechanism namely intrasexual selection and intersexual selection.Intrasexual selection refers to competition within the same sex (male-male compact).Intersexual selection is the selection of opposite sex from various individual of the same sex by another sex(Female is selecting from a group of sexually active male). Biologist have added a third mechanism named mate compulsion where there is a forced mating between the sex Example Tasmanian devil(Sarcophilus harrisii), Elephant Seal.Darwin stated that males possess certain specialized traits who have no role in their survival, their role is just limited to attract the opposite sex mate. These traits are known as secondary sexual characters like mane in lion, tusk in wild boar, vocal sacs in frogs, moustache and beard in humans. Traits used for intrasexual selection are called Weopens while traits used for intersexual were called ornaments.

Features of Sexual Selection:

1. Male sex was dominant than the female in all species.

2. Males secondary sexual characters are more pronounced in mammals and birds.

3. Males performed some pleasing activities like songs, dance etc. to attract their females.

4. A continuous struggle among males to get females especially during mating season.

5. Sexual selection doesn’t occur in female, it only found in males.

6. Sexual selection is only linked to reproduction while natural selection deals with the survival.

In Last 40 years, a lot of research had been done on the interpretation of Darwin Sexual Selection Theory. Some of its salient feature has been found to be partial true. Scientist have found about a phenomenon especially in mammals and birds where female decides the sperm which is going to fertilize the eggs. Females can simply disposes of male sperm. Female are controlling the natural selections process. Intra-sexual selection is happening in two different areas namely Males to Males fight which is physically done. Behind another intra-sexual selection is happening in the

form of sperm competition. Modern research has found that sexual selection is slightly biased towards females.

The basic essence of the Sexual selection theory is the development of good gene which are more disease resistant, have a better metabolism. Female have some preference of ornaments which they are looking in males mates. Theses ornament shows of a good gene with superior disease resistant, metabolism etc. These genes in turns benefits females. As Species success depends on offspring reproductive success not on the number of offspring. Species have evolved after an arbitrary set of female have mated with an arbitrary set of males possessed with some external ornaments. This initiated a genetic drift and after a few generation leads to group of individuals possessing quality which are different from others. Sexual selection forms the basic framework by which animals increases their ability to differentiate each other at the species level, interspecies level.

7.8 SUMMARY

Origin of Sex had happened some 2 billion years ago. This Origin has changed the animal world forever. Though the reason for it origin is still a matter of debates. Scientists have given some theory explaining the origin. These theory were divided into two section namely genetically and ecological hypothesis. Genetically talk about mutation and how to avoid the bad mutation, while ecological laid stress on parasites model where two species are evolving in co-existence.

The origin of sex brings an essential need for Animals for maintaining their population and genetic material was the copulation between the two sexes. Animals were living in groups, community or alone, they need to come in contact with the opposite sex with the sole objective of reproduction. Animals developed their own sex strategies based on climates, habitat and needs. These sex strategies were grouped into 2 Types namely K selection and R Selection. K selection was adapted by animals whose body size was small while R Selection was used by larger body size animal. Sex Strategies bring about the mating behavior with or without the domination of one sex. Some mating was owned by male or female sex. In others it used to be mutual. Each group of animals has developed their own mating patterns which are different from species to species.

Sex has led to increases in diversity and depth of animal kingdom. The theory of sexual selection states how Species have originated. Species have evolved after an arbitrary set of female have mated with an arbitrary set of males possessed with some external ornaments. This initiated a genetic drift and after a few generation leads to group of individuals possessing quality which are different from others. Sexual selection forms the basic framework by which animals increases their ability to differentiate each other at the species level, interspecies level.

7.9 TERMINAL QUESTION AND ANSWER

7.9.1 MULTIPLE CHOICE QUESTIONS:

1. Sexual Reproduction is more beneficial for an _____ size population.

a. Large b. Small

c. Intermediaryd. Depends on Species.

2. A Female Peacock select its mate having a large colorful tail. This is an example of _____.

a. Intrasexual selection b. Intersexual Selection

c. Feather selection d. Sexual Dimorphism.

3. Two Male Deer are fighting to mate with their Females. This is an example of _____.

a. Intrasexual selection b. Intersexual Selection

c. Feather selection d. Sexual Dimorphism

4. Traits used for intrasexual selection are called

a. Ornaments. b. Weapons

c. Secondary Characters d. None

5. Traits used for intersexual were called

a. Ornaments. b. Weapons

c. Secondary Characters d. None

6. Sperm competition is an example of

a. Intrasexual selection b. Intersexual Selection

c. Mating Selection d. Sexual Selection

7. A small group of animals living in a remote place, it has been observed that their tail have become shorter as compared to other animals. This observed shorter tail is an example of ____.

a. Mutation b. natural selection

c. sexual selection d. genetic drift

8. Which of the reproduction techniques is fastest and involves no loss of genetic material.

a. Sexual b. Asexual

c. Both speeds are same d. It depends on species

9. Secondary Characters traits _____ improve its acceptance in opposite sex but it _____ its survival.

a. Decrease, Increase b. Improve, Increase

c. Improve, Reduced. c. Increase, Decrease

10. Gorilla, Bonbon follows _____system of Mating in their group.

a. Monogamy b. Promiscuity

c. Polygynandryd c. Polygyny

11._____ fishmake a pattern of circles on the sea bed quite similar to crop circles.

a. Cat Fish b. Sea Horse

c. featherfin cichlid Processing d. Japnese Puffer

12. _____ hypothesis stated that each organism is the race between host and parasites.

a. Genetical b. Ecological

c. Sexual Selection d. Natural Selection

13. Sperm Competition is a _____ sexual selection.

a. Pre- copulatory b. Copulatory

c. Post- copulatory d. None of the above

14. Find the Odd One Out in terms of Reproductive Strategy Used:

a. Reptileb. b.Fish c. Insects d. Primate

15. Sex Selection Theory was given by _____ .

a. Darwin b. Weismann

c. Muller d. Crow & Kimura

16. Humans follows _____ reproductive strategies.

a. R b. K

c. Both d. None

17. Which group of vertebrates follows the K reproductive strategy.

a. Rodents b. Mammals

c. Birds d. Primates

Answer: 7.9.1

1(a) 2(b) 3(a) 4(b) 5(a) 6(a) 7(d) 8(b) 9(c) 10(c) 11(d) 12(b) 13(c) 14(d) 15(a) 16(b) 17(a)

7.9.2 Very Short Question:

1. What is Leks? Mention the role of Leks in Mating System.

2. How Male dominating Mating System are different from Female dominating Mating system.

3. Name the factors which affects Sex Strategies.

4. Name any two animals where female decides whose sperm is going to fertilize her egg.

5. Why we have so much diversity at species, interspecies levels.

6. Discuss how K Selection and R Selection Reproduction strategies are different.

7. Explain the theory given for Sex Evolution .

8. Write down key difference between Resource Defense Polyandry and Co-operative Polyandry.

9. Discuss the Step followed in Amphibian Mating.

10. Name the animals which follows forced mating in their reproduction.

11. Write the Salient Feature of Sexual Selection.

7.9.3 TERMINAL AND MODEL QUESTIONS

1. What do you mean by Mating. Discuss its Type.

2. Explain the concept of Sexual Selection. Explain how it had explained the reason for having some species.

3. Describe the concept of sperm competition. How it has led to increased diversity.

4. Differentiate between intrasex and intersex.

5. Explain how sex selection is slightly biased towards female.

6. How Promiscuity and Monogamy are similar and different from each other.

7. Discuss about the Animals who are known to have Finest Courtship in Nature.

7.10 REFERENCES

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7.12 GLOSSARY

Adaptation: The process of adjusting to the environment by undergoing changes.

Asexual Reproduction :A reproduction which doesn't require fusion of gametes.

Behavioral Adaptation: Adaptation done in their behavior by organism.

Binary Fission : A asexual reproduction which involves sepration of a body into two bodies.

Bisexual : An organism having both sex

Chromosomes: They are thread like structure in which DNA is packed.

DNA : genetic material in organism.

Eukaryotes: organism that contains nucleus and membrane bound organelle.

Extinction: The process through which a plant or animal species cease to exist

Fertilization: The process by which an ovum is fertilize by male gametes.

Fusion: The process of joining two unicellular cell combine together to become multicellular

Gamete: The organism reproductive cell

Genetic material: The hereditary material in a cell.

Intersex: sex between two species

Intrasex: sex within the same species

Mating: The action of animal to copulate to produce their offspring

Morphological adaptation: Adaptation done in their body structure by organism.

Mutations: Change of structure of gene which is transferred to several generation

Ovum: A Female Fertile sex cell that give rise to embryo after fertilization by spermatozoa.

Parasite : An organism that lives in another body

Pathogen: An microorganism that causes diseases.

Physiological adaptation: Adaptation done in their internal body regulation by organism.

Recombination: Rearrangement of genetic material

Sexual reproduction :A reproduction which doesn't require fusion of gametes

Spermatozoa: Male fertile sex cell that fertilize the female ovum.

Unisexual: An organism having only one sex.

UNIT 8: BIOLOGICAL RHYTHMS

CONTENTS

8.1 Objectives

8.2 Introduction

8.3 Circadian and Circa-Annual Rhythms

8.4Orientation and Navigation

8.5 Migration of Fishes, Turtle and Birds

8.6 Summary

8.7 Terminal Questions and Answers

8.1 OBJECTIVES

Study of this unit will let the students to:

- What is the concept of Biological Rhythms?
- What are the conditions of Biological Rhythms to be called as Circadian.
- What are the conditions of Biological Rhythms to be called as Circa-Annual Rhythms.
- How Circadian affects the health of Animals.
- How Orientation is different from Navigation.
- How Kinesis and Taxisare different from each other.
- What is the various tools animal use for navigation?
- Understanding the concept of Migration, it needs and significance.
- How migration of fish is different from Birds.
- How Migration is a Circa-Annual Phenomena.
- Understanding the factors which necessities the need to migrate.
- Understands the various types of migration in fishes.
- Understands the various types of migration in fishes.

8.2 INTRODUCTION

Animals have trained themselves with their environment, their surrounding and climatic conditions. Animals have morphed their body with the changing conditions even have formed a way to migrates thousands of km to mitigates the food shortages, harsh climatic conditions etc. Birds, Turtle and fish have evolved their biological rhythms on a daily basis and even on an annual basis. This behavior has been subjected to few stimuli prompted from internal change in body, their internal biological clock or change in their external environment. The animals have learned to arrange their position based on type and nature of responses. They respond by moving towards or away from the stimulus. Further their behavior has become an annual ritual marked by gonads changes, need of reproductions etc. This behavior requires navigating a large distance from the feeding grounds to breeding grounds. Animals have started to use earth, moon, stars even earth magnetic field as a tools in navigating them back to the place where they were born.

8.3 CIRCADIAN AND CIRCA-ANNUAL RHYTHMS

Every Living Organization undergoes a cyclic change in their body function or chemically flow. This is known as Biological Rhythms. This Biological Rhythm also includes physiological changes or change in activity undergoes daily, monthly, season wise, or annual in response to environment. This Biological Rhythms are divided into two type namely endogenous (controlled by internal biological clock body temperature) and exogenous (adjusting internal cycle in response to change in external environment like sleep/ wakefulness/day and night).

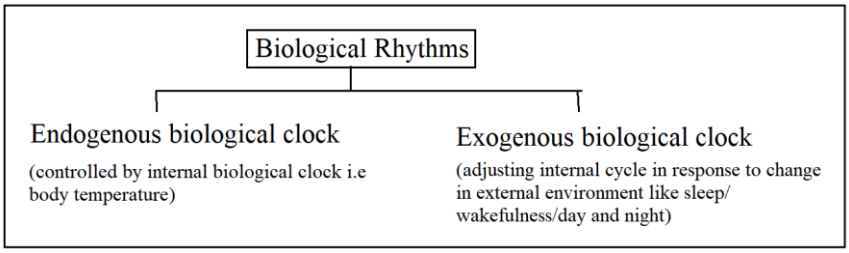

Diagram 8.1 Classifications Of Biological Rhythms

8.3.1 CIRCADIAN RHYTHMS:

8.3.1.1 Introduction: Circadian is the combination of term Latin words namely circa and Diem. Circa means around and Diem stands for day. So Circadian stands for changes in a living organisms occurring in a day i.e. 24 hrs. These changes are generally in response to light and dark. Circadian is an example of endogenous Rhythms, but they are subjected to changes after been expose to external cues called ‘zeitgebers’(German Name for ‘Time Givers’). Origin: The term circadian was coined by Franz Halberg in 1959.Halberg'sgave its definition as: The term "circadian" was derived from circa (about) and dies (day); it may serve to imply that certain physiologic periods are close to 24 hours, if not exactly that length. Herein, "circadian" might be applied to all "24-hour" rhythms, whether or not their periods, individually or on the average, are different from 24 hours, longer or shorter, by a few minutes or hours.

8.3.1.2 Criteria for a biological rhythm to be called Circadian:

A biological rhythm need to have the following three criteria.

1. The rhythm needs to have a period of 24 hours and should be of endogenous free- running. The free running implies that conditions should be constant.

