

## INTRODUCTION TO ANIMAL BEHAVIOUR

Man, from bygone days, had been interested in animal behaviour, for all animals (including himself) are involved in a variety of complex, vital relationships with members of their own species, with members of other species and with the physical environment. Man's survival, like that of animals, depends on its ability to procure food and shelter, to find mates and produce offsprings, and to avoid predation. Thus, the study of animal behaviour appears to have been fundamental to human existence as can be predicted from earliest cave paintings of animals.

The branch of biology that deals with the study of animal behaviour is called ethology. The word ethology is derived from the Greek word *ethos*, meaning "habit" or "character" and *logos*, meaning "study". The term ethology was introduced by Niko Tinbergen (1950). Ethology is defined as the systematic and scientific study of the behaviour of animal (including human) under natural conditions.

Genetics, developmental biology, anatomy, physiology, endocrinology, neurobiology, evolution, learning and social theory are all combined into one grand subject — animal behaviour. The field of ethology is, thus, integrative in the true sense of the word.

Animal behaviour is a continuous source of mystery that sparks the imagination of scientists and public alike. It is considered to be in its infancy though it has been studied

extensively for the last 50 years. It has a long way to go as it is not so easy to observe the behaviour of various animals. Animal behaviour studies do not depend upon elaborate mathematical treatments, delicate instruments and expensive chemicals. An experienced student of animal behaviour requires only a binocular, a stopwatch and a camera.

### HISTORICAL PERCEPTION IN ANIMAL BEHAVIOUR

During the course of history, interest in animal behaviour has stemmed from the fact that animals were a primary source of food, clothing, and materials for tools and shelter. Knowledge about their behaviour was, thus, necessary for successful hunting. Moreover, there has always been human curiosity about the natural world. The historical perception, thus, relates from the early days of human existence to the present experimental and theoretical approaches.

#### A. Early days of Human Existence

Humans from early days were hunters and meat-eaters. The early hominids (*Homo erectus*) practiced crude variety of hunting. The Peking man (a form of *Homo erectus*), some 4,00,000 years ago, was a better hunter. He knew the use of fire and made tools from animal bones.

Early *Homo sapiens* were keen observers of animal behaviour and utilised this knowledge for hunting and evading predators.

Hunters of the upper Paleolithic probably used fire to frighten away predatory animals or to drive animals over the cliff where they could be slaughtered with rocks or clubs.

Cave paintings of prehistoric man suggest close observation of the animals at various times in their life cycles, from game to hunting, and, thus, depicting man's relationship with animals.

**Later world :** After civilisation, interest in animal behaviour increased due to curiosity about natural phenomenon and a desire to record and categorise observations. Early scholars [Aristotle (384–322 B.C.), Pliny (23–79 A.D.) and others] attempted to record what they observed in the world around them. However, their perception of animal behaviour was poor due to lack of full knowledge about what was taking place or due to biased religious or philosophical outlook. However, these formed the basis of later development in the field.

## B. Emergence of Animal Behaviour as a Scientific Discipline

Scientific study of animal behaviour emerged in the latter part of the nineteenth century. Three major developments contributed significantly to the study of behaviour — (a) Theory of evolution by natural selection, (b) Development of a systematic comparative method, and (c) Studies in genetics and inheritance.

(a) **Darwin-Wallace theory of natural selection :** During the nineteenth century several voyages were made by Europeans to all parts of the globe for exploration and discovery of exotic fauna and flora. These scientists made observations and brought live and preserved specimens to zoos and laboratories in Europe, where scholars could observe, record their behaviour and inter-relationships of these discovered species.

One such scientist was Charles Darwin (1809–1882) who made voyages to the Galapagos Islands. Darwin's thinking about the competition for survival among mem-

bers of a species was influenced by Thomas Malthus' "Essay on the Principle of Population". Sir Charles Lyell (1797–1875), a geologist, made observations of rock strata and succession of fossils. This led others to believe that species were not fixed entities.

