

Book Description

Behavioral ecology explores the evolutionary basis of animal behavior, focusing on how behaviors maximize survival and reproductive success in specific environmental circumstances. This interdisciplinary field investigates how natural selection influences behaviors like as feeding, mating, and parental care.

Understanding trade-offs is a critical component of behavioral ecology, such as the allocation of energy between feeding and reproduction or parental care against mating opportunities. Social behaviors such as cooperation and altruism are also investigated, with mechanisms like kin selection and reciprocal altruism explaining group cohesion and individual sacrifice for community benefit.

Behavioral ecology investigates cognitive and sensory processes, explaining how animals understand their surroundings and make adaptive decisions. By evaluating these behaviors, researchers gain insight into the dynamic interactions between animals and their environments, ultimately demonstrating the evolutionary pressures that determine behavior across species. This comprehensive approach contributes to a better understanding of the adaptive techniques that animals use to flourish in their constantly changing environments.

About the Editors:

Dr. Vanita did her Ph.D. from the Department of Zoology, Kurukshetra University, Kurukshetra (Haryana). She has qualified CSIR-JRF in Life Sciences in 2017 (AIR 82). She has published 3 research papers and 2 books in the field of Animal behaviour and wildlife conservation. Currently, she is working as Assistant Professor in Department of Zoology, Career Point University, Kota (Rajasthan).

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Editor:
Dr. Vanita
Dr. Amit Kumar

BEHAVIOURAL ECOLOGY: A COMPREHENSIVE GUIDE



Behavioural Ecology

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Preface

Behavioral ecology explores the evolutionary basis of animal behavior, focusing on how behaviors maximize survival and reproductive success in specific environmental circumstances. This interdisciplinary field investigates how natural selection influences behaviors like as feeding, mating, and parental care.

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Book Description

“Behavioral Ecology” is a comprehensive study of the evolutionary mechanisms that shape animal behavior. This text integrates principles from ecology, evolution, and ethology to investigate how behaviors improve survival and reproductive success in a variety of ecological contexts. It answers fundamental issues concerning the adaptive value of behaviors like foraging, mating, parental care, and social interactions.

It includes how animals optimize resource acquisition and reproductive prospects, with a focus on trade-offs and cost-benefit calculations. For example, the book investigates how animals balance their energy expenditure between foraging and reproduction, as well as how much time they spend on parental care vs additional mating. Social behaviors are examined in length, including talks of cooperation, altruism, kin selection, and reciprocal altruism, as well as the evolutionary benefits of group life and self-sacrifice.

“Behavioral Ecology” is vital for students and researchers in biology, zoology, and allied subjects, as it provides a thorough grasp of how natural selection drives animal behavior and how these behaviors adapt to changing environmental constraints. The literature teaches readers how to grasp the complex and dynamic relationships between organisms and their natural environments.

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Editors

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Study of Animal Behaviour in Natural Habitat

Vanita

ABSTRACT

Animals display a combination of acquired and natural behaviors that are essential for survival and adaptability. Animals that have learned behaviors are more cognitively capable and adaptive due to their exposure to environmental signals and experience. Learning was highlighted as a crucial component of behavior change for survival in H. Thorpe's 1963 definition. Learned behaviors include modifying natural reactions, gaining new abilities, persevering over time, and adjusting to changes in motivation or weariness. These activities can be classified as non-associative, associative, latent, insight, and phase-specific learning, and they differ throughout species.

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4.1 Introduction

Approaches to study the animal behaviour can vary greatly depending on the subject matter, the goals of the study and the preferences of the individual or group conducting the research. These approaches are not mutually exclusive, and researchers often combine multiple methods to address complex research questions or gain a more comprehensive understanding of a phenomenon. Studying animal behavior, whether in controlled laboratory settings or in the wild, requires combination of theoretical understanding, methodological expertise, and practical skills. The psychological, ethological, and sociobiological approaches are three distinct perspectives within the broader field of animal behavior and evolutionary psychology.

Psychological Approach:

Researchers using this approach often conduct experiments in controlled laboratory settings to investigate the psychological mechanisms underlying behavior. They may employ techniques such as operant conditioning, classical conditioning, and cognitive testing to explore how animals perceive, process, and respond to stimuli in their environment.