2. The rhythms can be re trainable. The retainable means that rhythm can be reset after been exposed to external stimuli (such as light and heat). Example: Jet Lag. Jet Lag is account of change in time zone and the external stimulus had changed.

3. The rhythms should be acting in a constant temperature range.

8.3.1.3 Body Make and keep its own circadian Rhythms

Every Organism has developed a mechanism to develop their own circadian rhythms. They have been subjected to a series of natural factors like light, temperature etc. They have evolved in such a way that fits best with their survival. Thus they have been Selective in evolution. Some of the Animals have becomes Nocturnal and some Diurnal. Brain temperature, light intensity, light and dark cycle, body temperature etc. affects the biological clock of every tissue and organs. Every tissue and organs have their own circadian. These local circadian are controlled by a master clock in the brain. A group of nerve cells (neuron) forms the structure of managing circadian called suprachiasmatic nucleus, or SCN. SCN is a part of hypothalamus which receives input from our eyes.

8.3.1.4 How do circadian rhythms affect health?

Circadian rhythms can influence important functions in our bodies, such as:

i) Sleep Patterns: Animals have adjusted their lifestyle with the cycle of light and dark. They have their sleep patterns according to the cycle. Any disruption in sleep is bound to have a significant effect on the animals. All the habits like eating, digestion etc. are depending upon them

ii) Hormone release: Research has found that SCN controls the production of melatonin hormone. The melatonin hormone regulated the sleep. Level of melatonin depends upon the light intensity. Generally in human when the level of light become less, the quantity secreted by SCN increase, which leads to drowsiness.

iii) Eating habits and digestion: Every organism eating habits and its corresponding digestion is depending upon circadian. Circadian also effect blood pressure, Heart Rate, Appetite, Body Response to stress and medications of an organism. These all factors affect the eating habits and digestion.

iv) Body temperature: Body temperature is also having an effect of circadian. All Body Parameters like blood pressure, Appetite etc. affects the body temperature.

8.3.1.5 Factors which change circadian Rhythms:

i) Mutation: Scientist have found that PER mutation in mice and human effect the sleep patterns. They have found that in some insects like fruit fly etc. have mutation which effect their sleep pattern ,

ii). Work Condition: Exposure to artificial lights, working in late nights etc. have resulted in change of Circadian Rhythm behavior.

iii). Life Style: Late rising, late sleeping, and active night life have ended in changes to the normal circadian Rhythm.

8.3.1.6 Effects of changed Circadian Rhythms:

These changes can cause sleep disorders, and may lead to other chronic health conditions, such as hormonal imbalance, digestive problem, depression, obesity, diabetes, feeling of fatigue, bipolar disorder and mental health disorder. In animals Circadian Rhythms are an pattern of weather condition, its corresponding physiological changes, behavioral changes, food availability, strategies against predators and above all there survivability. Any change in Circadian rhythms is bound to effects their survivability.

8.3.2 CIRCA-ANNUAL RHYTHMS

8.3.2.1 Introduction:

Circa-annual rhythms are endogenous generated biological rhythms. They are the combination of two words namely Latin word named circa and English word annual. Circa means around and annual means for 12 months or a year. So Circa-Annual Rhythms stands for changes in a living organisms occurring in a whole year. **Origin:** The term circa-Annual was discovered EboGwinner and Canadian biologist Ted Pengelley.

8.3.2.2 Criteria for a biological rhythm to be called Circa-Annual:

A biological rhythm need to have the following three criteria.

1. The rhythm needs to have a one cycle of 24 hours spread over a period of 12 Months that will persist and reoccurs.

2. The rhythms can't be retrainable. These processes will continue even if there is some change in the environment. Example: Migration, Seasonal Mating etc.: Fish, Birds, Mammals start with their migration at a certain season irrespective of any change in their surroundings. This means that animals will not change its behavior even in artificial environment where seasonal cues have been removed.

3. The rhythms don't change with temperature.

8.3.2.3 Organisms has a unique Circa-AnnualRhythms:

Every Organism has a developed mechanism of Circa-Annual at the time of their birth. Organism is bound to show that behavior at a particular time or season even if external environment parameters change. They might be a delay or promptness of few days of showing a Rhythms, but it is bound to happen. Example: Plants can blossom early or Animal can delay their migration by a few days. Squirrels were put in an artificial environment having 12 hrs. of light and dark. Still the animal showed hibernation. It was account of their written Circa-Annual which have passed across generation.

8.3.2.4 How circa-Annual rhythms doeffects the survivability of Animals:

Circa-Annual rhythms have influenced Animals in their survival:

i) Time to prepare: Circa-Annual rhythms give the animal sufficient time to prepare it for changing climatic and topological environment in their surroundings. Example: Birds and Mammals start to grow their fur at the onset of autumn and shed them at the onset of spring.

ii). Avoid Food Scarcity &Adverse Climate: Animals moves through their annual migration covering thousands of km from one part of globe to another. Animals moves in search of food, water and to get away from adverse climate. Their Migration are timed in a certain part of season. Crane migrate from Siberia to South East Asia country in winter to avoid extreme cold weather. Whale do their annual migration from cold water to warm water in winter and warm water to cold water in summer.

iii). Better Reproduction Strategy: Animals have used their Circa-Annual as a part of their reproductive strategy. Animal's Reproductive organs change in response of photoperiod duration. Male organs get enlarged during the spring season for mating. In certain animals Female are in heat for a certain period in a year. Their strategies are well in placed to avoid inter-species competition and increase their reproductive success.

iv). Give better chance of survivable to Young Ones: Animals mates in a certain season and timed their young ones birth with a period which have a better chance of survivable. Majority of Animals gives birth at a times thus giving a chance that some young ones will survive.Birds like Parus major (common name-great tit)timed their chicks hatching with arrival of protein rich food in form of winter moth caterpillar.

8.4 ORIENTATION AND NAVIGATION

8.4.1 ORIENTATION:

8.4.1.1 Introduction:

Orientation means the current position of the animals with reference to earth gravity. The reference point can be any resource location like food, water or home etc. Every organism has to find a way to get optimized living condition for it survival. The adverse condition need to be avoided. The sensory organs play an important role in guiding through adverse condition to favorable condition. This guidance is done by animal through random or actively controlled movement in space. This change of position is known as Orientation Behavior.

Definition of Orientation: The ability of an organism to direct (orient) its positions and movements in space and time according to certain conditions and events, or by spatial adjustment of animal towards or in response to various stimuli.

8.4.1.2 Type of Orientation:

Orientation is divided into two different ways namely:

8.4.1.2.1 Based on the Factors which are aiding or not aiding. They are

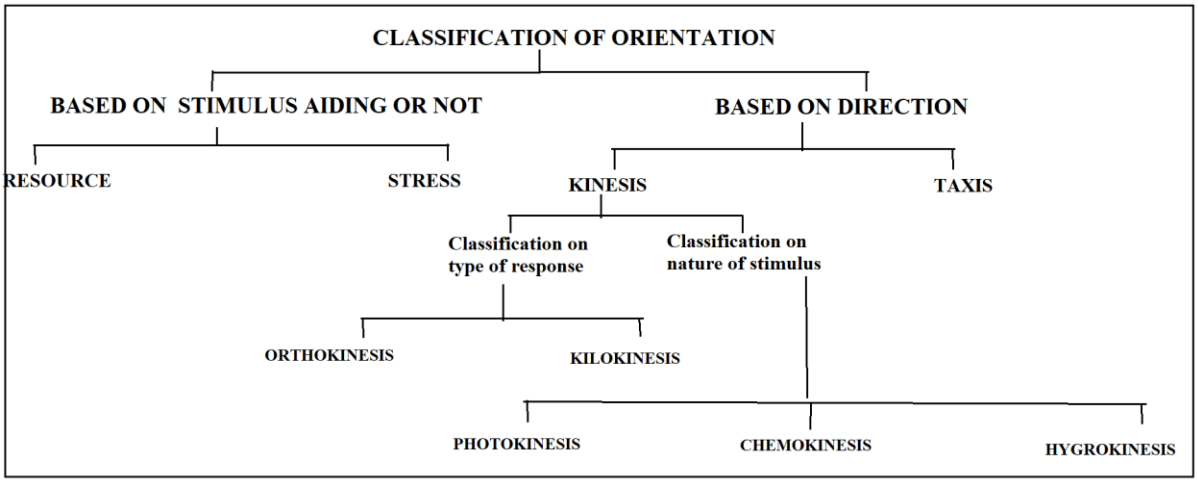

Fig 8.2: Classification of Orientation

i) Resources: it refers to all the stimulus which are aiding the animals

ii) Stress: They refers to all the stimulus which are stopping the animal.

Orientation is further is divided into Kinesis and Taxis based on the direction they taken while undergoing alteration in their position.

Classification of Orientation Based on Direction

Kinesis are unidirectional and movements areafter been subjected to one stimulus while Taxis are directional in respect to spatial position and been subjected to multiple stimuli. The Taxis are more complex than Kinesis.

8.4.1.2.2.1 Kinesis: it is a simplest form of orientation. The response of animal is unidirectional. The response is totally depending on intensity of stimulus. Animal movements are not related to a sensory stimulus but the stimulus cause an alteration in speed or direction of movement.

Definition:A type of movement in which an organism's response is related to the intensity of the stimulation but is not oriented in any spatial direction.

Kinesis is further divided into based on Response Type and Stimulus Nature.

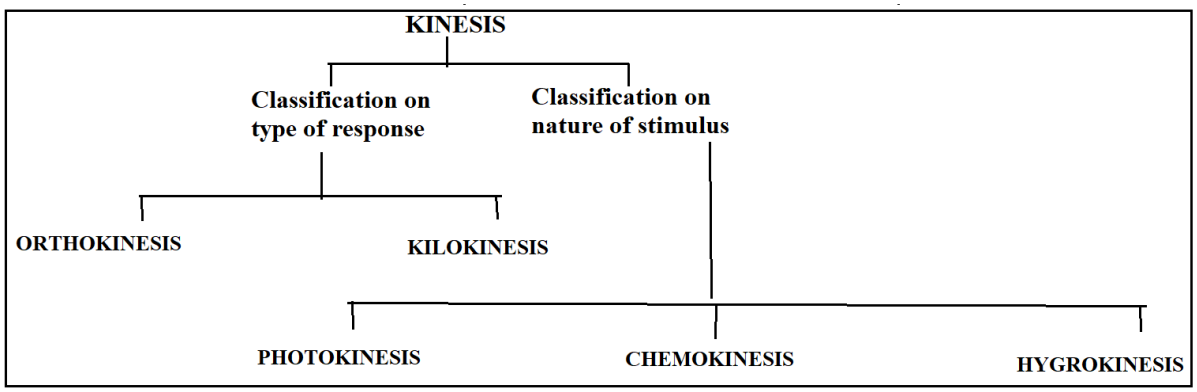

Fig: 8.3 Classification of Kinesis

1. Classification on Type of Response:

i) Orthokinesis: In Orthokinesis a relationship exists between speed of locomotion and intensity of stimulation. Example Wood lice. Wood lice move actively in damp site when humidity level is low but less active in high humidity condition. Cockroach move in all direction once the light is switched on. They move to dark area from light area.

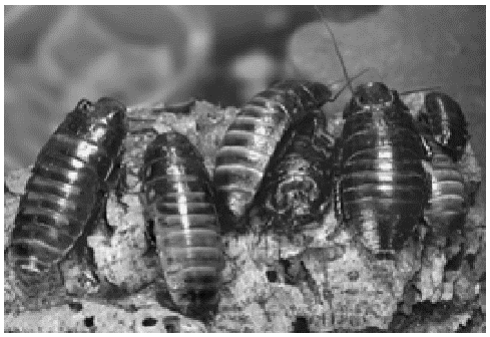

Fig: 8.4 Cockroach

ii) Kilo Kinesis: In Kilo Kinesis, the rate of changes of direction of the animal increase as the intensity of stimulus is increased. Example: Paramecium: Paramecium exhibits a change of rate in direction in response to change in concentration of Carbon dioxide (CO_2).

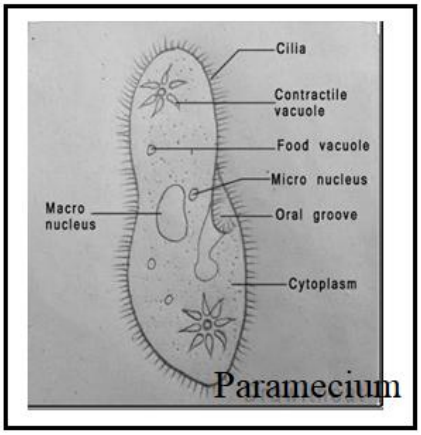

Fig :8.5 Paramecium

2. Classification on Nature of Stimulus:

i) Photokinesis: Velocity of movement of body changes in response to light intensity. Example: Tunicate Larva, Euglena gracilis. Swimming rate of Euglena gracilisspeed up with increased light intensity till its reaches a certain saturation level. Sea slug (Discodorisboholiensis) moves slowly at night, but much faster during daylight hours.