A. R. Wallace's (1823–1913) voyage to the Malay archipelago and Darwin's travels on the *Beagle* to South America and South Pacific, led each man – independently – to formulate the theory of evolution by natural selection. Behaviour, morphology and physiology of animals were thought to be subjected to the effects of natural selection. The theory of evolution by natural selection have been modified subsequently due to the recent developments in biology, particularly genetics.

(b) **Systematic comparative method :** The use of **comparative method** in studying animal behaviour is credited to George John Romanes (1848–1894). The comparative method involves the studying of animals to get insights into the behaviour of humans. Romanes proposed that there is a continuity of mental processes from one species to another. He put forward that although humans can know only their own thoughts, they could infer the mental process of animals, including other people, from knowledges of their own. Romanes suggested that a sequence would be constructed for the evolution of various emotional states in animals — worms, who exhibit only surprise and fear, were placed at the lowest scale; insects were capable of various social feelings and curiosity; fishes showed play, jealousy and anger; reptiles exhibited affection; birds displayed pride and terror; and, finally, mammals were credited with hate, cruelty and shame. Romanes' theory relied largely on inferences rather than on recorded facts.

(c) **Genetics and Inheritance :** Subsequently, the discovery of genetics and development of theories of inheritance by Gregor Mendel (1822–1884) greatly influenced research in animal behaviour. Present-day

Behavioural biology is a combination of evolutionary theory (explains how traits change through time) and genetics (how traits are passed from generation to generation). Any trait that evolves is passed on from generation to generation. Behaviour, thus, may change as a species evolves. Behavioural analysis from its early studies of inheritance got greatly expanded in the 1930s, and till modern times has been used as a powerful tool by many animal behaviourists.

### C. Present Experimental and Theoretical Approaches

The various theories, ideas etc. put forward in the latter half of the nineteenth century form the foundation of the present days experimental approaches to the study of animal behaviour.

Four major approaches are given :

(a) Control mechanisms of behaviour has been sought through studies by comparative animal psychologists and physiologists. Much of the earlier psychological researches were heavily dependent on introspections and inferences. These methods have been later replaced by systematic, objective observations and replicable experiments. Modern psychologists and physiologists explore areas such as learning processes, physiological control of behaviour, sensation and perception and behaviour genetics.

(b) The functional significance and evolution of behaviour patterns and explanations of behaviour mechanisms such as drives, innate releasing mechanisms etc. are the fields of classical ethologists. Behavioural traits are subject to natural selection. Ethologists have traditionally made many of their research observations in a natural setting, conducted to assess the function of behaviour pattern. Ethological approach is used to determine how key stimuli trigger specific behaviour patterns. Modern ethology is concerned with four area of enquiry — *causation, development, evolution, and function* of behaviour.

(c) Environmental context for behaviour

and the ways in which animals interact with their living and nonliving environments are under the purview of behavioural ecologists. Investigations are conducted in both field and laboratory settings.

(d) The study of the social behaviour and organisation in animals are the fields of sociobiologists. Sociobiology has emerged as a new approach to the study of animal behaviour. It applies principles of evolutionary biology to the study of social behaviour in animals.

These varied approaches to the study of behaviour has led to the modern synthetic view of animals living and behaving in their natural environment. Although these approaches has been shown above as separate entities, they however, did not develop entirely independently of one another. In recent decades they have been moulded into a single discipline. The workers working in these fields may call themselves ethologists, animal behaviourists or comparative psychologists. They, however, are all pursuing the same goal using the same general theoretical frameworks and using similar experimental techniques and methods.

### APPROACH TO ETHOLOGY

The approach to ethology is based upon three foundations — the force of natural selection, the ability of animals to learn and the power of transmitting learned information.

1. **The Forces of Natural Selection :** According to Darwin any trait that causes its possessor to have some sort of reproductive advantages, would be favoured by the process, which he named as natural selection. Thus, natural selection is the process whereby traits that confer the highest relative reproductive success (greatest relative fitness) on their bearers and which can be passed down across generations, increases in frequency over many generations.

