UNIT 13 INTRODUCTION TO ANIMAL BEHAVIOUR

Structure

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13.1 INTRODUCTION

Cave paintings and ancient art objects found in excavations strongly indicate that one of the earliest fascinations of our pre-historic ancestors was the study of animal behaviour. Perhaps they were motivated by the need to save themselves from harmful animals and to hunt some others for food or skins. They continued to study animals and their behaviour and applied their primitive knowledge to domesticate selected species and derive more benefits from animals. With the advancement of man's knowledge of animal behaviour more and more benefits have been flowing and the quest is progressively increasing with unlimited prospects.

To understand living animals, not any particular aspect from a specialists' point of view but animals and their life in totality, knowledge of animal behaviours is essential. Behaviour refers to the response of an organism to signals from its environment. The basic purpose of all actions, collectively called behaviour is continued existence and well being of the concerned animals. It is, therefore, futile to study behaviour in isolation from other aspects of the animal's life. Its study requires the application of principles and techniques from various specialties, particularly anatomy, physiology, genetics psychology and even physical sciences.

In this unit you will first learn the definition of animal behaviour and the importance of its study. We will also introduce you to the anatomical, physiological, genetic and ecological bases of behaviour. Other aspects such as development and organisation of behaviour will be discussed in the subsequent units.

Objectives

After studying this unit you should be able to:

- define animal behaviour in scientific terms,
- explain why it is necessary to study animal behaviour,
- describe the bases of behaviour development,
- relate animal behaviour to environment.

13.2 BEHAVIOUR

All living-beings are characterised by their activities or functions. An animal is declared dead the moment it stops its characteristic living functions. We can, therefore, conclude that a living being is what it is by virtue of its functions and not only by virtue of its body form or structure. Thus it is obvious that for a full understanding of animals and their life, a study of behaviour is as important as any other aspect.

Behaviour is one of the most interesting and complex aspects of an animal's life and it has several dimensions. The survival of an organism depends to a very great extent on its relationship with its environment, including all living organisms and non-living

things. Every living organism appropriately responds to changes in its environment. The nature of responses are basically different in plants and animals. Among plants climbers for example have thin and weak stems, they twine round the stronger stems of trees to reach out for light. They do so by growth movements and their response in that regard is irreversible. Animals however, respond differently and their responses to changes in environment, called behaviour, are active and reversible. A deer seeks shelter under a tree when it is too hot in the sun but comes out to graze in the open at dusk and dawn. The nocturnal owl becomes active in the dark but goes in hiding during the day. Each responds to the changes in its environment and these responses are reversible. Many birds and mammals may be seen fluffing their feathers or fur when the surrounding temperature suddenly drops. Fluffing increases the volume of insulating air envelope on their bodies and prevents the loss of body heat thereby, keeping them warm. Many species hibernate in severe winter season to conserve energy (heat), which is spent in normal activity and also to remain huddled in a warm place without having to go out in the cold searching for food and other requirements of an active life. These are clear responses of animals to changes in their physical environment directed towards their survival and well being and are therefore regarded as behaviour. There may be apparent similarities between many responses of animals and plants but the two are basically different. As pointed out earlier the responses of plants are **passive, slow and irreversible** (and are called tropism) while behavioural responses of animals are **active and reversible**.

The study of behaviour becomes quite complex because a living animal simultaneously responds to several stimuli in its environment and it is seldom possible to study the response to a single stimulus in isolation from other responses.

13.2.1 Definition of Behaviour

Defining behaviour in scientific terms is not as easy as many people may think because behaviour has to be studied and can be described at several different levels such as physiological, ecological or psychological. Behaviour includes gestures, postures, vocalisation, colour change, pilo-errection (hair raising) and even standing still is part of behaviour. Therefore, behaviour is a term with wide and varied connotations and its definition depends on the specific objectives of its study and description. **In a larger sense behaviour has been defined as the symphony of hormonal, neural and muscular systems.** We can, however, define behaviour as 'whatever an animal does'. Walking, resting, or chewing food are some of the simplest forms of behaviour. But mostly behaviour is far more complex, particularly when it involves intelligence, learning and experience.