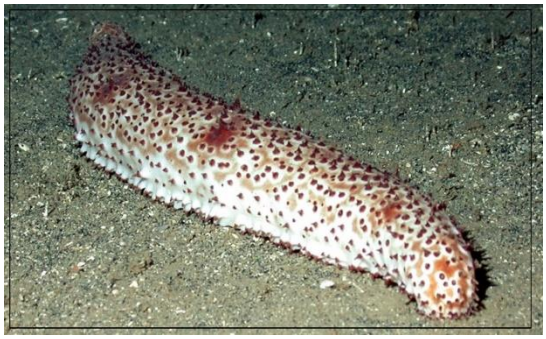

Fig 8.6 Sea Slug (Discodorisboholiensis)

ii) Chemokinesis: movement like changes in speed, direction occurs in response to some chemical substance: Example: Bacteria

Bacteria change their locomotive speed in response to chemical substance.

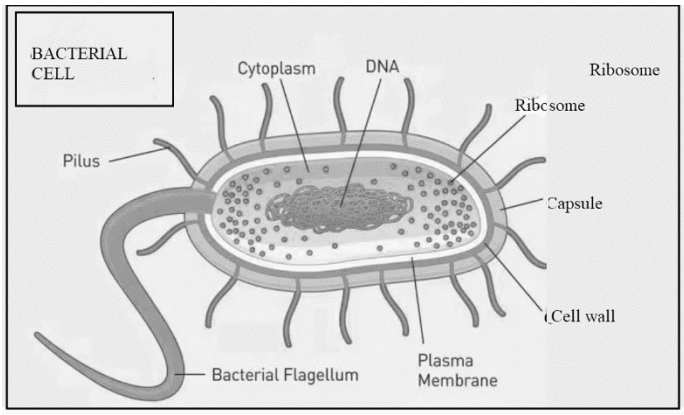

Fig 8.7 Example: Bacteria

iii) Hygrokinesis: Velocity of movement changes in response to change in humidity. Example: Planaria: Planaria show increase movement when as humidity level falls.

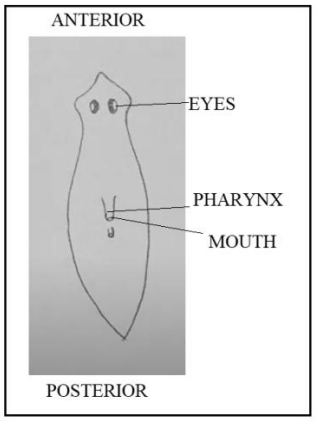

Fig 8.8 Example: Planaria

8.4.1.2.2.1 Taxis

1. Introduction:

Taxis are the term given to movement of an animal in response to stimulus. In Taxis animals orients itself in a spatial relationship to a stimulus. The movement can be a change in body position or change in direction to move or get away from stimulus. This involves change in speed, direction or both. An entire range of stimuli are taken into account like light, gravity, moisture etc. while undertaking an alteration.

A List of Stimulus have been listed below in a table.

Stimulus	**Type**
Light	Phototaxis
Gravity	Geotaxis
Moisture	Hygrotaxis
Fluid Flow	Rheotaxis
Change In temperature	Thermotaxis
Physical Contact	Thigmotaxis
Taste	Chemotaxis
Wind	Anemotaxis
Darkness	Scototaxis

2 Types of Taxis: Taxis are classified into 2 Types based on response control. They are Open-system control and Close-system control.

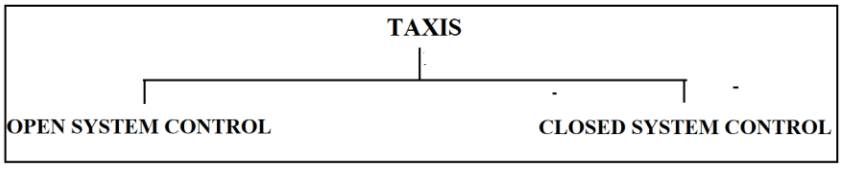

Fig8.9: Classification of Taxis

1. Open-system control: In Open –system control animal respond to the initial stimulus. Later animal shows no response to the same stimulus which are repeated. Example: Male Firefly: Male Firefly locates female by their brief flashes of light. Male continue to move in the direction of female even do female have moved from their position.

2. Close-system Control: In close-system control, animal continuously change its response based on feedback received. Example: Bat: A bat while chasing an insect continuously alters its flight subjected to change in insect flight.

8.4.2 Navigation:

Introduction:

Navigation means the approach through which an animal can reach its final destination from its current position. **Treccani** define animal navigation as "the ability of an animal to reach a spatially defined and limited destination, even relatively far away". Therefore, it does not include shifts towards an already perceptible destination (visible, odorable, etc.) upon departure. Animal reach a prescribed location after browsing a distance in search of food, water etc. This phenomenon is called homing (return to its home). They use a mechanism to remember the right path even in unknown location by combining different navigation systems.

Type of Navigation Tools:

A animal need to have 2 pre-requisite information before it started to move.

1. Reference Point: Animal need to remember some reference points which are encoded in their memory and measurable by them based on their own movements.

2. Biological Clock: Animal also have a sense of Time remembering their biological Clock (Set of Physiological activities spread over a day).

Animals use 4 different types of Tools for Navigation:

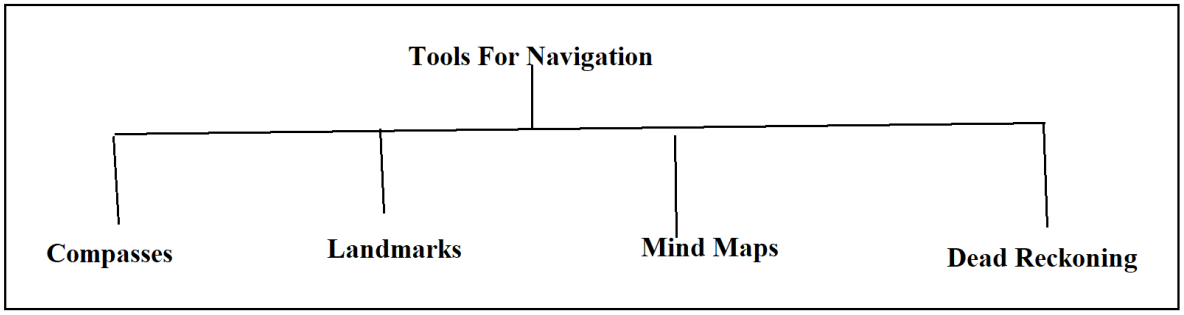

Fig 8.10 Tools for Navigation

i) Compasses: Compasses is use of earth magnetic fields as Navigation Tool. Animal using Compasses as a tool have an inmate ability to understand the direction by marking certain landmarks as point of reference and orient them accordingly.

There are 4 types of compasses Navigation:

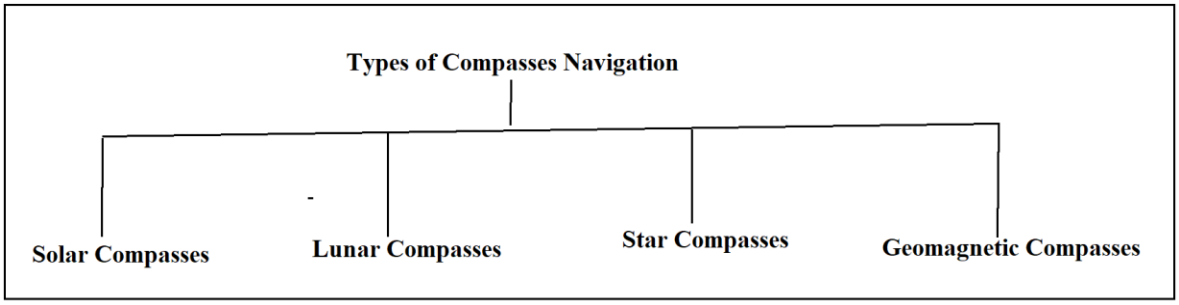

Fig 8.11 Types of Compasses Navigation

a. Solar Compasses: Animals use solar as a compass to decide their navigation directions. The sun moves nearly 15^{o}every hour. So animals re orient their reference point by taking care of solar rotation. Example: Starlings (*Sturnus vulgaris*), Wild pigeons(*Columba livia*).

Some animals use the wavelength generated after the polarization of the sun rays to find directions of their navigation. Monarch Butterfly (*Danaus plexippus*) and some Chiropteran use the polarization as a tool for Navigation.

b. Lunar Compasses: Some Animals use moon as a Compass to find their navigation direction. Example: Sandhoppers, tiny crustaceans that live buried in sandy beaches. They use solar and Lunar Compass to generate their navigation direction.

Dung Beetle (*Scarabaeus satyrus*) use the wavelength generated after polarization of moon light to get the direction for navigation

c. Star Compasses: Star Compass are been used by migratory birds during their flight in nights. Birds use sun and star imprints to orientate them and navigates to their destination. Birds have molded there organs to contribute in navigation support. Example: Golden Cheeked Warbler:

Fig 8.12 Golden Checked Warbler

These endangered birds move between central Texas in USA to southern Mexico each year. These birds have undergone a change in their organs to aid in navigation.

i) Eye: Eye is used to take the pattern of sun and star. Eye also co-ordinate with the brain to sense magnetic navigation and take a decision on direction.

ii) Ear: A tiny concentration of iron in inner ear helps to get the magnetic field of the earth.

iii) Beak: Beak acts as an olfactory device to map the magnetic fields of the earth.

Thus these three organs work together to aid the birds in navigation.

d. Geomagnetic Compasses: There are some places in our earth where solar, Lunar and star compass are not visible or having an effect like Deep Sea etc. Animal living in those habitats resort to the earth own magnetic field to help them in navigation. Example: Green turtles (*Chelonia mydas*), Bogong moths (*Agrotisinfusa*) . Green Sea Turtle are known to undertake large migration with some spanning over 1,600 miles. They use the earth own magnetic to navigate through such a long distance.

ii) Use of Landmarks: Animals use landmarks (environmental references) as a cluefor navigation. This navigation of using landmarks is known as piloting. This behavior has been derived from stimulus-responses association. The Landmarks can be visual, olfactory, tactile. Example: Clark's nutcracker (*Nucifragacolumbiana*),terraiola wasp. Clark's nutcracker (*Nucifragacolumbiana*) is a bird which hides up thousands of seeds in autumn. This bird uses a landmark to get those seeds to be consumed over several months.

iii)Use of Mind Maps: Some animals makes a cognitive map (A representation of all the object present in that location) in their mind. Animals are able to reorient themselves even if some environmental clue are removed. This learning is spontaneous and passive and independent of any reinforcements. Example: Rats, Bee. Rats are quite fast learners identify the shortcuts and circumvention strategies. They created a visual copy of their surroundings and take a decision accordingly.

iv) Dead Reckoning: Some animals have started to navigate using a blind estimation). This mechanism is self-learning mechanism where animals moves to a certain point knowing the distance and angles from its source(starting point). It is a complex phenomenon supplementary by clues such as odor, geomagnetism etc. Example desert ants (genus *Cataglyphis*), Honey Bees(*Apis mellifera*)

Desert Ants live in anthills dug into the ground. They explore the territory around them in search of food, reaching hundreds of meters away in disorderly paths. But their return takes place in an almost straight line (the shortest route).

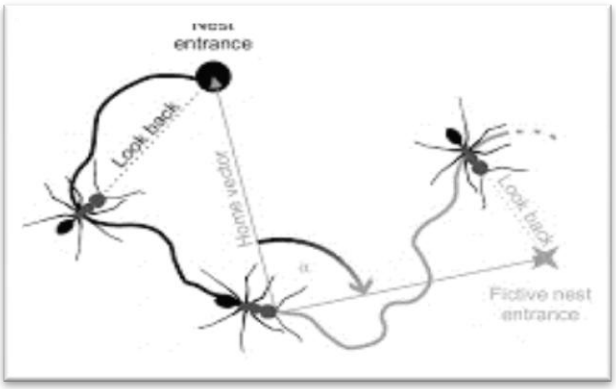

Fig 8.13 Navigation in Desert Ants

8.5 MIGRATION OF FISHES, TURTLE AND BIRDS

Migration:

The word Migration has come from Latin word 'Migrara' which means going from one place to another. Migration are circa-annual rhythm where all or part of an animal population move from one place to another regularly once in a year. They also revert back to the place from where they started to migrate. Migration has been seen in birds, Hoofed animals, bats, whale, porpoise, seal,

Fishes, crustaceans and Insects. They migrate for getting food, water, escape harsh weather and mating.

Definition: Thompson in 1942 define Migration as "Migration is a shift in what may be called center of gravity of the population".

8.5.1 Migration of Fishes

Cohen in 1970 states that nearly 8000 fresh water and 12000 marine fish & diadromous(Who moves from marine to fresh water) species show migration.

Types of Fish Migration based on their needs

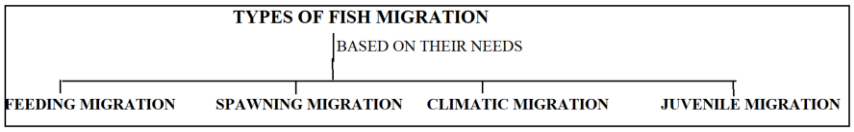

Fig 8.14 Classification based on Fish Migration on their needs.