To elaborate how natural selection operates in the wild, let us take the example of

beak size in Galapagos finches, which is also called Darwin's finches. Two such finch species, *Geospiza magnirostris* and *G. fortis*, beak size can be utilised to elaborate the role of natural selection in animal behaviour.

The bigger of the two species is *G. magnirostris*, which has relatively large beak. It can crack open large and very tough fruit of the caltrop (*Tribulus cistoides*) much more quickly and efficiently than the smaller finch, *G. fortis*. On the other hand, *G. fortis* is more efficient when it comes to small seeds. Thus, natural selection would favour larger beaked birds in times when caltrops and other large seeded plants are abundant and smaller beaked birds would be favoured when smaller seeded plants are plentiful. Such a prediction would hold true with respect to both a comparison between these two species, as well as within each species. Thus, not only should *G. magnirostris* be favoured over *G. fortis* when large seeds are abundant, but also larger *G. magnirostris* would be favoured over smaller *G. magnirostris* and, similarly, larger *G. fortis* over smaller *G. fortis*.

**2. Individual Learning :** Animals in course of their lifetime learn about everything from food and shelter to predators and familial relationships. Such individual learning represent a second major force and can alter the frequency of behaviour within the lifetime of an organism.

Individual learning can take many forms. Considering the hypothetical case of learning in the context of mating, it has been observed that females of most animals mate with numerous males throughout the course of a lifetime. For example, imagine a female bird mating with various males somehow able to keep track of how many chicks fledged their nest (1, 2, 3 and so on). Such a female might learn which male is a good mate by keeping track of the number of eggs she laid when associated with each male (Fig. 5.1). As more egg laying is the preference, during later mating opportunities, such female birds would be likely to choose male

bird 2 as she has learned that she lays the most eggs (four as shown in Fig. 5.1) after mating with him. In such a case, learning has changed the behaviour of an animal within the course of a life time.

The above is a good example of how learning and natural selection can be intimately tied together. In this example, females change their preference for mates as a result of prior experience and, therefore, learning affected behaviour pattern within a generation. Such behaviour based on personal experience can not only shift mate choices within a generation, but it can also change the ability to learn, which if genetically coded, can be subjected to natural selection. Natural selection might very well favour the ability to learn about mates, over the lack of such an ability.

**3. Cultural Transmission :** This is considered to be the third major force affecting animal behaviour, where animals learn something by copying the behaviour of others, through what is known as social learning. Cultural transmission can allow newly acquired traits to spread through populations at a very quick rate, as well as permit the transmission of information across generations rapidly.

The importance of cultural transmission and social learning in animals can be exemplified in the case of foraging in rats. Rats, being scavengers, are often presented with opportunities to sample new food. On one hand, a new food source may be an unexpected rat bounty, while, on the other hand, new foods may be dangerous, because either they contain elements inherently bad for rats or the rats do not know how a new food should smell. So the rats face the difficulty to tell whether this new food is fresh or spoiled. To overcome this, foragers often learn critical tidbits about the location and identity of food by interacting with others who have recently returned from a foraging bout.

In case of individual learning, it is certainly possible that if the above behaviour of



Fig. 5.1 : Learning behaviour of an individual bird

"copy the diet choice of others" is genetically coded, then the rule might increase in frequency through natural selection. The case of cultural transmission, on the other hand, is more complicated than that of individual learning. The reason being that what an animal learns via individual learning is lost when the animal dies. The actual information that one learns via individual learning never makes it across generations. However, this is not the case with cultural transmission, where what a single animal does, if copied, can affect individuals many generations later on. Cultural transmission, thus, has both within- and between- generation effects.