Behaviour is generally described in terms of an animal's responses to stimuli arising within the body or in the external environment. Since behavioural responses are regarded as an animal's attempt to adapt itself to its changing environment, the basic objective of behaviour remains survival, continued existence and well-being.

13.2.2 Importance of Studying Animal Behaviour

The science of animal behaviour is comparatively a new branch of zoology. It was not a subject of serious study until the middle of nineteenth century. With the gradual acceptance of Darwin's theories it was realised that adaptations as a consequence of natural selection play a very important role in the process of evolution, and behaviour of animals has also evolved gradually along with morphological features. Animal behaviour received special attention of biologists when it was seen that animals get adapted to their environment largely through their behaviour and not only by structural changes. Interest in the study of animal behaviour has been increasing since then.

Traditionally three major fields of study of animal behaviour have been recognised. **Comparative psychology** is the study of mental processes and behaviour. It is the comparison of animal and human behaviour, usually under experimental conditions and mostly aimed at a better understanding of human behaviour. **Ethology** is the study of animal behaviour under natural and seminatural conditions. Ethologists usually take pains to compare their laboratory observations with observations taken under natural conditions. The third area of study which in a way integrates the other two approaches ethology and comparative psychology, is **neurobiology** – the study of the anatomy

and physiology of the nervous system. Each of the three disciplines has developed a body of concepts, terminology, and methodology about which you will learn in the next unit, but since the middle of twentieth century these disciplines have reunited on several common grounds. Let us first try to understand why we need to study animal behaviour.

Many species of animals, particularly birds and mammals, have been domesticated for economic gains. Their well-being and propagation have become our concern. Maximum benefits can be derived from domesticated livestock (milk, eggs, fur, manure etc.) by good management which requires scientific knowledge of animal behaviour and there may be many more such uses of animals which are not foreseen at present.

With our growing consciousness of environmental problems; global warming, ozone layer depletion, deforestation, soil erosion etc., our attention has been focussed on the maintenance of ecological balance which depends to a great extent on the important role played by free-living animals (wildlife). We also know that many wildlife species, particularly birds and mammals, have become extinct in the past and many more are now regarded as endangered. To preserve these species and to save these from extinction it is absolutely necessary to know a great deal about their behaviour; how much space they need, what and how much they eat. What sort of cover and shelter they require and so on. All this can be known only when we study their behaviour.

There is a generally held view that knowledge of animal behaviour can be applied to understand human behaviour. Though we now know that human behaviour, if interpreted by direct application of theories developed through studies of animal behaviour, may lead to misleading conclusions, several aspects of human behaviour can certainly be understood to a limited extent by studying animal behaviour. This is the reason why studies on primates are being done in many psychology laboratories. Experiments are conducted on animals with the objective of tracing the roots of human behaviour.

Some animals, those that we consider pests, are a direct threat to us, to our health, food supplies, we must know their behaviour to be able to put a check to them. There is an interesting example to illustrate this point. A government official in the US spent $ 5000 on mothballs to keep birds away from runways of an airport where they often collided with jet planes. What he didn't know was that birds do not have a well developed sense of smell and therefore the smell of mothballs did not deter them at all!

Some interesting facts have come to our knowledge recently. Several species of animals are seen to behave in a peculiar and abnormal manner before certain natural calamities such as earthquakes or volcanic eruptions. It seems that they are able to sense the forthcoming disasters. We lack this ability. There are apparent prospects of preventing losses to human life if we are able to interpret animal behaviour prior to the occurrence of earthquakes, volcanic eruption, severe storms, and landslides.

It is, therefore, understandable that studying animal behaviour is very important from many points of view and for a variety of reasons.

SAQ 1

a) Fill in the blanks.

i) ..... is the scientific study of behaviour under natural conditions from the point of view of adaptations.

ii) ..... is a study of the mental processes and behaviour.

iii) All behaviour stems from the need for and continued ..... to one's .....

b) List the broad objectives of studying animal behaviour:

i) .....

ii) .....

iii) .....

iv) .....

v) .....