1. Feeding Migration: This migration is for finding suitable feeding habitats.

2. Spawning Migration: This migration happens during breeding season for finding suitable spawning ground

3. Climatic Migration: This migration happens to avoid adverse climatic conditions. It is a seasonal migration which happens during a certain period when the climatic conditions turn worse and moves to some suitable climatic conditions habitats.

4. Juvenile Migration: This migration happens when fishes larval migrate from spawning ground to their feeding habits of parents.

Types of Fish Migration:

Fish Migration is classified into following types:

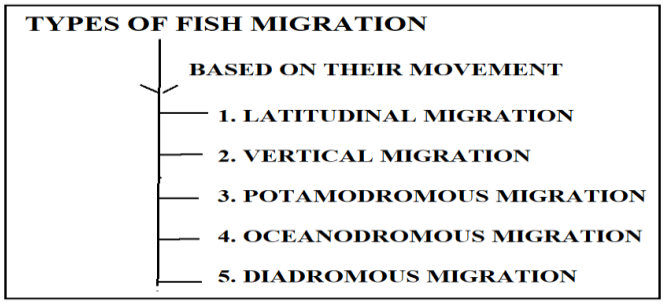

Fig 8.15 Types of Fish Migration

1. Latitudinal Migration: This is a climatic migration of fishes from north to south and vice versa. This migration happens in the months of spring and autumn to get away from harsh environment. Example: Swordfish, Barracudas.

2. Vertical Migration: This is a daily migration of fishes from ocean depth to ocean surface and vice versa. This is on account of food, or to get away from their adversary. Example: Sword Fish, Squid

3. Potamodromous Migration: This migration happens in fresh water where fish moves from one habitat to another in search of food or need of spawning. Example: Carps, CatFish

4. Ocenodromous Migration: This migration happens in ocean where fish move from one habitat to another in search of food or need of spawning: Example: Tuna, Clupea.

5. Diadromous Migration: This migration happens between ocean water and fresh water. This happens for the needs of mating and gives births to their young ones. They are true migratory fish.

Diadromonus are further classified into 3 types:

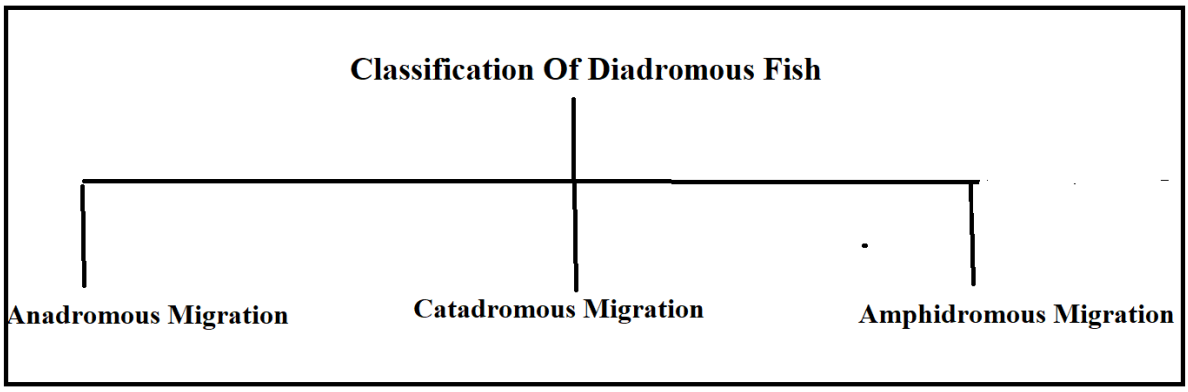

Fig 8.16 Classification of Diadromous Fish

i. Anadromous Migration: A migration from ocean to fresh water for spawning. These Marine Fishes spent most of their live in ocean but come for mating and giving birth to young ones. Example: Salmon, Hilsa, Sturgeon etc.

ii. Catadromous Migration: A migration from fresh water to marine water for spawning. These Fresh Water Fishes spent most of their live in rivers but come to marine waters for mating and giving birth to young ones. Example: Freshwater Eel.

iii. Amphidromous Migration:A migration from fresh water to marine water and vice versa for the purpose other than spawning, it can be of food, shelter etc. Example: Megalopa, Chanos (common name- milk fish) etc.

Migration in Eels:

Migration in Eels is the most sought migration in Catadromous Types of Migration. Freshwater Eel starts to prepare for their migration by changing their color from yellow to metallic silver, shrinking of digestive tract, eye become larger; snot becomes sharper and gonads becoming mature. These silver color eel enters sea and navigates thousands of kilo meters to reach their breeding ground. Adults die after mating before laying eggs in deep waters.

Eggs hatch into little, transparent leave shaped larva called Leptocephalia. They have sharp needle like teeth for feeding. They grow into elvers or glass eel having a length of nearly 8 cm with cylindrical bodies. These glass eel flow with the ocean current and enter the rivers. These eel finally settle down in the rivers. These glass eels grow to become yellow eel (Sterile Eel) in few years. Scientists have found that eel uses Lunar compass in their navigation. They migrate from sea to fresh water and vice versa only in night.

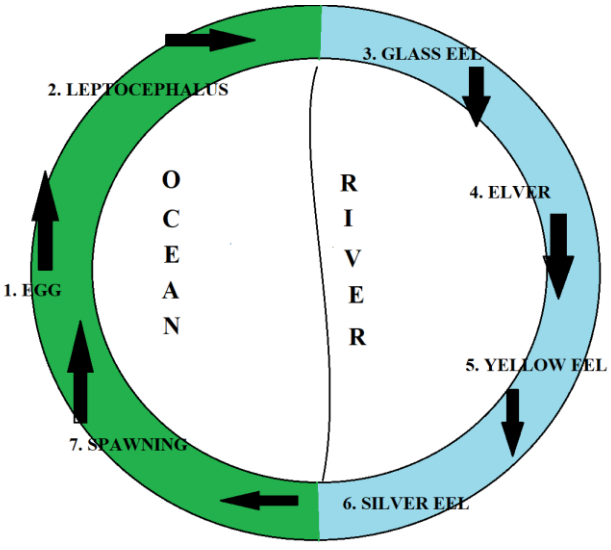

Fig 8.17 Stages of European Eel (Anguilla vulgaris)

Migration in Salmon: Migration in Salmon is the most sought migration in Anadromous Types of Migration. In winter months Fish start to move from their feeding grounds towards the fresh water river. Salmon have started to adjust their body to live in fresh water by changing their color into dull reddish brown from silver. They also stop feeding. They navigate through the river obstacle and finally reaches their breeding ground. They mate and lay their eggs in the river stream. Once the egg are laid, the adult salmon dies.

Eggs hatched into larval fish called Alevins. These Alevins is the juvenile stage feeding on zooplankton and aquatic invertebrates, mayflies, caddisflies, stoneflies and worms. They develop to fry and finally into adult smolt fish.Oncethey have become adult fish, they started to move towards ocean for the need of food. They spent their 3 or 4 years in ocean. They finally return to the places where they are born.Recent research has found salmon use the earth geometry compass while moving from ocean to rivers. While navigation from river to sea in their early day fish keep a track of the earth geometry. They kept in their location and use it while navigating back from ocean into rivers.

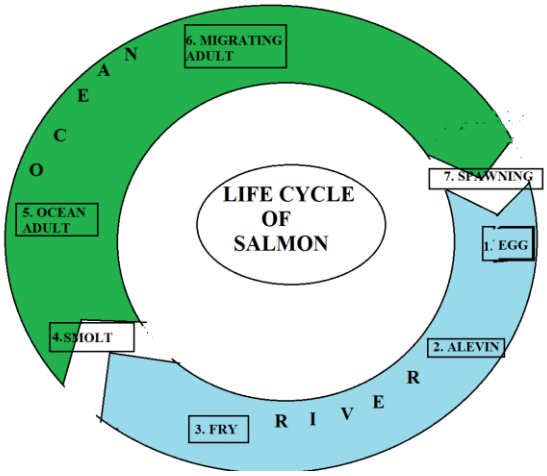

Fig 8.18 Stages of Salmon

8.5.2 Migration of Turtle:

Turtle are known to cover one of the longest migrations on the earth. They nest in tropical and sub- tropical region of the earth. Male and Female turtle moves from the feeding habitats to their spawning area (area where they were born). They migration involves covering distances spread over few thousands of Kilometers. Leatherback turtle moves from the Caribbean coast to Canada

or from Indonesia waters to California. In Feb 2020 a sea turtle Yoshi was tracked to cover a distance of 22,000 km from Australia to Angola on the African Eastern Coast.

These turtle use a combination of sea current, ocean temperature, earth magnetic fields, Lunar Compass etc. in deciding the navigation and orientation.

Migration in Green Sea Turtle:

Green sea Turtle are recognized by its shell. Shell are heart shaped and smooth having a blend of color like brown, olive, grey and black. The adult turtle are of length 3 to 4 feet with weight around 300 pounds. Green Sea Turtle live in warm tropical and sub-tropical waters. They come to land only for laying their eggs. These species are known to highly migrative and takes complex migration movements.

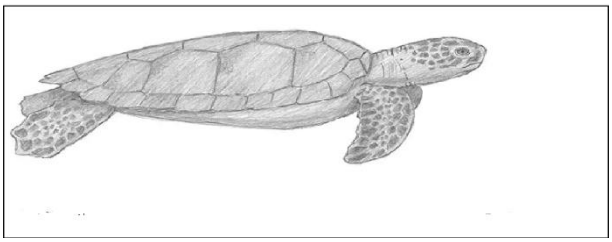

Fig 8.19 Green Sea Turtle

Green sea turtle mating season starts in late spring or early summer. Male Turtle come to shallow water to wait for female turtle. They mate in that water. After few weeks female come to the shore and lay their eggs by digging a hole in the sand. She lay 75 to 200 eggs at a time. Once the eggs are laid female turtle returns to water leaving eggs on their own.

Two months later eggs hatch and hatchling comes out. They small turtle overcomes all obstruction and move straight to the sea. Small turtle transforms into juvenile turtle and finally into adult turtle.

Migration in Leatherback Sea Turtle:

Leatherback Sea Turtle are the biggest turtles among all the species of turtle found in earth. They can measure upto8 ft and weight of 2000 pounds. These turtle species have no carapace but a hard and rubber skin strengthened by thousands of tiny bone plates which protects them. These turtles are found in Atlantic, Pacific, Indian Ocean spread over tropical and sub-tropical region.

Leatherback turtle are most migratory turtles. Mordern Research have found that these turtle can navigates upto 15,000 Km from their feeding habits to their breeding grounds Turtle use earth magnetic fields to navigates. Turtle have a particle named magnetite in their brain which is a magnetic in nature. This helps in arranging the turtle with the earth magnetic field and navigates back to those grounds or beaches where they were born.

Adults and Females start to navigated from their feeding habitats to their breeding grounds. Male Turtle reaches early and stay in shallow waters waiting for the female to arrive. Once Female arrives they mates. Male can mate every year but female mates in 3 years. Once the mating is done, Female comes to beach to lay their eggs. The eggs are laid in a cluster of 100 by building a nest by digging sand. Female go to ocean after laying the eggs.

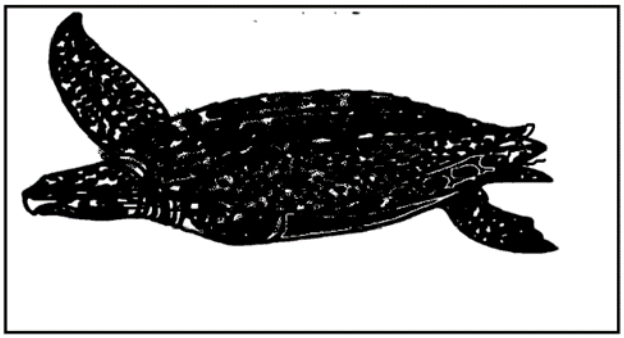

Fig 8.20 Leather Back Turtle

After 60 days small turtle comes out from the egg. They have the natural instance to move towards oceans. Baby turtle have a magnetic impression of beach where they will come back to lay their eggs.

8.5.3 Migration of Birds:

Causes of Migration In Birds: Migration in birds occurs in a certain season or month, their routes are generally fixed. There are certain factors which aids the birds to migrates

1. Instinct Behaviour: Birds undergoes change in gonads which brings an instinct behavior to move to their breeding grounds for need of mating.

2. Scarcity of Food: Scarcity of food associated with the decrease of daylight and increase of cold brings an endocrinal change in birds body which aids in migration.

3. Photoperiodism : The increase in day light duration effects the pituitary and pineal glands of the birds. These glands stimulate the gonad which acts as a stimulus for birds to start the migration. Siberian Crane, Geese, swan starts to migrate back to Siberia from India fromearly March.

4. Seasonal Variation: The change in seasons effects the internal conditions of gonads in birds. The change in gonads acts as a stimulus to initiated the birds for migration.