### CONCEPTUAL-THEORETICAL-EMPIRICAL APPROACHES IN ETHOLOGY

Studies in animal behaviour tend to use all these three approaches :

In **conceptual approaches**, ideas generated in different subdisciplines are imported and combined in a new, cohesive way. Major conceptual advances tend to generate not only new experimental work, but they also reshape the way that a discipline looks at itself. In many species, like the vervet monkey (*Cercopithecus aethiops*), exhibits kin selection and mother-offspring bond, where mothers go to extreme lengths to provide for and protect their young offsprings. This provides a conceptual framework for understanding the special relations that blood relatives share. Individual's total fitness, measured by its genetic contribution to the

next generation, is not simply a function of the number of viable offsprings that it produces—rather, it is a combination of the number of young it raises, plus some benefit assigned for any help it provided in raising the offspring of blood relatives.

**Theoretical approach** to animal behaviour relates to the construction of a mathematical model. A question of interest is : If a list of potential edible items are given, which one should a foraging animal add to its diet and under what conditions? Ethologists have constructed mathematical models of foraging that determine which potential prey items should be taken. The value assigned to each prey is a composite of energy value ( $e$ ), handling time ( $h$ ), and encounter rate ( $\lambda$ ) associated with various items to predict which such item should be added to an animal's diet to optimise some quantity, such as energy intake per unit time. For example, the model predicted that whether or not a low-ranked food item would be added to an animal's diet depended on the availability of the low-ranked item itself. Such as, if for wolf predators, rabbit provided more energy per unit time than did chickens, then the availability of rabbits, not chickens, would determine whether chickens would be added to the wolf's diet.

**Empirical studies** are designed to test the theories and concepts that have been proposed as explanations for behaviour. Of the many forms the most essential empirical work in ethology is either observational or

and recording of what animals do, but no attempt is made to manipulate or control an ethological or environmental variable. For example, one might go out into a forest and record every action of a particular flock of birds. In doing so, he would note various behaviours like foraging, encounter with predators, feeding of nestlings, the time and duration it sits on a particular tree, and so on. From such work, one can visualise — 1. the time budget of the birds in study, 2. the foraging of the males and females, 3. predict their relation of foraging bouts when predators are present in their vicinity, and 4. find the correlation between foraging behaviour and predation pressure, and so on.

However, from the above observational work, it is difficult to speak of what caused what. It may be that there are other variables which might be responsible for the correlation of foraging with predation pressure. To know that, one might have to *experimentally* manipulate the system. For example, two areas might be taken. In area 1 the predators may be increased, while in area 2 natural conditions may prevail. Now it is to be seen whether foraging is affected by the increase in predators or not. Therefore, we can then confidently conclude whether increased predation pressure causes decreased foraging activity or not.

#### AIMS AND OBJECTIVES OF ANIMAL BEHAVIOUR

Behaviour is recognised as one of the most important functions of animal life. The study of the behaviour of animals is the final objective of all other branches of biology. Some of the elementary actions of the animals — to avoid predators, to gather food, to reproduce etc., depend on an extraordinary complex and beautiful synchronised mechanism of nerve cells, glands and muscles, along with a supporting skeleton. These structures are part of a complex mechanism that must combine properly through the inherited constitution of each individual. Ethology has, thus, made important contri-

by, *environmental biology, sociobiology etc.* Animal behaviour has also applications to human behaviour, to neurosciences, to the study of animal welfare and to the educating of future generations.

**A. Ethology and Environment** : Animal behaviour generally provides the first clue to environmental degradation. Changes in sexual behaviour affects the population size of animals allowing us to take measures to save the environment. Field studies of natural behaviour of animals are vital to provide baseline data for environmental monitoring. For example, Environmental Protection Agencies use changes in swimming behaviour of minnows as an index of possible pesticide pollution.

Animal behaviour studies have led to the understanding of insect reproduction and host plant protection, leading to the discovery of non-toxic pheromones for insect pest control. Thus, the need for toxic pesticides can be avoided.

Knowledge of predator-prey relationships would lead to the maintenance of proper food web in a given ecosystem.

**B. Foraging behaviour and habitat preservation** : Understanding of foraging behaviour in animals has led to an understanding of forest regeneration. Many animals serve as seed dispersers resulting in propagation of plant species and are, therefore, a tool for habitat preservation.

Knowledge of foraging behaviour of honey bees, when applied to mechanisms of pollination can be important for plant breeding and propagation.