13.3 BASES OF BEHAVIOUR

In the preceding section you have read a general description of behaviour; its definition and the importance of its study. There are two main approaches to study animal behaviour, physiological and the animal as a whole. Physiological approach is mainly concerned with how the nerves, muscles and sense organs are coordinated to produce a complex behaviour, for example, singing in birds. Those that take a whole animal approach study the factors that affect the behaviour of the animal. For example, they may be interested in the environment of the bird that prompts it to sing or why it sings at all.

The whole animal approach is used by both psychologists as well as ethologists, though psychologists make comparative studies in the learning abilities of some species of animals in laboratories. Ethologists on the other hand are more concerned with naturally occurring unlearnt behaviour of animals in their wild habitats. Now-a-days ethologist have become interested in the role of learning in the life of wild animals and psychologists are interested in the study of responses of animals to natural stimuli and both are learning from each other. However, physiologists, ethologists and psychologists, none can rely solely on one source of information to explain how or why an animal behaves as it does. Therefore, we will now consider the factors which determine an animal's behaviour and the mechanisms of its physical control. These factors, processes and mechanisms are termed here as 'bases' of behaviour. The following bases will be explained:

1. Anatomical and physiological
2. Genetic
3. Ecological

Behaviour is the composite and ultimate product of interaction between all such factors, processes and mechanisms just like the collective actions of different parts of a machine. None of these should be viewed in isolation from the others for that will be a misleading over-simplification. It is only for the sake of convenience that we describe each separately and not because these are completely independent of each other.

13.3.1 Anatomical and Physiological Basis

As has been discussed earlier in this unit, behaviour is generally explained in terms of an animal's responses to internal and external stimuli. The feeling of hunger for example is an internal stimulus and the animal responds to it by seeking food. Dim light at dusk time is an external stimulus and diurnal birds respond to it by seeking roosting sites. Thus the starting point in behaviour is perception of stimuli such as perception of characteristic feeling of hunger or perception of decreasing intensity of light.

Perception of stimuli is made possible by the presence of receptor organs which vary in different species. Receptors (called sense-organs) are connected to the nervous system and they receive stimuli i.e. they detect what goes on inside or outside the animal's body. These sense organs are of different kinds, each sensitive to a specific sort of stimulus. Eyes for instance are sensitive only to light and ears to sound.

You have already studied in Unit 10 about basic properties of nervous tissue, and the organisation of the vertebrate nervous system and sense organs. Behaviour can also be explained as a function of the nerve cells. The simplest model of the neural basis of behaviour is the vertebrate reflex. The few neurons of a reflex process information in such a way so as to give a predictable response always. Everytime a bright light flashes towards us we tend to close our eyes. Reflexes and more complex behaviour share a number of properties that are the result of the functioning of individual neurons. Complex behaviours may include many reflexes. Both show latency i.e. a time delay between stimulus and response. If a painful stimulus like a prick is given to dog in the leg, the latent period between the stimulus and the response of withdrawing the leg by the flexion reflex is between 60 to 200 m sec. The delay is not the result of the time taken for the impulse to travel, the delay occurs between the synapses.

Complex behaviour, therefore, also show latency because there are several synapses to be crossed. In case of reflexes the stronger the stimulus the shorter the latency. If the prick is strong then the withdrawal of the leg is faster. The same is true for complex behaviour. The central nervous system may add together stimuli arriving from different sense organs or at different times this is known as **summation.** We know that individual neurons are able to add up or summate excitation coming at different times or from different places. Summation can be seen at the level of reflexes as well as complex behaviour. Sherrington (see margin remark) gave several examples of summation at the level of reflexes. The scratch reflex in a dog can be elicited if an irritating stimulus is given on the saddle shaped area of its back. The hind leg on the same side automatically begins to scratch at that area. Weak stimuli say 5- 10 touch may not elicit any response but if 20 or 30 touches in quick succession are given then the scratching appears. With more complex behaviour summation often occurs between stimuli of quite different types perceived by different sense organs. Experiments showed that male rats respond sexually to a combination of visual, tactile and olfactory stimuli. Young males will not respond unless atleast two stimuli are presented while mature males with previous sexual experience will respond to one type of stimulus alone.

In the early 1900s Charles S. Sherrington studied the physiology, functions and detailed anatomy of various parts of the mammalian nervous system; identified and named the synapse as the connection between adjacent neurons.

