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Synergies in Defence

Exploring the Interplay of Science Technology Arts and Commerce

Avinash S. Jagtap | Ashok E. Kalange
Jagdish D. Deshpande | Devidas V. Bhosale
Aniket S. Kothawale | Vivek A. Bale
Shashikant C. Nakate



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Synergies in Defence:

Exploring the Interplay of Science,
Technology, Arts, and Commerce

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Role of Zoology in Defence

Prof. Kishor More*

INTRODUCTION

Zoology is the branch of biology that deals with scientific study of animals. Animal diversity is a testament to the incredible variety of life on Earth. From the tiniest insects to the largest mammals, the animal kingdom encompasses an astonishing array of species. Each animal has its unique characteristics, adaptations, and behaviours, allowing them to thrive in diverse habitats and ecosystems. The vast diversity of animals includes vertebrates such as mammals, birds, reptiles, amphibians, and fish, as well as invertebrates like insects, arachnids, molluscs, and crustaceans. This diversity plays a crucial role in maintaining ecological balance, contributing to pollination, seed dispersal, and nutrient cycling. Animals come in various shapes, sizes, and colours, each showcasing nature's ingenuity in creating life forms. Studying animal diversity provides valuable insights into evolutionary processes, genetics, and ecological interactions, advancing scientific knowledge.

Humans interact with and rely on animals for numerous purposes. These include companionship, agriculture, research,



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entertainment, and transportation. The animals have been integral to human societies throughout the history; ethical considerations have sparked discussions about their welfare and rights. Animals have played a significant role in warfare throughout history, both on the battlefield and behind the scenes. From ancient civilizations to modern conflicts, various species have been trained, utilized, and sometimes even revered for their contributions to military endeavours. This chapter aims to explore the historical significance of animals in war, highlighting contemporary examples where insights from the animal kingdom have influenced defense strategies, innovation, sustainability and how the animals served as sources of inspiration for technological advancements, biological detection methods.

ANIMALS IN ANCIENT WAR

During ancient times, animals served as valuable assets in warfare, fulfilling a diverse range of functions. Horses, for instance, were widely employed by ancient civilizations such as the Greeks, Persians, and Romans. Mounted cavalry units relied on the speed and mobility of horses to launch swift attacks, encircle enemies, and deliver devastating charges. These equine (members of the horse family) companions became symbols of power and prestige on the battlefield, enhancing the mobility and striking power of the ancient armies.

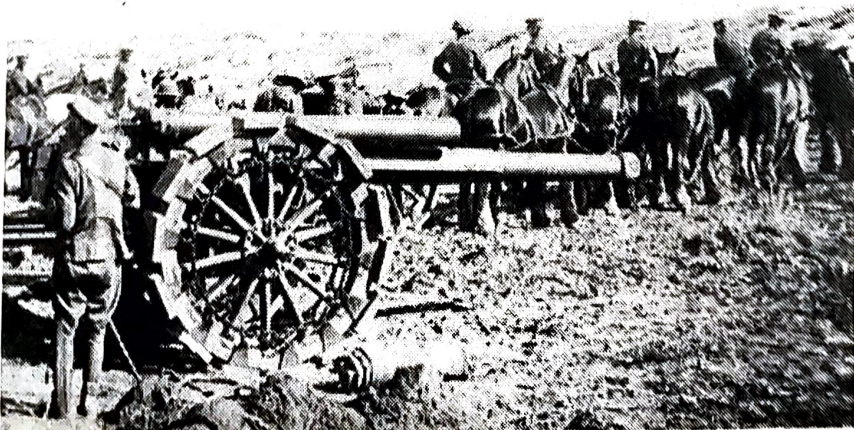


Fig: Use of horses in World War-I

https://www.nam.ac.uk/sites/default/files/styles/slice_sm/public/2018-10/124079_slice.jpg

Elephants also played a crucial role in ancient warfare. The armies of Carthage and the Mauryan Empire employed war elephants as formidable weapons. These colossal creatures struck fear into the hearts of enemy soldiers, trampling and goring them with their massive size and tusks. The mere presence of elephants often caused panic and chaos among opposing forces, leading to strategic advantages for their handlers.