Types of Birds Migration:

Birds Migration is classified into following types:

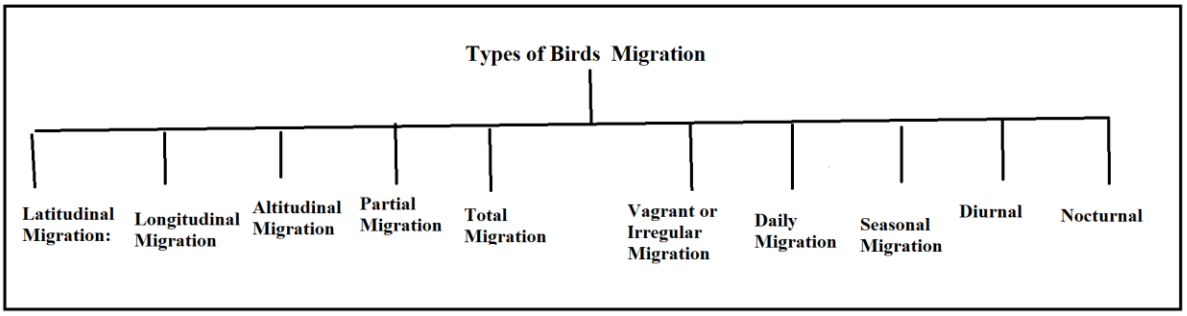

Fig 8.21 Types of Birds Migration

1. Latitudinal Migration: This is a climatic migration of birds from north to south and vice versa. Example: Cuckoo, Penguins.The Indian Koel breeds in India and spends the summer atSouth-east Africa.

2. Longitudinal Migration: This is aseasonal migration of birds from east to west and vice versa. Example: Starlings (*Sturnus vulgaris*),

3. Altitudinal Migration: This migration happens in mountains region when the birds migrate from higher reach to lower reach. This happens in the winter months. Example: Golden Plover

4. Partial Migration: This migration happens when only a part of population of a bird species moves from one place to another and vice versa. Example: Blue Jays in Canada

5. Total Migration: This migration happens when the entire population of the species moves from one place to another and vice versa. Example: Arctic Tern (*Sternaparadisaea*)

6. Vagrant or Irregular Migration: This migration happens for safety and food. It happens for a short duration and is not regular. Example: black stork (Ciconianigra),Glossy ibis (*Plegadis falcinellus*), spotted eagle (*Aquila clanga*), and bee eater(*Meropsapiaster*).

7. Daily Migration: Birds moves away from their nests to a designate location on daily basis under the influence of climate. Example: Crows

8. Seasonal Migration: birds migrate at different seasons of the year for food, breeding etc. Example: Cuckoo

9. Diurnal: These birds migrate in day time only in search of food. Example: Crows, Robins, Hawks, Jays, Blue birds, Pelicans, Cranes, Geese etc.

10. Nocturnal: These birds migrate in night time only. Example: Sparrow, Warbles etc.

Mechanism in Birds Navigation:

Birds are guided by number of factors

i). Earth's Magnetic Field: Birds use the earth magnetic fields in their navigation. The coriolis force coming due to earth rotation plays a significant role in their navigation while migration.

ii) Sun: This concept that birds use the sun direction while navigation was first given by Gustav Kramer in Germany and G.V.T Matthews in England. They use pigeon to demonstrated the concepts and concludes that pigeon uses the sun as a compass and its own internal clock while calculation the orientation in their flight.

iii) Stars: This concept uses the stars position while navigation in night was given by Sauer. He uses the warblers to demonstrated and conclude that birds have hereditary ability to navigates by using stars during their flight.

Advantage:

i) Birds Get Food Resources, Good environment

ii) Get away from Harsh Environment like cold etc.

iii) Birds gets a good environment to breed and take care of young ones.

iv) They play an enormous role in environment by controlling the insects, pests populations.

Disadvantage

i) Many young ones lost their lives in course of journey.

ii) Sudden change in climate results in number of death.

iii) Many human build structure like high rise building, light houses etc. obstructs there navigation resulting in deviation from their path, which result in death.

iv) Humans have been killing those birds for their leisure and fun activity.

Migration in Arctic Tern:

Arctic Tern are the animals with one of longest migration on earth. These birds migrate from Arctic circle to Antarctic circle covering a distance of close to 30,000 k.m. They breed in Arctic in summer and migrate to Antarctic in winter. This is due to the fact that Arctic and Antarctic summer are in opposite to each other. It means that when Arctic have summer, it is winter in Antarctic. Arctic Tern are quite sensitive to day –light duration. They continuously fly in the direction with longer day-light duration. These birds lives in large social group and are monogamous in their life span. Breeding starts in their 3^{rd} or 4^{th}Year. Courtship is quite elaborate with female chasing the males and then males sharing the fish with females. Both sexeschoose the place to build nest. Female make the nest with male sharing the food. They mate and lays 2 to 3 eggs in their nest. They bird are quite territorial and quite furious in protecting their nest. Male and Female both share the responsibility of feeding, protecting young ones. They feed the young ones for few days till the time these birds start to find food by themselves. These young ones flew with the parents during the migration.

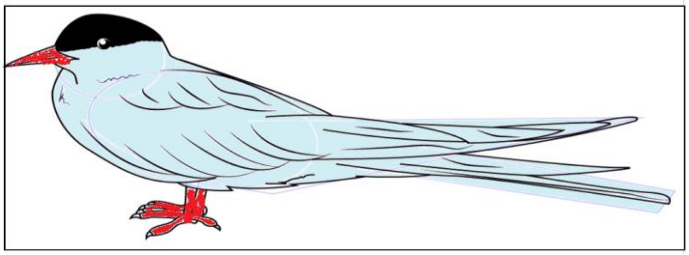

Fig 8.22: Arctic Tern

8.6 SUMMARY

Animals are subjected to a lot of factors in the daily life. These factors can be environmental like physical, chemical, climatic and biological stimulus etc. or internal factors like body temperature, size, food, habitats, mating rituals etc. Animals have evolved an unique habits for each activity. They have developed their own communication signals and social behavior patterns. Animals show these behaviors after been subjected to these factors. They undergo a cyclic change in in their body function or chemically flows known as Biological Rhythms. Diurnal animals generally gets active at day-length while nocturnal animals gets the same at night time. This behavior continues on a daily basic known as Circadian. Every animal have developed their own circadian subjected to a series of factors like light, temperature, humidity etc. Every tissue and organs have their own circadian. These circadian in turn makes the biological clock. These circadian can be extended on a season basics where each season come annually. Animal behave differently in each season as the factors changes from one season to another. This Biological Rhythms happens in a year is known as Circa-Annual Rhythms.

Migration is a type of circa-annual rhythms where animal migrate from one place to another. This migration happens in search of food, better climatic conditions etc. Animals have evolved to match their activities with the migration. This migration involves need to travel a huge distance. This travelling involves the need to have some tools which can navigate them. Sun, Moon, Star and Earth own magnetic fields have been used by animals especially birds, turtle and fishes in their migration. During navigation the need arise to stay close to each other and stay a safe distance from each other. Orientation helps them in those objectives. Orientation is of two types namely kinesis and Taxis. Kinesis are unidirectional and movements are after been subjected to one stimulus while Taxis are directional in respect to spatial position and been subjected to multiple stimuli.

8.7 TERMINAL QUESTION AND ANSWER

8.7.1 MULTIPLE CHOICE QUESTIONS:

1. _____ are known to cover maximum distance in their migration.

a. Fish b. Birds c. Turtle. d. Depend on Species

2. _____ is a type of orientation which is directional and happens due to several stimulus.

a. Kinesis b. Taxis c. Both a and b d. None of them.

3. _____ is a type of orientation which is unidirectional and happens due to one stimulus.

a. Kinesis b. Taxis c. Both a and b d. None of them.

4. There are _____ types of birds migration.

a. 7 b. 8c. 9d. 10

5. Salmon migration is an example of _____ migration in fishes.

a. Anadromous b. Catadromous c. Amphidromous d. None

6. Eel migration is an example of _____ migration in fishes.

a. Anadromous b. Catadromous c. Amphidromous d. None

7. Turtle use _____ tool for navigation

a. Solar Compass b. Moon Compass c. Star Compass d. Earth Geo magnetic

8. Pigeon use _____ tool for navigation

a. Solar Compass b. Moon Compass c. Star Compass d. Earth Geo magnetic

9. Biological Rhythms happens in an year is known as _____.

a. Circadian b. Circa-Annual Rhythms c. Poly Circadian d. Poly-Annual Rhythms

10. The sleep wake cycle is an example of

a. Circadian Rhythm b. Exogenous Zeitgeber c. Circa-Annual Rhythm d. None of them

11. Rats, Bee uses_____ as a tools for navigation .

a. Mind Map b. Dead reckoning c. Earth Geo Magnetic Field d. Moon Magnetic Field

8.7.2 Very Short Question:

1. Discuss the Significance of Migration.

2. How Kinesis is different from Taxis.

3. Name the various list of Stimulus which stimulus the animal in taxi.

4. Name the various tools which animal use for navigation.

5. Write the various stimulus used in Kinesis.

6. Name the 2 pre-requisites information needed by animals before it started to move.

7. How Open-system control is different from Close system Control

8. How Navigation is different from Orientation.

9. Explain the Mechanism in Birds Navigation

10. Explain the Migration in Eel.

Answer

1(c) 2(b) 3(a) 4(d) 5(a) 6(b) 7(d) 8(a) 9(b) 10(a) 11(a)

8.7.3 TERMINAL AND MODEL QUESTIONS

1. Explain the concept of Kinesis. Explain how they have been classified.

2. Describe how warbler Birds have modified the organs to aid in navigation.

3. Discuss the need to havemigration in fishes. Mention its various types.

4. What do you understand by Navigation? Explain the various tools used by animals in their navigation.

5. Explain the migration of Salmon fish.

6. Discuss the migration in Turtle.

7. Discuss the concept of Orientation. Explain how an animal performs orientation.

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8.9 GLOSSARY

Biological Rhythms: A cyclic change in their body function or chemically flow.

Circadian Rhythms: Biological Rhythms occurring repeatedly during 24 hour

Circa-Annual Rhythms: Biological Rhythms occurring repeatedly during the whole year.

Orientation: The current position of the animals with reference to earth gravity

Navigation: Approach through which an animal can reach its final destination from its current position.

Kinesis: Type of movement in which an organism's response is related to the intensity of the stimulation but is not oriented in any spatial direction

Taxis: The term given to movement of an animal in response to stimulus

Migration : Migration are circa-annual rhythm where all or part of an animal population move from one place to another regularly once in a year

UNIT 9: LEARNING AND MEMORY

9.1 Objectives

9.2 Introduction

9.3 Conditioning

9.4 Habituation

9.5 Insight Learning

9.6 Association Learning

9.7 Reasoning

9.8 Cognitive Skills

9.9 Summary

9.10 Terminal Question and Answers

9.1 OBJECTIVES

Study of this unit will let the students to:

- What is Learning?
- What are the various types of Learning?
- Understanding the factors which effects Learning.
- How the process of Learning happens
- Understanding the difference between classical and operant Learning.
- How Habituation effects the Learning
- How the Associative Learning Happens
- Understanding the concept of insight Learning.
- Elucidate the concept of reasoning.
- Understanding the various type of reasoning.
- Explain the concept of Cognitive Skill
- Understanding the various type of Cognitive Skills

9.2 INTRODUCTION

Learning and memory are closely interrelated with each other. Animal always store the learning in memory to be used in their adaptations, socialization and survivability. Learning involves the acquisition of knowledge while the memory is expressing what has been acquired through learning. Learning is quite a slow process where as Memory is an instantaneous process gained over a period of time. Memory enables past experience and learning to influence current behavior. Research have shown that animals have immense power of learning and memorization. Elephants, Birds, Whales etc. have been known to do mass migration spread over thousands of kilometers. There survivability skills have been passed from one generation to another with known source of water, food, threats etc. Animal have also developed a learning mechanism where new set of learning is happening based on their environments. They have developed a mechanism to link several learning to one learning. Animals have shown a set of insight learning. Higher Order Animal have surprised the scientist with their reasoning skills in their behavior. Animals have different set of cognitive skills habitslike Attention, Perception,Memory, Logic &Reasoning and Processing. Their cognitive skills have developed over the period of their evolution. They are still evolving and been reflected in their behaviors. Wolf and Dog have evolved from same set of parents.Humans have trained dogs after been

subjected to conditioned learning. In Last 300 years a distinction in behavior can be seen in the behavior of dogs and Wolf.