**C. Animal behaviour and conservation** : It is essential that we know about the natural behaviour (foraging, reproductive, migratory, home range etc.) of endangered species in order to develop protective measures for their conservation. Re-introduction of animals into their natural habitat, such as the

Golden lion tamarin of Brazil, requires detailed knowledge about the behaviour of such species.

Reproductive behaviour studies have led to improved captive breeding methods of near-extinct species such as snow leopard, red panda, golden lion tamarin, whooping cranes etc., so as to save them from extinction.

Animal behaviour research, both in captivity and in natural habitat, has become increasingly important. Many of the world's leading conservationists have a background in animal behaviour or behavioural ecology.

**D. Animal behaviour and economic implication :** Research on salmon migration has revealed a lot about the mechanisms of migration. This information has been valuable in preserving the salmon industry in the Pacific Northwest, which has led to the development of the salmon fishing industry in the Great Lakes, USA. Thus, basic animal behaviour research has important economic implications.

Such behavioural researches, if conducted on hilsa fish, can result in a boom of the dwindling hilsa fishing industry in India.

**E. Animal behaviour and welfare of animals :** Knowledge about the welfare of animals is possible only through the studies of its behaviour. The Society of Animal Welfare has placed increased emphasis on the welfare of domestic, pet and research animals. Cruelty on animals are punishable by law. It is the duty of an ethologist to look at the behaviour and well-being of animals in laboratory and field.

**F. Animal behaviour and neuroethology :** Through close observation of animal behaviour, Sir Charles Sherrington (1954), a Nobel Prize winner, developed a model for the structure and function of the nervous system. This work of Sherrington has been amply supported through subsequent neurobiological research on humans.

Neuroethology is the science of animal behaviour and neurobiology combined

together. It provides an important framework for explaining neural mechanisms which can benefit humans. Behavioural studies of poisonous and venomous animals, and the extraction of poison (neurotoxic chemicals) from such animals, is used to make various medicines which has undoubtedly benefited mankind.

**G. Animal behaviour and science education :** Courses on animal behaviour and behavioural ecology have been recently introduced in Indian universities. Still, the related departments like Anthropology, Zoology, Psychology and Wildlife have very little syllabus on Ethology. Students are still far away from wildlife and their behaviour. It is disheartening that most students have very little knowledge about the commonly found birds and animals around their own residence, leave aside those found in National Parks, Sanctuaries and Reserves. It is, therefore, essential that schools, colleges and universities should give emphasis on the study of Wildlife Biology, Conservation, Management, Animal Behaviour and Animal Husbandry.

**H. Ethology and human behaviour :** Many problems in human society are related with the interaction of environment and animal behaviour. Studies on animal behaviour has led to interpretation of the framework of human society and to understand the various society-related problems. Many studies on child abuses and infanticides in humans, finds its bearing from observation of animal behaviour. Various ethologists document that human societies have gradually evolved from animal societies and that understanding the behaviour of animals has helped in unfolding the mysteries of our own social organisations. For example :

1. Researches on chimpanzee and monkey has illustrated the importance of cooperation and reconciliation in social groups. This work provides new dimensions for understanding the aggressive behaviour of human

- beings. The behavioural studies of human being would have been much less today without the influence of animal research.
2. Work on social development in rhesus monkeys has been of major importance to theories of child development and to psychiatry.
  3. The woolly spider monkey in Brazil displays no aggressive behaviour among group members. Studies on how this species of monkey avoids aggression can be implemented to minimise human aggression.
  4. Male parental care studies on California mouse, marmosets, tamarins and others can give us insight of father's involvement in child care.
  5. Researches on circadian rhythms in animals has led to research relevant to human factors such as jet-lag or changing from one shift to another in an industry.
  6. It has been possible to detect stress and psychological disorders through research on animal behaviour.
  7. Researches on chimpanzee using language analogues have led to new technology (computer keyboards using arbitrary symbols) that has been successfully applied to teaching languages to disabled or physically challenged humans.