Ethological Approach:

The ethological approach to studying animal behavior emphasizes the naturalistic observation of animals in their natural habitats. Ethologists seek to understand behavior in the context of evolution, ecology, and natural selection. Ethological research often involves long-term field observations of animal behavior, detailed descriptions of species-typical behaviors, and comparative studies across different species.

Sociobiological Approach:

The sociobiological approach to studying animal behavior applies principles from evolutionary biology and genetics to understand the social behavior of animals, including humans. This approach often involves mathematical modeling, genetic analyses, and comparative studies to investigate the genetic basis and evolutionary history of social behaviors.

Study of animal behaviour can take place:

- (1) In Wild:** The study of animal behavior in the wild involves observing animals in their natural habitats without limitations on the species or size, ranging from amphibians to mammals. Researchers can observe animals freely moving around in their natural environment, provided that the terrain and climate are conducive to such observation.
- (2) In Lab:** In laboratory settings, behavioral experiments are conducted on small to medium-sized animals, including invertebrates, frogs, fish, pigeons, doves, and a variety of small mammals such as rats, mice, hamsters, guinea pigs, cats, dogs, and apes. These animals may undergo surgical procedures or be subjected to psychological tests such as mazes, jumping boxes, Thorndike boxes, or Skinner boxes. Additionally, they may be tested on grids or exercise wheels. This unit focuses specifically on studying the relationship between the brain and behavior through surgical, chemical, and electrical methods.
- (3) In Zoo:** In zoo settings, there are no limitations on the type of animals studied, ranging from rats to rhinos and from eels to elephants. Any animal capable of surviving in captivity can be observed for its behavior. In zoos, behavior is recorded solely through visual observations, meaning researchers observe the animals directly with their eyes. No surgical procedures or direct handling of animals take place in this context. However, it's important to note that this aspect is not covered in your syllabus.

4.2 Methods of study of Animal Behaviour:

The study of animal behavior encompasses a range of methods, including psychological, physiological, and field biological techniques.

1. Psychological Techniques:

This technique involves training animals to perform specific behaviors in response to cues or stimuli and then reinforcing those behaviors with rewards or punishments. Through operant conditioning, researchers can investigate learning processes, motivation, and decision-making in animals. This Helps assessing animals' cognitive abilities, such as problem-solving, memory, spatial reasoning, and decision-making. Researchers use tasks like mazes, puzzles, and object discrimination tests to measure cognitive performance in animals.

2. Physiological Techniques:

Techniques such as functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and electroencephalography (EEG) allow researchers to visualize brain activity associated with specific behaviors. Neuroimaging helps identify brain regions involved in various cognitive processes and emotional responses in animals. Researchers administer drugs or chemicals to animals to manipulate neurotransmitter systems and study their effects on behavior. Pharmacological manipulations help identify the neurochemical basis of behavior and the role of specific neurotransmitters in regulating behavior.

3. Field Biological Techniques:

Field biologists conduct direct observations of animals in their natural habitats to document behavior. This may involve recording behaviors such as feeding, mating, territoriality, and social interactions. Field biologists use tracking devices such as radio collars, GPS tags, and satellite transmitters to monitor the movements and behavior of animals over time. Tracking data help researchers understand migration patterns, habitat use, and social structure in wild animal populations.

Study of Behaviour of Wild Animal in their Natural Habitat :

Studying the behavior of wild animals in their natural habitat is a fascinating and challenging endeavor that requires a combination of observation, field research techniques, and ecological understanding. The initial step in studying the behavior of animals in their natural habitat is to conduct observational studies to gather as much information about their behavior as possible across various contexts.