However, studying single neurons and studying the whole animal may require very different techniques and different concepts and it may not be possible to explain all behavioural abbreviation using the reflex terminology. Let us now learn about the genetic basis of behaviour.

13.3.2 Genetic Basis

You would recall that behaviour is the result of an enormously complex interaction of nerves, muscles, sense organs and hormones. Genes can affect all of these. Genes determine how an organism will form, what anatomical characteristics it will possess, what functions it will be able to perform, what changes it will undergo from birth to adulthood and in what respects it will differ from other organisms. In short, genes determine the very nature of every living organism. Therefore, we can say that behaviour is genetically based as genes determine how an animal can and does respond to its environment.

Sometimes genes must act very specifically on the way the developing nervous system grows and forms connections. For example the song that the bulbul is able to sing is due to the appropriate connection among the neurons of the brain, genetic instruction are necessary for the growth and design of the brain. Hence genes contribute in an important way for the development of all behaviour.

Genes have more indirect and general effects by altering the amount of an enzyme or hormone secreted or the sensitivity of a sense organ. Mutations which block or alter behaviour patterns provide a useful tool in understanding how genes influence behaviour. Most experiments have been done using *Drosophila* where mutant genes for vision in males affect their ability to see as well as normal male and therefore, they have trouble in locating females. Another mutant gene alters the form of wings grossly which affects their ability to vibrate their wings which is an important part of courtship behaviour. Thus it becomes clear that these genes affect courtship behaviour by disrupting their normal vision and beating of wings and we can appreciate the indirect influence of genes on behaviour.

Studies have shown that some behaviour is linked to a single gene but most behaviour patterns involve several genes and this can be shown by hybridisation experiments. A classic experiment to demonstrate the genetic basis of nest building behaviour in lovebirds was performed by William Dilger (1962). These members of the parrot family tear strips of material from leaves to build their nests but while some i.e., the Fisher's. lovebirds carry the strips in their bills, the other species peach faced lovebirds carry the strips tucked in their rump feathers (Fig. 13.1). A cross between these two species was incapable of building a nest at all because they attempted to perform a compromise between the two methods of collecting nest building material. They tried tucking the strip between the rump feathers but either failed to let go of it or failed to tuck it properly. They could succeed only if they carried the strip in their beaks after first attempting to tuck it and after several months of trials only 41% attempts lead to nest building. Even after they learnt to carry the strip the hybrid birds always turned their heads as if to tuck the strip.

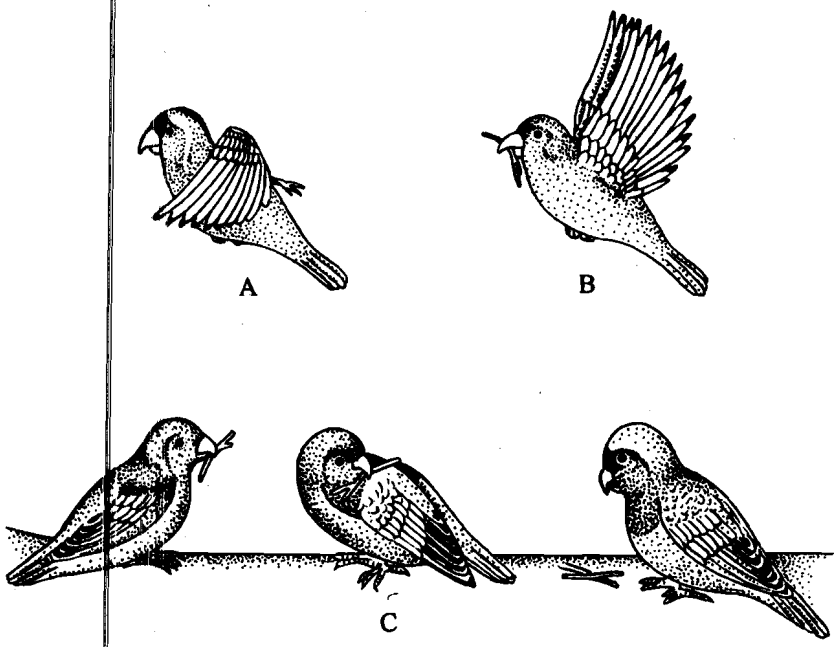

Fig. 13.1: Confused nesting behaviour in lovebirds A) Peach-faced lovebirds; B) Fischer's lovebird; C) hybrid. (Based on Dilger WC 1962 Scientific American 206(1) : 88-89).