9.2.1 Types of learning:

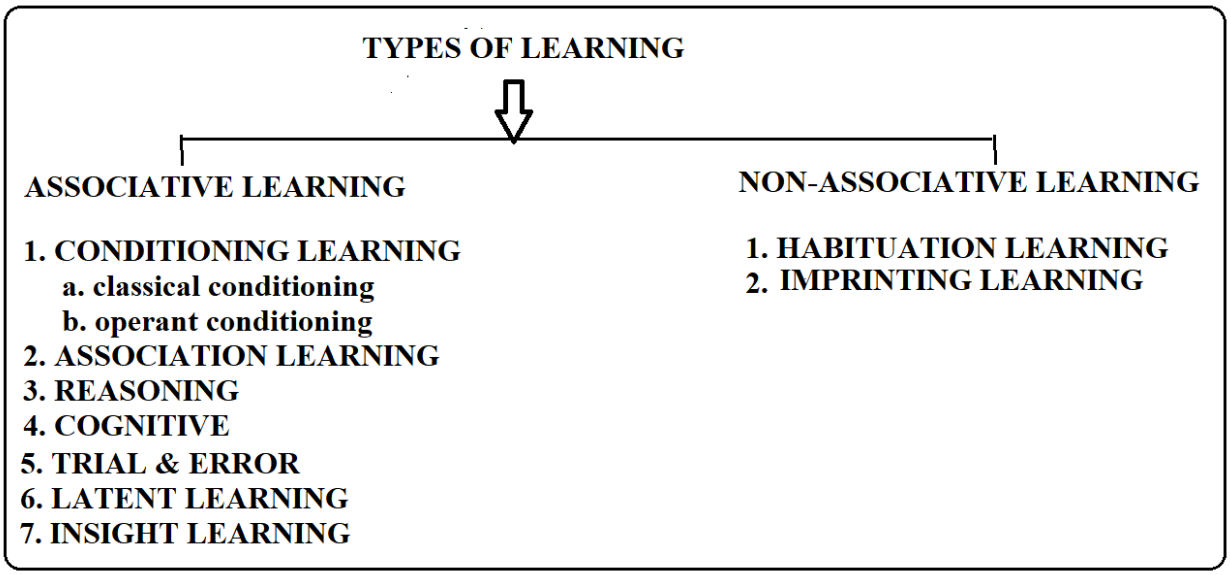


Fig 9.1 types of learning

9.3 CONDITIONING

Conditioning is a type of learning where a subject uses his nervous system (stimulus) to detect a change in its surrounding and response corresponds to that change. Conditioning has been classified based on the response.

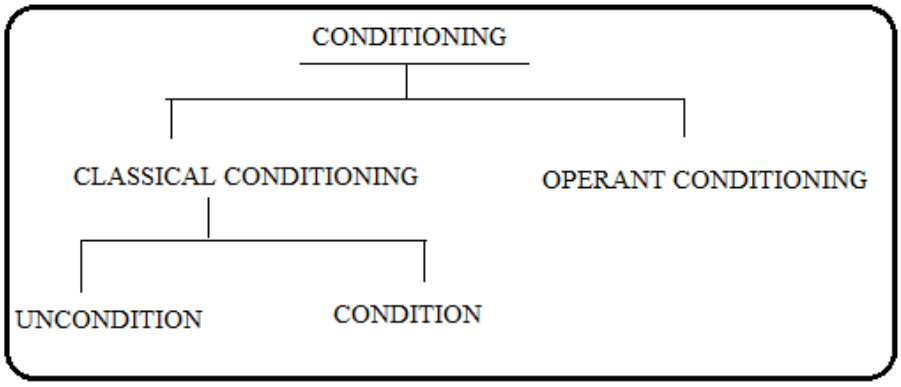


Fig 9.2 *Types of conditioning*

9.3.1 Classical Conditioning:

Classical condition is a learning technique associated with relation between stimulus and its response.It involves the three elements

i. Conditioned stimulus it refers to the naturally response during subjected to a stimulus.
ii. Unconditioned Stimulus it refers to the naturally response before subjected to a stimulus
iii. Conditioned Response It refers to the gained knowledge after subjected to a stimulus

Conditional Experiment Given by Pavlov:

Russian scientist Ivan Pavlov in 1890 use dog as a subject and put up the theory. He stated that dog began to salivate by just sensing the food stimulus. Food Stimulus can be a food trayor a utensil sound,personal assistants sound even though there is no food.

Experiment:

- **Step1:**A Hungry dog was caged in a stand.
- **Step 2:**A Meat piece was put in front of the hungry dog. Dog Salivation was seen.
- **Step 3:** Food stimulus was used but no food was provided. No Salivation was seen.
- **Step4:** He use a Food stimulus before providing food. There is no response.

He repeated this process for 5 to 6 times.

Final Observation: Salivation was seen after hearing the food stimulus before the meat arrive.

The salivation was seen just hearing the food stimulus only.

The Experiment comprises of two steps namely conditioning and Un-conditioning. Step 2 and 3 are before conducting unconditioned) Step 4 and its repeating is during conditioning (Conditional)

Final Result: Food Stimulus result in Salivation (After Conditioning)

Step 1 to 4 is a Learning curve for a dog but ones it was repeated it became a memorization and its further behavior was a response to its learning.

There are 4 components of condition

a. The unconditioned stimulus it is the one of the stimuli that unconditionally or automatically trigger a response.
b. The unconditioned response it is the unexpected response that occur naturally in response to unconditional response.
c. The conditioned stimulus it is a naturally occurring stimulus that happens after becoming associated with the unconditioned stimulus.
d. The conditioned response. It is the learned lesson after subjected to some stimulus.

The above work became the foundation for classical conditioning and the behavioral approach to psychology.

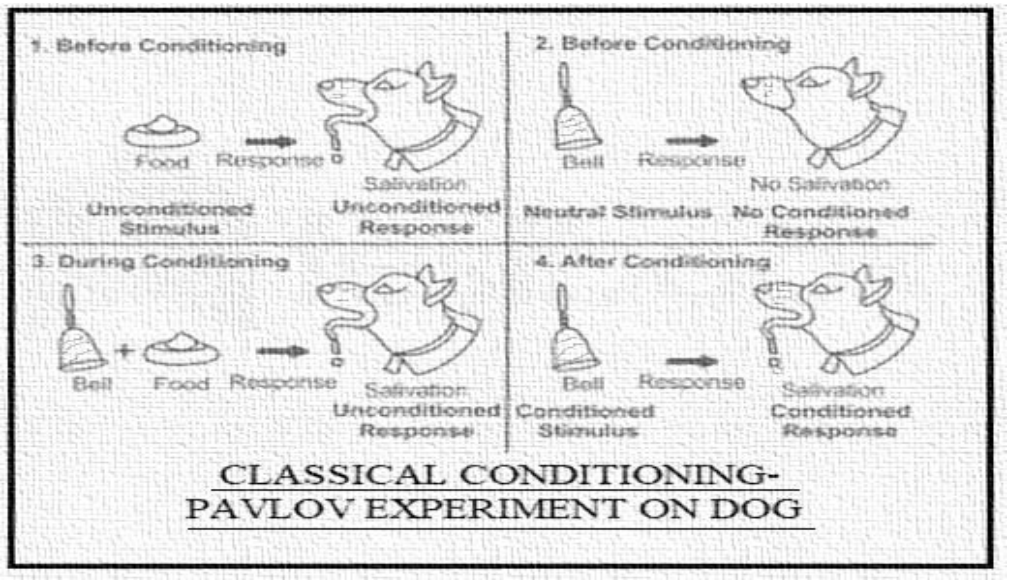


Fig 9.3 *Classical conditioning done by pavlov*

9.3.2 Operant Conditioning:

It was given by B F Skinner. It is method of learning that uses the concept of reward and punishment to stimulate the behavior. Skinner was a behaviorist so he postulates that behavior is

not just to look at internal thought and motivation process but it should be looked from external, observable causes.

Skinner use the term operant to refer to any stimulus that operate in environment which leads to any active behavior.

Operant Conditioning tries to correlate the operant with the consequence. This consequence was classified as positive or negative based on the consequence. Positive refers to favorable events where a response or a behavior is strength by the Operant. Whereas Negative is referring to removal of an Unfavorable events after where a response or a behavior is weakened by the Operant.

The study says that a subject is modeled to a certain behavior by providing rewards and punishments. Rewards stimulate the subject to repeated the certain action. Whereas punishment forces the subject to minimize or totally stop a certain behavior.

The conclusion can be a reinforcement (repeated the action) or Punishment (stop or minimize the action).

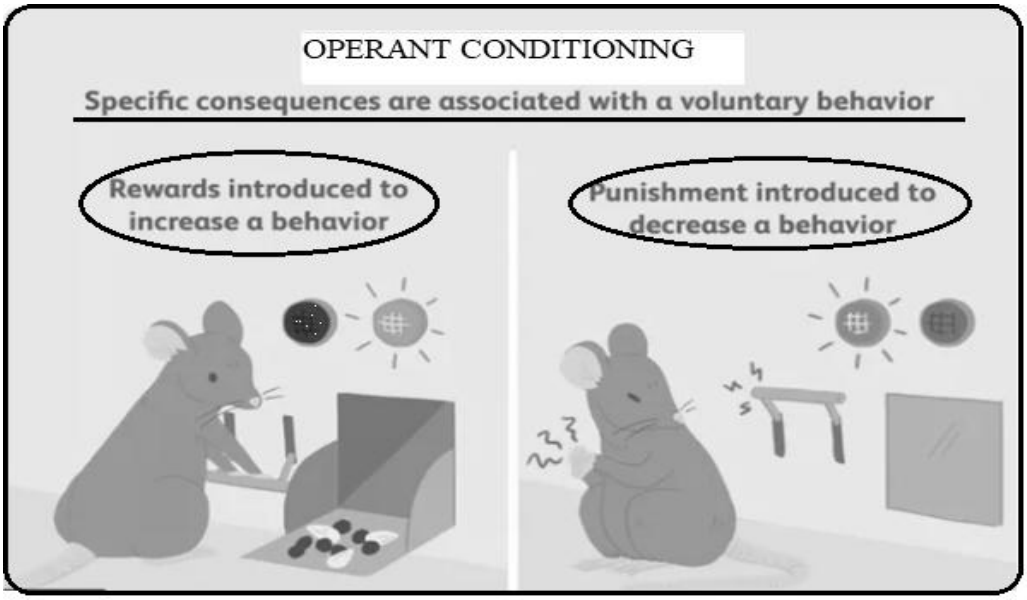


Fig 9.4 Operant conditioning

Reinforcement can be positive or negative.

Positive Reinforcement: It refers to a set of favorable events or outcome.Example: Given a Bonus to a hard-working manager

Negative Reinforcement: It refers to a removal of an unfavorable event after display of behavior. **Example:** Threating a person negatively reinforce its behavior. Punishment can also be positive or negative.

- **Positive punishment-** it refers to a punishment those weakens the unfavorable event. For example, Scolding a child for a misbehavior
- Negative punishment; it refers to a punishment when a favorable event is removed after a behavior. For example. Taking away a video games from a student.

This conditioning is usually applied in animal training.

Experiment- B.F. Skinner use a rat as a subject to stimulate the behavior.

- **Step 1:** Ratwas placed in skinner box.
- **Step 2:** Skinner was designed in away that when a rat presses lever it was rewarded with a food.

Final Result:

Initially Subject keep themselves around the floor. Randomly they were pressing lever. Once they realize that lever has to be pressed for food. Their behavior changes and random behavior becomes deliberate. The time taken for food got reduced in each successive trial.

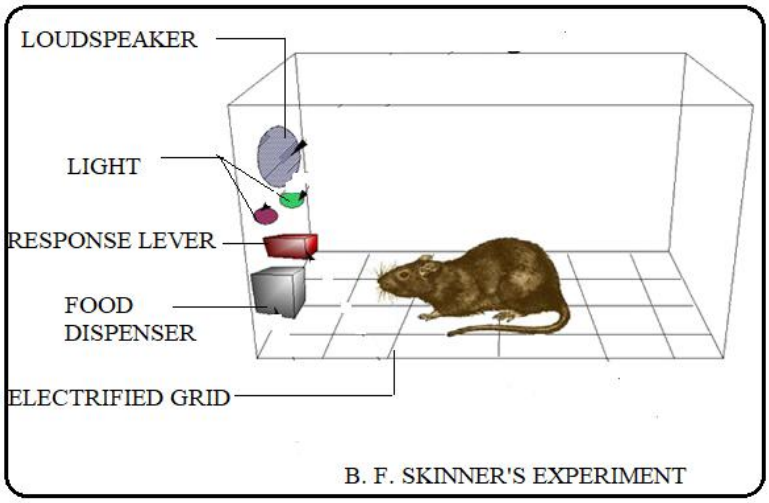


fig 9.5 Skinner experiment of operant conditioning

NON -ASSOCIATIVE LEARNING:

Non-associative learning is a type of learning where the change in behavior is due to only one stimulus. Subject has been exposed to various level of Stimulus Strength. The learning gained by the repeated exposure is generally permanent in nature. Habituation and imprinting are an example of non- associative learning.

9.4 *HABITUATION*

Tim Bergen gave the concept of Habituation. He concluded that an animal shows a gradual reduction in response to a repeated stimulus that is not relevant. A stimulus associated with no reward and being repeated are been ignored by the subject. Initially when a new stimulus is given to a subject, that animal responds with a sense of threats. The initial response of the animal is to flee, crouch,become immobile or any form of startle response.

Once the animal is subjected to same stimulus having gained a knowledge that it has no gain and no threatsthen the animals starts to ignore it.

In Habituation animal gets the sense but its nervous system sends a message to ignore the signal.

Habituation refers to the working of central nervous system where itprioritizes the stimulus as relevant or not relevant. It also works out a action plan to conserve energy, time based on it rewards.

Experiment 1

The habituation theory was first stated by Tinbergen by using Hawk-goose model. He uses the silhouette as a stimulus for young chicks of turkey.

Step 1: Silhouette was first flown in hawk direction it results in a activation of threats signal. The response was to run away from the silhouette.

Step 2: Silhouette was flown in goose direction it results in No response.