4.3 Tools and Techniques to Study the Animal Behaviour:

Studying animal behavior often requires various tools and techniques to observe, record, and analyze their actions. Here are some commonly used tools in animal behavior research:

- 1. Observation:** Direct observation of animals is the foundation of behavioral research. Researchers carefully watch animals in their natural habitat or controlled environments to document their behaviors. This can involve visual observation using tools like binoculars or telescopes to observe from a distance without disturbing the animals.
- 2. Video Recording:** Video recording allows researchers to capture animal behaviors in detail, providing valuable visual data for analysis. High-definition cameras are often used to record behaviors continuously or during specific observation periods. Video footage can be reviewed frame by frame to analyze behaviors such as social interactions, foraging, and locomotion.
- 3. Data Loggers:** Data loggers are electronic devices that record environmental parameters and animal movements. They can include GPS trackers to monitor animal movements, accelerometers to measure activity levels, and temperature sensors to track environmental conditions. Data loggers provide quantitative data that can be used to analyze habitat use, activity patterns, and responses to environmental changes.

4. **Ethogram:** An ethogram is a systematic catalog of observable behaviors exhibited by a particular species. Ethograms are developed through careful observation and description of behaviors, which are then categorized and defined. Researchers use ethograms as a reference guide to record and classify behaviors during observation periods, ensuring consistency and accuracy in data collection.
5. **Radio Telemetry:** Radio telemetry involves attaching radio transmitters to animals to track their movements and behaviors. Transmitters emit radio signals that are picked up by receivers, allowing researchers to locate animals and monitor their movements over large distances. Radio telemetry is commonly used in wildlife research to study migration patterns, habitat use, and behavior in remote or inaccessible areas.
6. **Bioacoustics:** Bioacoustics is the study of animal sounds and vocalizations. Researchers use microphones and audio recording equipment to capture animal vocalizations and sounds in their natural environment. Bioacoustics analysis helps researchers understand communication, mating calls, territorial behaviors, and other acoustic signals used by animals.
7. **Endocrine Monitoring:** Endocrine monitoring involves analyzing hormones in biological samples such as blood, urine, or feces to assess physiological states and reproductive behaviors in animals. Enzyme immunoassays (EIAs) and radioimmunoassay (RIAs) are commonly used techniques to quantify hormone levels and study hormonal influences on behavior, reproduction, and stress responses.
8. **Computational Tools:** Computational tools such as data analysis software, statistical packages, and programming languages are essential for processing and analyzing large datasets generated from behavioral observations and experiments. These tools allow researchers to conduct quantitative analyses, visualize data, and test hypotheses, providing valuable insights into animal behavior.
9. **Camouflage tents and hides:** Camouflage tents and hides are incredibly valuable tools for studying animal behavior. By providing a concealed observation point, camouflage tents and hides allow researchers to observe animals without causing disturbance. This minimizes the impact of human presence on animal behavior, enabling more natural and unaltered observations.

Selecting Study Sites: Choosing the right study area for behavioral observation is indeed crucial as it significantly impacts the outcome and validity of the results. Researchers choose study sites that are representative of the habitat and the species of interest. These sites should provide opportunities to observe animals in different contexts, such as feeding areas, resting sites, breeding grounds, and social gathering spots.

Selection of Animal: Selecting the appropriate experimental animal is also critical step in designing research studies, especially those focused on behavioral observations.

4.4 Capturing animals:

Capturing animals for research purposes requires careful planning and adherence to ethical guidelines to minimize stress and harm to the animals. In many behavioral studies, researchers need to track and observe individual animals over time to understand their behavior patterns, social interactions, and other aspects of their lives. Capturing animals allows researchers to mark them for individual identification, which facilitates accurate tracking and observation. By capturing and marking animals, researchers can ensure that they are tracking the same individuals consistently throughout the study period.

Ensure that capturing methods are conducted in accordance with ethical guidelines and regulations. Choose appropriate capture methods based on the species, habitat, and research objectives. Common capture methods include traps, nets, CO₂ cartridge gun, tranquilization, and hand capture. Select methods that are least invasive and least stressful for the animals. Ensure that personnel involved in capturing animals are properly trained and experienced in handling and capturing animals safely and humanely. This includes knowledge of species-specific behaviors and appropriate handling techniques.