Further, as has been explained, the starting point in behaviour is the perception of stimuli. An animal's capacity to perceive stimuli depends upon receptors (i.e. sense organs, such as eyes, ears, nose etc.) and the transmission of impulses depends upon the design of the motor apparatus. Each species has differential capacities for perception of stimuli and transmission of impulses. Elephants for example, have poor eye-sight but very keen senses of hearing and smelling, fish can see the water and can sense vibrations/waves of water by special organs called lateral line organs. Snakes do not have external ears but can perceive sound waves passing through layers of earth through the under (ventral) side of their bodies. Dolphins and bats can hear ultrasonic sound waves inaudible to human ears. This is due to differences between species in regard to the basic design and function of receptors (sense organs) and motor apparatus. The basic design of sense organs and motor apparatus is determined during embryonic development which in turn remains under the control of genes.

Males and females of most species can be distinguished on the basis of their body-size and shape or colour and many other external characters. Apart from these, behavioural differences also exist between males and females of the same species. In your day to day life you yourself can see common behavioural differences between the males and females for example, you would notice that it is the male of most song birds that sings and not the females; most courtship displays are performed by males. The peacock dances and not the peahen. Much of these behavioural differences are due to the different hormones secreted in the body of males and females as also the differences in their anatomy. Anatomical studies on some song birds reveal that the structure and size of the brain region that connects to vocal organs in males is different from that of female birds. The development of this song system is influenced by hormones. Let us take the example of zebra finch, a bird species whose sexually mature males but not females produce courtship song. During development the pre-testicular cells in males manufacture estrogen, whereas the preovarian cells in females do not. Thus estrogen acts on embryonic brain cells of males leading to development of special chain of neural elements that run from the front of the brain to the spinal cord, where it connects with the neural pathways to the syrinx, the organ that produces vocalisations. This network of the song system grows rapidly during the first 40 days after hatching while the number of cells in the corresponding part of the females brain becomes less due to cell death. As a result, the mature brain of the male is different from the female in structure and function.

At the start of the breeding season in temperate zones, testosterone is secreted from the enlarged testes. Cells of song systems have receptors for testosterone. Binding of the hormone triggers metabolic changes that enable the bird to sing after it has marked its territory to repel other males. Thus estrogen organises the song system and testosterone

activates it to allow the bird to sing when properly stimulated. As both hormones and anatomy are controlled by genes, it is not difficult to understand the indirect but very important role of genes in shaping animal behaviour.

SAQ 2

Will adult female song birds sing if they receive an implant of testosterone?

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13.3.3 Ecological Basis

For survival animals must maintain a positive relationship with the environment and behavioural responses are regarded as an important aspect of an organism's efforts for adjustment to a given environment. In the broadest sense, the term behaviour is used to collectively describe the overt actions of organisms to adjust themselves to environmental circumstances so as to ensure their survival and well-being. Unless behaviour is relevant to the needs arising in the environment, it will be a futile exercise leading to unnecessary wastage of an animal's energy and avoidable fatigue of its body. There are innumerable instances when even a layman can observe interesting behavioural changes and can relate them to changes in environment.

Bats, owls, jackals, hyenas, remain active mainly during night while crows, kites, vultures and many other birds and animals can be seen active during the day time. These are some examples of behavioural responses to the day and night changes in environment. Animals have adapted to different life styles to avoid conflict or to reduce competition as some remain active at night and some during the day time. Animals active at night have eyes to see at night and are unable to see in bright light which is an important ecological reason for their nocturnal activity. Kites and vultures feed mainly on carrion scattered unevenly in the environment which is difficult to spot in poor light therefore, they feed during the day time and are unable to see in dark, which is again an important ecological reason for their diurnal activity.