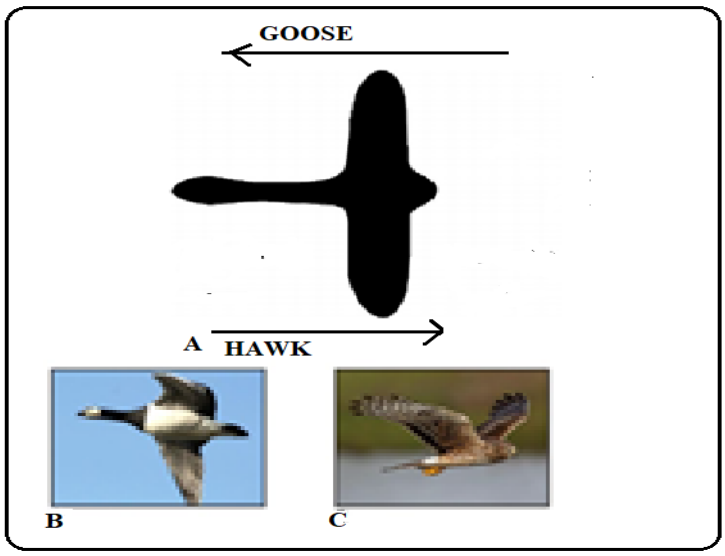


Fig 9.6 habituation done by tinbergen

Concluding Results:

This experiment shows that Turkey chick have been habituated with the shadow of goose. It is account of their close proximity and they fly just above those chicks. The Hawk shadow was different, so they take it from a threat perspective. This result in their response of run away from silhouette.

Experiment 2:

The above theory was stated by using snail as a subject:

- **Step 1:** A land snail was placed on glass plate.

Result: Few minutes later it projects the stalked eyes and start crawling.

- **Step 2:** A stimulus of knocking was provided.

Result : Snail immediatedly retracts eye and stop moving.

- **Step 3:** No stimulus for few moments.

Result: Snail again start moving.

- **Step 4:** A stimulus of knocking was again provided.

Result: Snail emerge quickly and keep moving.

- **Step 5:** A series of knocking was provided.

Result: Snail ignore the stimulus and continuous moving.

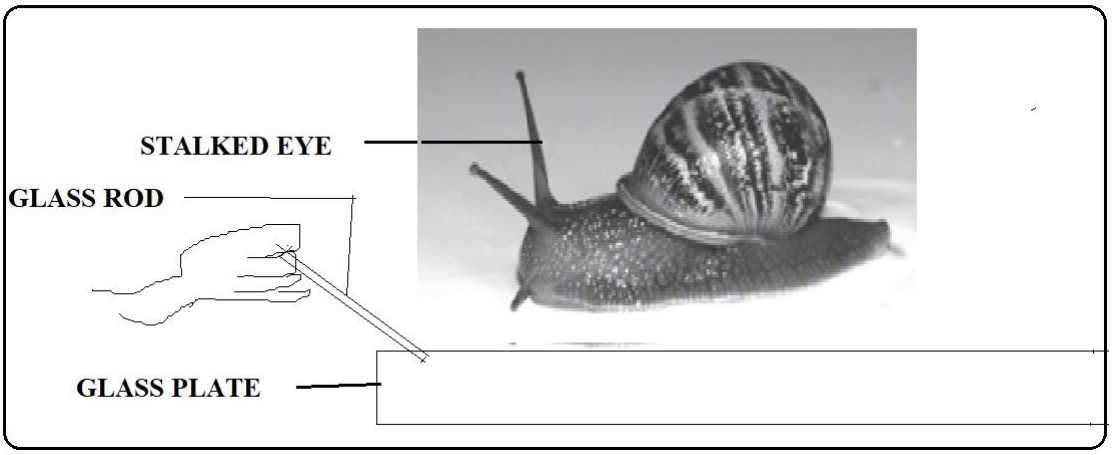


Fig 9.7 habituation done on snail

Concluding Results:

This experiment shows that Snail have been habituated with the stimulus of Knock. Snail initially take the stimulus as a threat and it shows the behavior of crawling and stay for a while. Once the same stimulus was given snail become habituated with the stimulus. This results in no reaction from the subject and it keep doing its normal activity.

Experiment 3:

This experiment was also conducted using domesticated animal cat and dogs.

Cat and dog are generally wary with human. Once they realize their new human owner are not a threat. They started to ignore it.

Concluding:

The experiment shows that once the subject realize that the human owner are not a threat they start to ignore it or start to enjoy.

Experiment 4:

New Born Human baby also show the property of Habituation

New Born Baby are generally afraid with a new set of sound in their house.

- **Step 1:** New Born Baby is brought to house.

- **Step 2:** Some peculiar set of sound are played.

Result: The baby starts to cry.

- **Step 3:** Once the same set of sound are played repeatedly.
  Result: Baby shows No response.

Concluding:

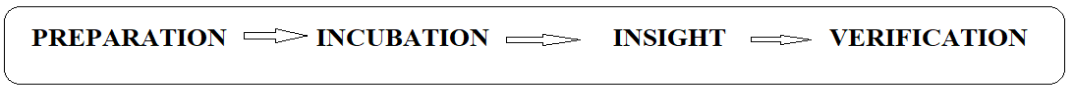
The experiment shows that ones the subject realize that the new set of sound is not a threat,it startsto ignore it. Crying is a mechanism to activate the threat level.

9.5 INSIGHT LEARNING

Insight learning uses a reason to reach a conclusion. It uses a more of memorization to deduce a solution to a problem. It is used to form conclusions, inference or a judgement. It is also known as Gestalt learning. This learning is an individual oriented. It depends on how the individuals has interacted with situations and environment.

Insight means the capacity to gain an accurate and deep understanding of someone or something.

There are 4 stages of insight learning-



1. **Preparation:** it is the first phase of insight learning. In this phase problem and all the resources available are been introduced. The subject start using its stimulus to analyze the problem.

2. **Incubation:**In this phase the problem has been visualized. The subject start to thinks of various approach of solving the problem.
3. **Insight:** in this phase the subject has come up with the approach of solving the problem.
4. **verification:** In the Last Phase the subject verifies the finalized approach to assess whether the finalized approach will work as such or by some modification.

Factor affecting the insight behavior:

1. **Experience:**Past Experience helps the subject in conceptualizing the problem. For example, Solving a math problem
2. **Intelligence:**The Solution depends upon the Subject Way of analyzing.
3. **Learning situation:** The Problem solutions are depending on whether subject had been in the same situation. What subject have learned from those situation. It come after a series of Trial and Error Trial.
4. **Repetition and Generalization:** A series of Trial and Error trial results in the subject understanding of Generalization of the problem

How Insight is different from Trial and error learning:

Point Of Difference	**Insight Learning**	**Trial and Error**
Mental Level	High Mental	No Mental
Awareness	High	It is a matter of Chance
Decision	Sudden	It is gradual and need practice
Acquisition, retention and transfer of knowledge	Possible	Not possible
Good for learning	scientific involving creative thinking	learning motor skills, language and arithmetic skills

This behavior was first observed by Wolfgang Kohler in 1900s. Kohler uses chimpanzees as a subject.

Experiment:

Banana was placed quite high for chimpanzee the subject uses a combination of boxes stacked over each to reach to a height where banana was stalked. The subject even uses stick to take down the banana. Kohler concluded that chimpanzee was using their memorization to deduce a solution with a known set of inferences and conclusion.

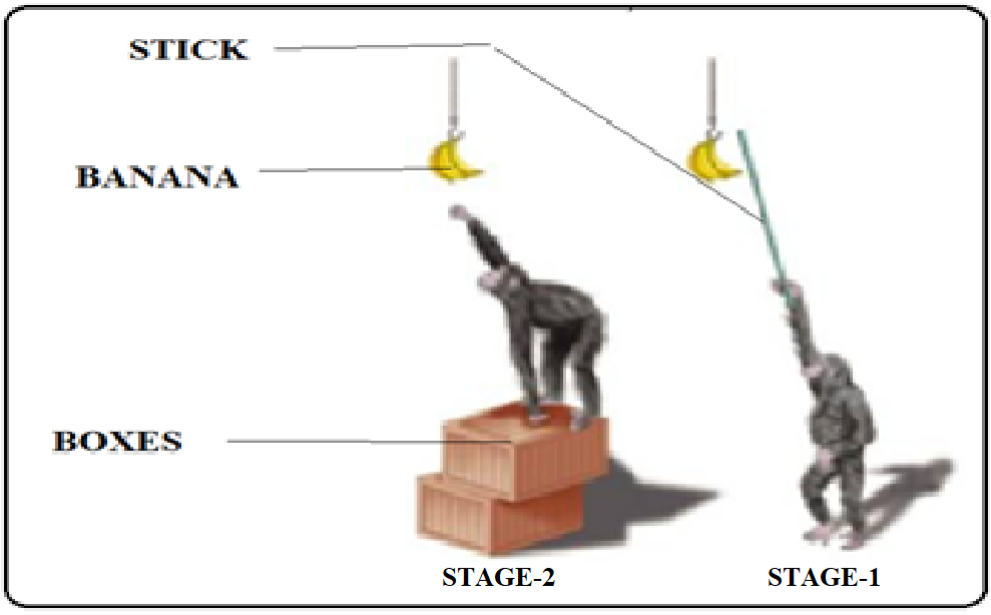


Fig 9.8 kohler experiment for insight learning

9.6 ASSOCIATION LEARNING

Association Learning is an extension of operant conditioning given by skinner. The term association has been introduced as a relation between two stimuli, conditions, environment etc. It states that idea and experience complement each other and get stored in memorization (Associative Memory). This experience helps to group the stimulus, conditions or environment.

The above Learning is a form of conditioning where the subject behavior can be modified using stimulus and response. Behavior can be learned or unlearned on the basics of response it received.

For example: wagging of tail by dog on arrival of its owner or its friends.

The response can be both positive enforcer or negative enforcer. Some example of positive enforcers

1. Awarding Bonus to hard worker manager
2. Giving a chocolate after completing an assignment.
3. Appreciating the student in front of the whole class.

Some example of negative enforcers

1. Financial Penalty for the employee for Late Coming.
2. Taking of the Recess for the misbehaving student.
3. Humiliating the student in front of the whole class.

Example of Associative Learning:

1. A child put its hand in a warm water and hurts themselves. Child is able to associative warm water with another warm object. Next time child will never put its hand in a warm thing.
2. An ownershows its affection to its pet animal by rubbing its back. The pet animal performs an activity each time owner get inclined to show the affection.

9.7 REASONING

Reasoning refers to a continuous process of reason seeking. It is a process of generating new argument in respect to the given argument and evidence. The ability to reason built a framework to deduce, learn from new set of data or problem and apply to a different set of data or problem. It also lead us to think out of box solution.

Importance of reasoning;

1. Reasoning allows understanding how the subject thinks, analyzing and trying to get a new solution.
2. Reasoning allows us to develop a scientific world.
3. Reasoning allows the subject to differentiate among themselves.

4. Reasoning allows the animal in their survivability, search for food, water.
5. Reasoning also the subject to reproduce.

Types of Reasoning:

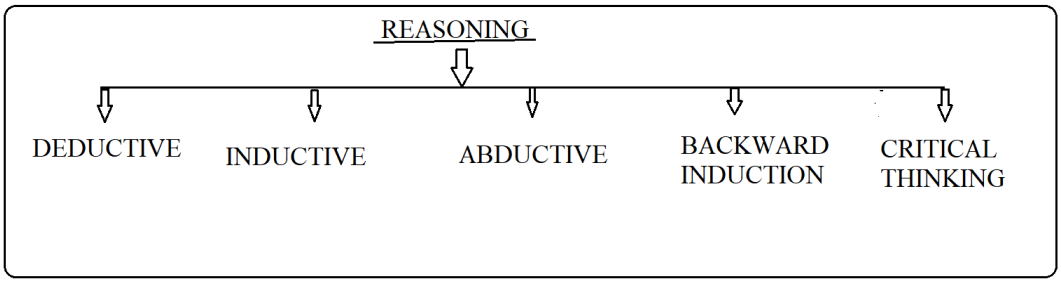


Fig 9.9 types of reasoning

Reasoning are of two types namely:

1. **Deductive reasoning:**

Deductive reasoning is a logical approach where the subject starts from a general idea and finally reaches to a conclusion. In this approach some deduction (reason /statement) are been used to reach a final conclusion.

Characteristics of Deductive Reasoning:

Top-to-bottom reasoning

Effective for reaching certain conclusions

Not a “foolproof” method

2. **Inductive reasoning:** Inductive reasoning is a logical approach where the subject starts from observation and generalized a general solution

Characteristics of Deductive Reasoning

Bottom-to- Top method

Effective for reaching general conclusions

A “foolproof” method

Besides Deductive and inductive we have few other types of reasoning

i) **Abductive reasoning:**In this approach a set of data is been fitted with a model or a theory .

For example: Doctor fits a patient disease with a set of symptoms already postulated.

ii) **Backward induction** In this approach end result are known then a series of steps are postulated which leads us from its initial to the conclusion.

For example: Solving a Chess game or solving a murder mystery.

iii) **Critical thinking:** in this approach a set of data are been analysis and their evidence are been closely observed, monitored step by step till a an informed decision is made.