4.5 Marking and Identification:

In behavioral studies, accurate identification of individual animals is crucial for tracking behaviors, understanding social dynamics, and analyzing data effectively. Here are several methods commonly used for animal identification during behavioral studies:

1. **Natural Markings:** Some animals have unique natural markings, such as patterns on their fur, scars, or distinctive coloration. Observing and documenting these natural features can help researchers distinguish between individuals.
2. **Physical Tags or Markings:** Physical tags or markings, such as ear tags, neck collars, leg bands, or toe-clipping (removing a small portion of a toe), can be applied to animals for identification. These tags or markings are typically non-invasive and allow researchers to visually identify individuals from a distance.
3. **Radio Transmitters:** Radio transmitters are attached to animals to track their movements and behavior remotely. Each transmitter emits a unique frequency, enabling researchers to identify individual animals based on their transmitter signal.
4. **Pit Tags (Passive Integrated Transponders):** Pit tags are small electronic devices implanted under the skin of animals. They contain a unique identification number that can be read using a handheld scanner. Pit tags provide a permanent and tamper-proof method of individual identification.
5. **Microchips:** Similar to pit tags, microchips are small electronic devices implanted under the skin of animals. They contain a unique identification number that can be scanned using a microchip reader. Microchips are commonly used in companion animals but can also be used in research animals for identification.
6. **Photographic Identification:** Photographs of animals' unique features, such as facial markings, scars, or dorsal fin shapes (in aquatic animals), can be used for individual identification. Specialized software may be used to analyze and compare photographs to identify individuals.
7. **DNA Profiling:** In some cases, DNA profiling may be used for individual identification, especially in species with high genetic variability. DNA samples, such as hair follicles, feathers, or tissue samples, can be collected non-invasively and analyzed to identify individuals based on their unique genetic profiles.

4.6 Tracking animals:

Tracking animals in behavioral studies is essential for understanding their movements, behaviors, and interactions within their natural environment. Here are several methods commonly used for tracking animals:

1. **Radio Telemetry:** Radio telemetry involves attaching radio transmitters to animals and using radio receivers to track their movements. Transmitters emit radio signals that can be detected by receivers, allowing researchers to locate animals in real-time. This method is particularly useful for tracking animals over large areas or in dense vegetation.

2. **GPS Tracking:** Global Positioning System (GPS) tracking involves attaching GPS collars or tags to animals to track their movements with high spatial accuracy. GPS devices record location data at regular intervals, which can be downloaded and analyzed to study animal movements, home ranges, and habitat use.
3. **Satellite Tracking:** Satellite tracking utilizes satellite technology to monitor animal movements over large spatial scales. Animals are fitted with satellite tags that transmit location data to orbiting satellites, which are then relayed to researchers on the ground. Satellite tracking is useful for studying long-distance migrations or movements in remote areas.
4. **Acoustic Tracking:** Acoustic tracking involves attaching acoustic tags to animals and using underwater or terrestrial receivers to detect their unique acoustic signals. This method is commonly used for tracking aquatic species, such as fish or marine mammals, in underwater environments.
5. **Visual Observation:** Visual observation involves directly observing animals in their natural habitat using binoculars, spotting scopes, or cameras. Researchers may use blinds or hides to conceal themselves and minimize disturbance to the animals. Visual observation allows researchers to record behaviors, social interactions, and movement patterns.
6. **Remote Cameras:** Remote cameras, also known as trail cameras or camera traps, are stationary cameras equipped with motion sensors that automatically capture images or videos of animals when they pass by. Remote cameras can be placed in strategic locations to monitor animal activity over extended periods.
7. **Traditional Tracking:** Traditional tracking involves following animal tracks, trails, or other signs (e.g., scat, burrows) to infer animal presence and movements. This method requires expertise in tracking and interpreting animal signs and is often used in combination with other tracking methods.

The choice of tracking method depends on factors such as the species, habitat, research objectives, budget, and logistical constraints. Researchers often use multiple tracking methods in combination to obtain comprehensive insights into animal behavior and ecology.

4.7 Recording Methods:

When establishing systematic guidelines for behavior recording, two tiers of decisions need to be addressed. The initial level, termed sampling rules, outlines which subjects are observed and at what times. This encompasses the differentiation between ad libitum sampling, focal sampling, scan sampling, and behavior sampling. The subsequent level, termed recording rules, delineates how the behavior is documented. This involves distinguishing between continuous recording and time sampling, which further includes instantaneous sampling and one-zero sampling.