Other than these day and night changes, animal behaviour can be seen to change with seasons. We hear frogs croaking with the onset of monsoon but never in summer or winter. Since frogs are adapted to a partly aquatic environment and they breed only in water they come out of aestivation with the onset of monsoon and their croaking, starts as a part of their breeding behaviour. We see peacocks dancing just before and during monsoon season. The peacock's dance is a part of its courtship behaviour which precedes breeding. The species feeds on insects, lizards, small snakes, grain, vegetable shoots etc. which become abundantly available during monsoon. Peafowl breeds in that season so that the chicks get plenty to eat. There are several other factors influencing peafowl's breeding during monsoon but we can see the relation of behaviour to ecological factors.

Large flocks of migratory geese and ducks are frequently seen moving in one direction with the onset of winter and in the opposite direction towards the end of winter season (Fig. 13.2). These species migrate from the northern hemisphere habitats where food resources get covered with snow and life becomes difficult due to very low temperature. These birds come in winter to place of warmer climate in search of food and for comfortable living. Once the temperature in this region starts rising and conditions become favourable in their northern abodes, they go back. This interesting phenomenon of bird migration indicates that behaviour is related to environment. You will learn more about migratory behaviour in Unit 15.

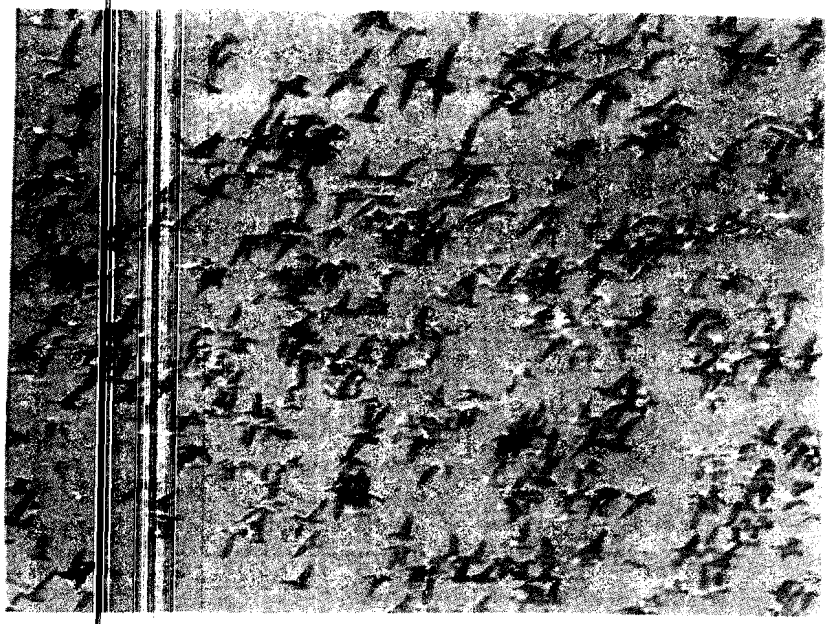

Fig. 13.2 : Migrating geese fill the sky as they travel southwards from their breeding grounds in Canada.

Thus we see that the environment affects behaviour in two main ways. In the immediate sense animals perform behaviour in response to stimuli from the environment while in the long run environment influences gene expression in the development of many behavioural patterns.

Even reflex actions do not develop normally in an unfavorable environment. Newborn chimpanzees were reared in the dark for 40 months and then brought out in light, they showed no eye blink reflex. The reflex appeared only after the chimpanzees had been in the light for about five days. The presence of light (an environmental factor) is necessary for this reflex to develop.

So far we have been discussing the behavioural changes in accordance with changes in environment. Other than these, there are many instances of a permanent relationship between animal behaviour and environment. We all know that certain species of animals are found in particular regions each with a characteristic set of environmental (ecological) conditions. Penguins are found only in Antarctica and associated islands. Sea gulls live only on sea-shores. Some other species such as tiger and spotted deer are widely distributed in the Indian subcontinent but are found only in forested habitats. When a species lives exclusively in a particular environment, a preference is indicated. One of the several reasons for this preference is behavioural compatibility of the concerned social organisation. Group composition, sex ratio all are determined by ecological factors such as forest cover, availability of water, food dispersion, food. You can, therefore, understand how behaviour is related to environment.