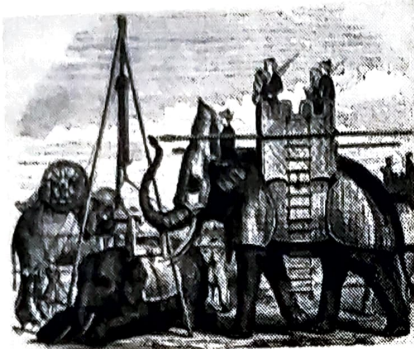


Fig: Use of elephants in war

<https://historydaily.org/wp-content/uploads/2016/05/290365458ad826ff8d146.jpg>

The Pigeon Spy and His Work in War

How a German spy-theory filled prescriptions by carrier Pigeons and how

his son invented a camera where by pigeons could make photographs for the German army



Fig: Use of pigeon in war

<https://blog.sciencecentral.com/wp-content/uploads/2020/02/fig-4-Pigeon-Spy-and-his-work-in-war.jpg>

Pigeons and other birds were employed as messengers during ancient wars. Their remarkable homing instincts made them reliable carriers of vital messages across long distances. Falcons and other birds of prey were used for scouting and intelligence gathering, as their keen eyesight and flying abilities allowed them to survey the battlefield and report back crucial information to their human counterparts. In World War I and World War II, pigeons were used as messenger birds. They carried small capsules with messages across enemy lines or between ships and shore, providing a means of communication when other methods were unavailable or compromised.

MODERN WARFARE AND ANIMALS

The use of animals in warfare has diminished over time; some roles persist even in modern conflicts. Animals have been instrumental in shaping various aspects of defense and security strategies across the world.

1. Biomimicry and Military Technology:

Biomimicry is the imitation of natural processes, structures, and functions found in animals to develop innovative technologies.



A. Military Camouflage



Fig: Military camouflage costume

<https://5.imimg.com/data5/00/OY/XG/SELLER-21824060/army-uniform-500x500.jpg>

Military camouflage techniques have been significantly influenced by the natural camouflage abilities of animals, notably the adaptive coloration observed in species like chameleons and cuttlefish. This inspiration has played a pivotal role in the advancement of adaptive camouflage materials. Animals, with their exceptional adaptations tailored for seamlessly blending into diverse environments, have proven invaluable in shaping the creation of effective camouflage patterns. Emulating the intricate coloration and textural nuances found in creatures such as chameleons, frogs, and insects has paved the way for ground breaking developments in camouflage technology.

These biomimetic designs hold the potential to empower both soldiers and equipment with the capability to remain inconspicuous across a range of terrains, thus increasing their stealth and survivability within the complex theatre (specific area or environment where military operations or activities take place) of the battlefield. Through the integration of nature's camouflage strategies, military forces have strategically positioned themselves to evade detection and achieve tactical objectives with mastery.

B. Stealth Drone

Drone provide surveillance, reconnaissance, and even engage in combat operations. Their small size, maneuverability, and ability to gather real-time intelligence have revolutionized the way modern militaries conduct operations, providing an aerial advantage without endangering animal lives. The development

of stealth aircraft is based on owl wing feathers, while drones are inspired by bird flight.

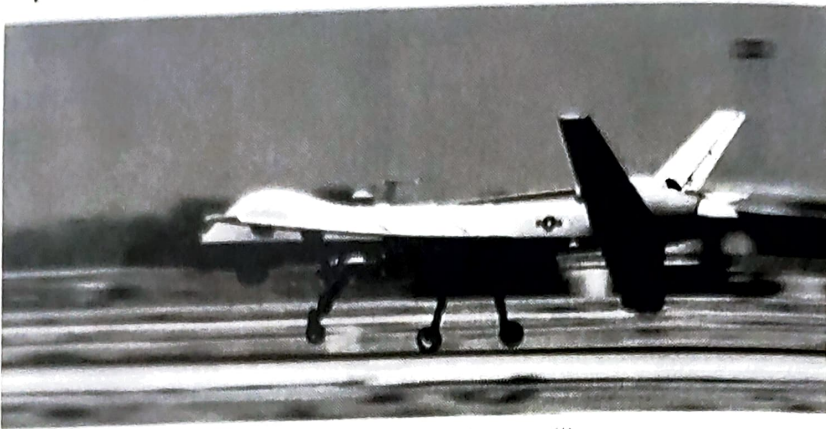


Fig: Military Drone for surveillance

<https://cdn.britannica.com/13/129813-050-4A169831-General-Atomics-MQ-9-Reaper-reconnaissance-US-Air-2008.jpg>

Owls are known for their silent flight due to the unique structure of their feathers. The serrations on the leading edges of owl feathers break up the turbulent air, reducing noise. Drone designers have explored incorporating similar serrations on the edges of drone wings to make them quieter and stealthier. Drones, especially those designed for surveillance and reconnaissance can benefit from these wing designs to enhance stability and agility during flight.

C. Aircraft Design and Animal Adaptations

Aircraft designs draw inspiration from the remarkable flight abilities of birds. By studying the aerodynamic principles that allow birds to navigate the skies with agility and efficiency, engineers have developed innovative aircraft designs. These designs incorporate features such as wing shapes, wingtip vortices, and flight patterns observed in birds. The goal is to enhance maneuverability, fuel efficiency, and overall performance of aircraft, bringing them closer to the natural mastery exhibited by avian species in flight.