For example: A Science experiment etc.

9.8 COGNITIVE SKILLS

9.8.1 Introduction:

Cognitive Skills refers to aids that are involved in knowing, learning and understanding things. These skills are also involved in the process of thinking and reasoning. These skills trained the brain to think, learn , remember , reason and pay attention. Cognitive skills can be defined as the traits which makes learning possible.

There are mainly classified into 5 core types namely

i. Attention
ii. Perception
iii. Memory
iv. Logic & reasoning
v. Processing

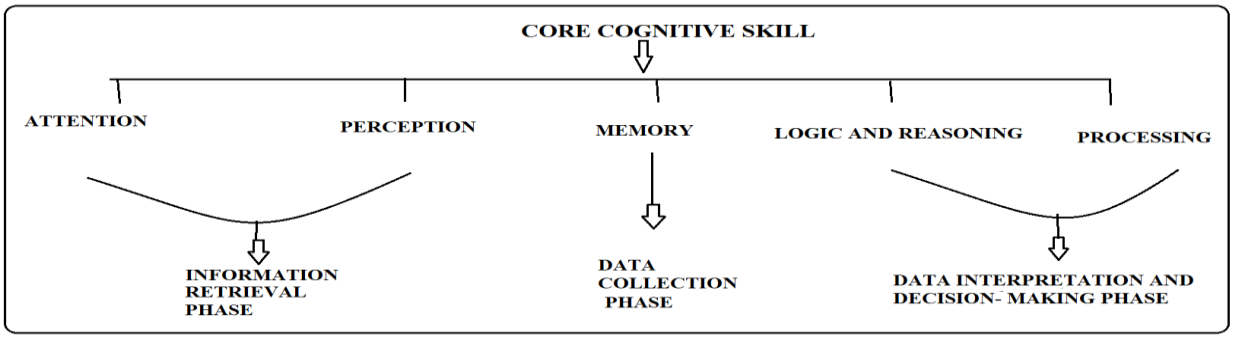


Fig 9.10 cognitive skills applied during learning.

Attention, perception falls under information retrieval phase

Memory is data collection phase

Logic & reasoningand processing are data interpretation and decision-making phase

9.8.2 Core Cognitive skill.

9.8.2.1Attention: Attention is the process of filtering incoming data coming from sensory organ. William James was the first psychologist to lay importance of attention in our action.

The attention are further divided into 3 types

i. **Focused Attention:** The data on which subject lay maximum importance while processing.
ii. **Sustained Attention:** The data on which subject have to continuously processed data over a sustained period of time.
iii. **Divided Attention:** Subject has to process data continuously coming from more than one sources to get an outcome.

9.8.2.2 Perception: Perception is a process of interpretation of what is been sensed. The sensationare done with the aid of sensory organs. These sensory organs letsthe subject collect information of its surrounding.

The Perception are divided based on typeof data generated by sensory organs:

i. **Visual Perception:** Visual perception refers to the set of data used by brain generated by what they see in the environment.
ii. **Auditory Perception:** Auditory perception refers tothe set of data used by brain generated by what they hear in the environment.
iii. **Phonological Awareness:** Phonological awareness is the ability to differentiate the individual sound from one another in a group or community. For example: Wild beast child only identify the mother by unique sound which are unique within a community.
iv. **Processing speed:** This is time taken to process the generated data from the sensory organ into an action. For example, sloth is able to sense data quite faster but it take a lot of time to process data. Minke Whale is one of the mammals having the fastest

processing speed. Squid and octopus are also the animals having fastest co-ordination between sensory organs and their actions.

9.8.2.3 Memory: Memory is the process by which the gathered data is conceptualized, stored, and processed. This stored data will be used as a knowledge for further action.

Memory are classified based on time taken to store Data:

i. **Sensory Memory:** Sensory Memory is the shortest memory in terms of time taken to store. It is the duration between when a sensory organ captures a data after the stimulus have ended. Example: Finding its prey using sense.

ii. **Short Term Memory:** Short Term Memory refers to the memory which the subject might be thinking about at that moment. It has a very short period of remembering generally of a few seconds to a few minutes. Example Dog have a short memory of 2 minutes. In those 2 minutes it segregates the data which it found to be useful.

iii. **Working Memory:** Working Memory refers to the memory which the subject was using while performing an action. Example: Animal might be having food but it always keep a look at the surrounding for any threat.

iv. **Long Term Memory:** Long Term Memory refers to the memory which is stored permanently. For example: Images of Dove in a Turkey Chicks,

v. **Visual Memory:** Visual Memory refers to any previously stored Visually sensation and retrieved it. For example, Dog have an angry bark with hackles while a cracker is busted in their surroundings. Bottle Neck Dolphin can remember the visual signal of another member in their surrounding for 20 years.

vi. **Auditory Memory:** Auditory Memory refers to the signals which are given in an oral mode and stored to be used in further action. Example; Dog is able to understand just by human oral action.

vii. **Sequential Memory:** Sequential memory refers to the order in which the action needs to perform. Example: New Research have found that few animals like Chimpanzee, Orangutan, Rats, Mole can do an ordering of events.

9.8.2.4 Logic & Reasoning: Logic and Reasoning is the cumulation of the reason and the rationality behind the events.

Experiment:

Greg Jensen at Colombia University have tested Macaque Monkey to test how they are able to make a decision. Their team found that these monkeys not only have a sequential memory but they can mold their approach based on the situation. Still scientist is divided on whether animals have the capability of logic. Few animals have shown that they can use logic in their decision. Scientist have the assumption that their choice is more based on associative learning.

9.8.2.5 Processing: Processing is the process how the data is been processed. All animals mapped the data with their surroundings and used in their activities.

9.8.3Importance of Cognitive Skills in Animals:

Cognitive skills define the behavior, inter-community complexity, adaptation, survival skills for an animal. It also defines how the animal store data, process it and use it in their action. Animal use these Skills in remembering food, water resources. They also remember the location where the resources can be found in a given climate. Animals are found to migrate thousands of kilometers in search of food, water or get away from adverse environment. The Animals have developed their cognitive skills according to the needs, climatic situation and a level of threats. Animal also make the sex selection based on the cognitive skills.Animals have shown a remarkable set of cognitive skills. Each species have an unique set of these skills which are unique from one another. Some animals have those skills which we human might have lose in the process of evolution.

9.9 SUMMARY

Learning is the animal's ability to change its behavior after subjected to a certain stimulus. The Learning has been classified as Associative and Non-Associative. Associative Learning is the animal ability to learn after deducing the inference between the two stimuli. Non-Associative Learning is the animal ability to learn after subjected to one stimulus. Associative Learning can be of classical, operant and Insight Learning. Classical theory is associated with relation between stimulus and its response.Operant Conditioning tries to correlate the operant with the

consequence. This consequence was classified as positive or negative based on the final result.Insight Learning state that an subject take its decision based on past experience.Animals form conclusions, inference or a judgement before taking its action.Habituation is an example of Non-Associative Learning which states thatan animal shows a gradual reduction in response to a repeated stimulus that is not relevant. Learning is the cumulation of three steps namely information Gathering, Storing and Processing. Information Gathering in animal is largely done by sensory organs like smell, sight, ear etc. by using Cognitive skill of Perception and Attention. Memory is the process by which the gathered information is stored in their memory. Logic & Reasoning and Processing are the Cognitive Traits used in final process of data interpretation and decision making. Scientists have an idea that animals lack cognitive traits, they just have a short memory which they forget after few moments. New Research have started to reveal that animal also posses these cognitive skills, they can also adapt, change their behavior, learn new things on subjected to a stimulus. Scientists have sensed of surprise and shocked to see that Animal world have those sets of Cognitive skills which are lacking in human beings.

9.10 TERMINAL QUESTION AND ANSWERS:

9.10.1 MULTIPLE CHOICE QUESTIONS:

1. _____ is the animal's ability to change its behavior after subjected to a certain stimulus

a. Learning b. Memorization

c. Reasoning d. Cognitive Skills

2. _____is the animal ability to learn after deducing the inference between the two stimuli.

a. Associative Learning b. Non-Associative Learning

c. Memorization d. Cognitive Skills.

3. _____is the animal ability to learn after subjected to one stimulus.

a. Associative Learning b. Non-Associative Learning

c. Memorization d. Cognitive Skills.

4. Classical, Operant and Insight Learning are type of _____ .

a. Associative Learning b. Non-Associative Learning

c. Memorization d. Cognitive Skills.

5. Positive or Negative based consequence on the final result is a part of _____.

a. Classical Learning b. Operant Learning

c. Insight Learning d. Habituation

6. The Term where an animal shows a gradual reduction in response to a repeated stimulus that is not relevant.

a. Classical Learning b. Operant Learning

c. Insight Learning d. Habituation

7 There are _____ phases of Learning.

a. 1 b. 2 c. 3 d. 4

8. Name the traits which makes learning possible. These skills trained the brain to think, learn, remember , reason and pay attention.

a. Learning b. Memorization c. Habituation d. Cognitive

9. Cognitive skill of Perception and Attention comes in _____ phases of Learning.

a. Information Gathering b. Storing

c. Processing d. None of them

10. Cognitive skill of Memory comes in _____ phases of Learning.

a. Information Gathering b. Storing

c. Processing d. None of them

11. Cognitive skill of Logic & Reasoning and Processing comes in _____ phases of learning.

a. Information Gathering b. Storing

c. Processing d. None of them.

12. It is a process of generating new argument in respect to the given argument and evidence.

a. Memorization b. Reasoning

c. Learning d. Associative Learning

13. Name the theory which states that Animals form conclusions, inference or a judgement before taking its action.

a. Classical b. Operant

c. Insight Learning d. Habituation

14. Top-to-bottom approach is used in _____ reasoning.

a. Deductive reasoning b. Inductive reasoning

c. Abductive Reasoning d. Critical Thinking

15. Bottom-to-Top reasoning is used in _____ reasoning.

a. Deductive reasoning b. Inductive reasoning

c. Abductive Reasoning d. Critical Thinking

16. The credit for understanding the mechanism of conditioned reflex is given to

a. Kohler b. Pavlov

c. Thorndike d. Tinbergen

17. Which group of vertebrates, learning ability is of higher order

a. Rodents b. Fish

c. Birds d. Primates

Answer:

1(a), 2(a), 3(b), 4(a), 5(b), 6(d), 7(c), 8(d), 9(a), 10(b), 11(c), 12(b), 13(c), 14(a), 15(b), 16(b), 17(d)

9.10.2 Very Short Question:

1. What is Learning?
2. Categorize the Learning on the basis of stimulus inter relationship.
3. Define Insight Learning.

4. Name any two animals whose coordination between sensory organ and processing is fastest.
5. Discuss the process of Learning.
6. Discuss the importance of Cognitive Traits in Learning.
7. Explain the term Reasoning.
8. Write down key difference between Classical Conditioning and Operant Conditioning.
9. Discuss the Experiment finding done by Pavlov.
10. Name the animals that have shown the presence of sequential memory during Experimental.
11. Name the Learning Techniques which are generally used in Animal Training.

9.10.3 TERMINAL AND MODEL QUESTIONS

1. What do you mean by Learning? Discuss its Type.

2. Explain the concept of Conditioning Learning. Explain with the help of Skinner Experiment.

3. Describe the need of memorization in Learning. Explain the various type of memory.

4. Differentiate between abductive reasoning and backward induction reasoning.

5. Explain the significance of cognitive skills in the animal Learning. Discuss the core cognitive skills used by animal in their learning process.

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9.12 SUGGESTED READING

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9.13 GLOSSARY

- **Association:** A relation between two stimuli, conditions, environment
- **Conditioned Response**: The gained knowledge after subjected to a stimulus
- **Conditioned stimulus:** The naturally response during subjected to a stimulus.
- **Conditioning:** Conditioning is a type of associative learning where a subject uses his nervous system (stimulus) to detect a change in its surrounding and response corresponds to that change.
- **External Stimulus:** A signal (stimulus) that originates from outside an organism.
- **Favourable events:** The set of events which help in attaining objective.
- **Habituation:** Process or set of events which animals starts to ignore.
- **Incubation:** The process of incubating an egg.
- **Insight:** The capacity to gain an accurate and deep understanding of someone or something.
- **Learning:** it is a process by which an activity orginates or changed after reacting to a stimulus.
- **Memorization :** Process of remembering an observation or learning
- **Memory:** Memory is a storage of learning.

- **Migration:** A part of a population or whole population move from one location to another and return along a well defined route.
- **Nervous System:** It is a complex network of neurons and cells that carry messages to and from the brain and spinal cord to various parts of the body.
- **Non-Association:** The change in behavior is due to only one stimulus.
- **Operant Conditioning:** A form of associative learning in which behavior changes after subjected to certain consequences.
- **Response:** A set of action followed after subjected to some stimulus.
- **Salivation:** Excess Flow of Saliva.
- **Silhouette:** A picture of outline of an object usually in black color
- **Stimulus:** A thing or event those arouse a specific function in a body.
- **Successive Trial:** Set of Events repeated.
- **Unconditioned Stimulus**: The naturally response before subjected to a stimulus
- **Unfavourable Events:** The set of events which prevents in attaining objective
- **Wagging:** Moving animal tail to and fro.

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