Many behavioural acts such as eating food or drinking water are performed basically in response to the stimuli arising inside the body of the concerned animal, nevertheless the basic and the most important function of behaviour is well-being of the individual and continued existence of the species in a given environment. Thus it can be concluded that survival of animals in changing environments is dependant to a great extent upon the flexibility of their behaviour. Life will be in jeopardy if animals did not appropriately respond to environmental stimuli.

An animal may be capable of performing several behavioural acts but each of these acts should be performed at proper time and in a particular environmental situation. A deer can move in and out of a cover or shelter and can graze on grass. But when should it graze, when should it retreat into the cover or shelter depends upon the environmental circumstances. If the deer continues to graze in the open when it is too cold or too hot or when a predator comes in view, it will jeopardize its well-being or even survival. Conversely, if the deer does not come out of shelter or cover to graze even when it is comfortable and safe in the open, it will starve. Atmospheric temperature in this example is an abiotic factor affecting behaviour. Grazing on the other hand is a response to an internal stimulus (feeling of hunger). It is interesting to note that the deer suppresses its response to the internal stimulus when biotic or abiotic factors of

environment assume overriding importance. This explains the strong ecological basis of animal behaviour.

Behaviour is the composite and ultimate product of interaction between all such factors, processes and mechanisms just like the collective actions of different parts of a machine. None of these should be viewed in isolation of the others for that will be a misleading over-simplification. It is only for the sake of convenience that we describe each basis separately and not because these are completely independent of others. In the next unit you will learn about innate behaviour and how behavior is shaped through learning and experiences.

13.4 SUMMARY

In this unit you have learnt that:

- Animal behaviour attracted the attention of humans very early in history and still continues to be an interesting field of biology.
- It is important and profitable on many considerations to study animal behaviour.
- Defining behaviour is not as easy as many people may think, for it depends on the specific objectives of its study and description. However, we can conclude that whatever an animal does is behaviour.
- The physical capacities of an animal determine its behavioural capacities but behaviour is also influenced by several other factor such as genetic and ecological.
- Behaviour is influenced by inheritance of anatomical and physiological characteristics.
- Since behaviour is a means of adjustment of animals to the environment in which they live, it is necessarily directed by ecological factors.
- Behaviour originates and gets organised by physical capabilities of animals which are inherited and is relevant to the environmental needs and therefore cannot be properly understood without taking into consideration all these interacting factors.
- The basic objective of behaviour for the concerned animal is continued survival and wellbeing in a given environmental situation.

13.5 TERMINAL QUESTIONS

1. Why has animal behaviour attracted the attention of humans since early time?

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2. Define behaviour in your own words.

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3. Why does behaviour have to be in accordance with the needs of the environment in which the animal lives?

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4. What is the anatomical and physiological basis of behaviour?

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5. Why is it said that behaviour has a genetic basis?

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13.6 ANSWERS

Self-assessment Questions

1. a) i) Ethology
   ii) Comparative psychology
   iii) Adaptation, environment
   b) i) Satisfying mind's curiosity
   ii) Deriving more benefits from livestock and training of pets
   iii) Conservation of endangered species and wildlife management
   iv) Getting advance warning of natural calamities

Terminal Questions

1. Archaeological excavations have provided enough evidence to indicate that animal behaviour attracted man's attention very early in history. Man's pre-historic ancestors studied animal behaviour probably with the objective of saving themselves from dangerous animals and subsequently to domesticate some animals and to derive benefits from them.
2. Behaviour can be defined in several different ways depending upon the specific objectives of its study and description. However, we can define it as the overt activities of animals. In brief, whatever an animal does is behaviour.
3. The basic objective of behaviour is survival and well-being of animals in their environment. Behaviour will fail to achieve this objective if it is not relevant to the specific needs arising in their environment.
4. Animal behaviour depends to a great extent on their physical capacities – body-size, shape of body parts and physiological characteristics. No animal can do anything which its body design and function do not allow.
5. Behaviour as such can not be inherited from parents. But the anatomical and physiological characteristics which have a profound influence on behaviour are inherited by animals from their parents. Thus behaviour has genetic basis too.