1. **Ad libitum sampling:** Ad libitum sampling is a method of observing and recording behavior without predetermined rules or constraints regarding what to observe or when to observe it. Here are a few examples of ad libitum sampling in different contexts:
 - **Animal Behavior Studies:** In a study observing the behavior of a group of chimpanzees in their natural habitat, researchers might employ ad libitum sampling. They would record various behaviors such as grooming, foraging, and social interactions as they occur without a predefined schedule or specific behaviors to focus on.
 - **Classroom Observations:** A teacher conducting ad libitum sampling might observe and record student behaviors during a free-form discussion session. The teacher would note instances of participation, engagement, and off-task behavior without following a strict observation protocol.

- **Observing Children in a Playground:** A researcher studying children's play behavior in a playground might use ad libitum sampling. They would observe and record various activities such as running, climbing, playing with toys, or interacting with other children without predetermined categories or time intervals.
- **Birdwatching:** A birdwatcher using ad libitum sampling would observe and record bird behaviors in their natural habitat without a specific agenda. They might note behaviors such as feeding, mating displays, or vocalizations as they happen during their observation period.

In each of these examples, ad libitum sampling allows for flexible and spontaneous observation of behavior, capturing a wide range of behaviors without predefined criteria or schedules. However, it's important to note that while ad libitum sampling offers flexibility, it may also introduce biases and overlook certain behaviors or patterns.

2. **Focal sampling:** Focal sampling, also known as focal animal sampling, involves observing one specific individual (or unit) for a set duration and recording all instances of its behavior across various categories. Ideally, the choice of the focal individual should be predetermined, and the sequence of observation should be systematically varied. When observing the social behavior of the focal individual, it may be necessary to also note certain aspects of interactions with other individuals, such as who initiates interactions and the recipients of these behaviors. Focal sampling is often considered the most effective method for studying groups. During focal sampling, if the focal individual becomes partially obscured or moves out of sight, recording should pause until it becomes visible again. These interruptions are typically recorded as "time out," and final measurements are adjusted based on the time the focal individual was observable. However, it's important to note that excluding periods when the subject is not in view may introduce bias, especially if subjects engage in specific behaviors while out of sight. For instance, animals may seek privacy while eating or mating, making their visible behavior less representative of their overall behavior.

Focal sampling can be challenging in field conditions, as the focal individual may leave the observation area entirely. In such cases, researchers must decide whether to pursue the individual, for how long, or if observations should cease and a new focal individual selected. Clear guidelines are necessary for determining the course of action if the focal individual disappears during a recording session.

Here are a few examples of focal sampling in different contexts:

- **Primate Studies:** In studies of primate behavior, researchers may use focal sampling to observe a particular individual within a group. For instance, they might focus on a single chimpanzee within a troop and record all instances of grooming behavior initiated by that individual.
 - **Bird Behavior Research:** Ornithologists might employ focal sampling to study the foraging habits of a specific bird species. They could select one bird and observe its feeding behavior, noting the types of prey it captures and the frequency of its foraging activities.
3. **Scan sampling:** Scan sampling involves quickly surveying or observing an entire group of subjects at regular intervals, with each individual's behavior recorded at that moment. Typically, scan sampling focuses on simple categories of behavior, such as whether a specific activity is happening or which individuals are asleep.

During scan sampling, each individual's observation time should ideally be minimal, though in practice, it may be relatively short and consistent. The duration of a single scan can vary widely depending on factors like group size and the level of detail recorded for each individual. Scan sampling may introduce biases because some individuals or behaviors are more noticeable than others. However, it offers practical benefits for certain research goals. For instance, de Ruiter (1986) employed scan sampling to study wild capuchin monkeys' activity across different individuals, times of day, and seasons, facilitating diverse behavioral and ecological comparisons between groups. Combining scan sampling with focal sampling in the same observation session is feasible. While detailed observations of a focal individual are recorded, the entire group is periodically scan-sampled for specific behaviors, such as predominant activity or proximity to others. Here are a few examples to illustrate how scan sampling works:

➤ **Primate Social Behavior:**

Description: A researcher is studying the social behavior of a group of chimpanzees in the wild.

Procedure: At regular intervals (e.g., every 5 minutes), the researcher quickly scans the entire group and records specific behaviors, such as grooming, feeding, or resting.

➤ **Bird Flocking Behavior:**

Description: Observing the flocking behavior of birds in a large aviary.

Procedure: Every 10 minutes, the observer scans the entire aviary and records whether each bird is in flight, perched, or engaged in social interactions.

➤ **Fish Schooling Patterns:**

Description: Studying the schooling behavior of fish in an aquarium.

Procedure: The researcher conducts scan samples every 15 minutes, noting the spatial arrangement of the fish in the tank—whether they are schooling together or exhibiting solo behaviors.

In each example, the key is to systematically survey the entire group or environment at predetermined intervals, capturing a snapshot of the behaviors present at each moment. This method allows researchers to gather data on a wide range of individuals and behaviors over time, providing insights into group dynamics and activity patterns.

4. **Behaviour sampling**

Behavior sampling involves observing an entire group and documenting each instance of a specific behavior, along with details regarding the individuals involved. This method is primarily employed to record rare yet significant behaviors, such as fights or copulations, where it's crucial to document each occurrence. Rare behaviors that might be overlooked by focal or scan sampling methods can be captured through behavior sampling. Often, behavior sampling is used alongside focal or scan sampling techniques. However, it is susceptible to the same bias as scan sampling, as conspicuous occurrences are more likely to be observed. In some contexts, behavior sampling is also known as "conspicuous behavior recording."

An example of behavior sampling could be observing a group of chimpanzees and documenting each instance of aggressive interactions, including who initiated the aggression and who was involved in the altercation. This method allows researchers to gather detailed data on rare behaviors that are important for understanding social dynamics within the group.

4.8 Recording Rules

1. Continuous recording:

Continuous recording involves observing and recording behavior continuously throughout the observation period. With this method, the observer documents every instance of the behavior of interest as it occurs, providing a detailed account of frequencies, durations, and start-stop times. Continuous recording aims to capture a faithful and exact record of behavior, allowing researchers to analyze patterns and sequences accurately. This method requires close attention and meticulous recording to ensure that no behaviors are missed during the observation period.

2. Time Sampling:

Time sampling involves dividing the observation period into discrete time intervals and recording behavior only at specific points within each interval. Unlike continuous recording, time sampling does not capture every instance of behavior; instead, it provides a snapshot of behavior at selected moments.

Common time sampling methods include momentary time sampling (recording behavior at the end of each interval), interval recording (recording behavior throughout each interval), and focal sampling (focusing on a specific individual or group during each interval). Time sampling is less resource-intensive compared to continuous recording and may be more practical in situations where continuous observation is not feasible or necessary.

Time sampling indeed can be subdivided into two principal types: instantaneous sampling and one-zero sampling.

A. Instantaneous Sampling:

In instantaneous sampling, the observer records whether a specific behavior is occurring at a particular moment in time. The observation period is divided into discrete intervals. At the beginning of each interval, the observer quickly scans the subject(s) and records whether the behavior of interest is occurring or not.

Example: Imagine studying the feeding behavior of a group of birds in a park. Using instantaneous sampling, you might set intervals of one minute. At the start of each minute, you observe the birds and record whether any bird is actively feeding (e.g., pecking at the ground or foraging) or not.

B. One-Zero Sampling:

One-zero sampling involves recording whether a specific behavior is occurring at the end of each time interval. Similar to instantaneous sampling, the observation period is divided into intervals. However, instead of recording behavior at the beginning of each interval, behavior is recorded only at the end of the interval.

Example: Suppose you are studying the social interactions of primates in a zoo enclosure. Using one-zero sampling with five-minute intervals, at the end of each interval, you observe and record whether any grooming behavior is happening among the primates. If grooming is observed at the end of the interval, you record a "1"; if no grooming is observed, you record a "0".