D. Underwater Warfare Technology

Sonar systems play a crucial role in military operations. These systems utilize sound waves to detect, locate, and track underwater objects such as submarine, mines. It is essential for ensuring maritime security, protecting naval assets, and maintaining strategic dominance in underwater environments.



The role of animals, particularly marine mammals like dolphins and bats, has been influential in the development of sonar technology.

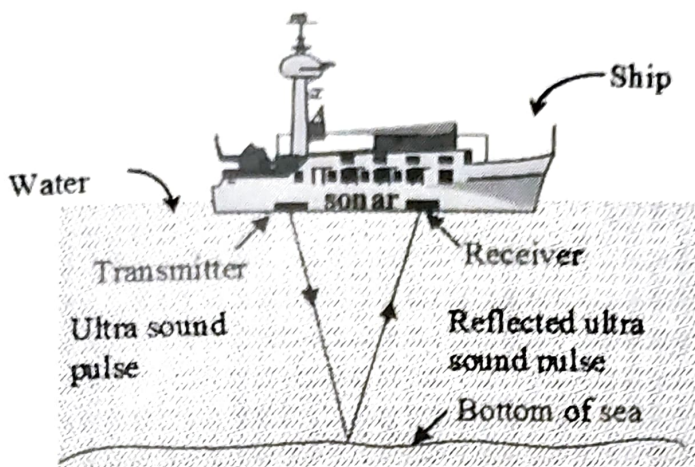


Fig: Sonar system

<https://www.knowledgeuniverseonline.com/images/physics/sonar-working.png>

Dolphins are known for their sophisticated echolocation abilities. They emit high-frequency clicks that bounce off objects in their environment, allowing them to “see” and navigate through underwater surroundings. This concept inspired the development of active sonar systems, where sound pulses are emitted and echoes from objects are detected to create images of underwater structures and objects.

Bats use echolocation to locate and capture insects in the dark. They emit ultrasonic calls and listen to the echoes to determine the location, size, and speed of objects around them. This concept influenced the development of ultrasonic sensors used in both military and civilian applications, including detecting objects underwater and aiding in navigation.

2. Surveillance and Reconnaissance

Surveillance and reconnaissance play critical roles in defense strategies by providing valuable information and intelligence that inform decision-making, enhance situational awareness, and contribute to overall security. Animals have played a role in military surveillance and reconnaissance in various historical contexts, before the widespread use of modern technology. Drones, satellites, sophisticated sensors, and communication equipment now play a significant role in military surveillance

and reconnaissance activities. These technologies provide greater accuracy, range, and efficiency compared to the capabilities of animals.

In recent times, Russia trained dolphins for underwater reconnaissance and mine detection. These dolphins were trained to respond to specific signals and commands, enabling them to carry out tasks such as marking underwater mines or identifying objects of interest. Their exceptional sensory capabilities, including echolocation, made them valuable assets in underwater operations. These programs were known to involve various marine mammals, including dolphins and sea lions.

3. Detection of chemicals and mines

Animals have played roles in the detection of mines and chemicals in military operations. Dogs have an exceptional sense of smell and are often trained to detect explosives, drugs, and other hazardous materials.



Fig: Sniffers dog in action

<https://static.independent.co.uk/s3fs-public/thumbnails/image/2018-03/03/12/bomb-dogs-usarmy.jpg>

Military forces have employed sniffer dogs at checkpoints, airports, and other security areas to quickly identify potential threats. Dogs have been trained to detect a wide range of substances, including explosives and hazardous chemicals. Their acute sense of smell allows them to identify trace amounts of substances, making them valuable in detecting chemical threats.

4. Military biosensors:

The natural sensing abilities of animals have been leveraged to create innovative biosensing technologies that have applications in military and defense operations. By emulating the extraordinary sensory capabilities found in the animal kingdom, researchers are advancing the field of biosensors to enhance security, situational awareness, and threat detection.

A. Biomimetic Optical Sensors

The animals, like mantis shrimp, possess extraordinary visual abilities. Researchers have drawn inspiration from their compound eyes to develop advanced optical sensors capable of detecting a wide range of light spectra, including ultraviolet and polarized light.

B. Bioacoustic Sensors

Marine animals like dolphins and whales communicate using intricate vocalizations. These natural communication patterns have inspired the development of underwater acoustic sensors for detecting and classifying sounds, such as those produced by submarines or other underwater vessels.

C. Bio-inspired Robotic Sensors

Animals such as bats use echolocation to navigate and detect objects in their surroundings. This concept has influenced the development of bio-inspired robotic sensors that use similar principles to navigate and map environments in low-visibility situations.

Summary

Throughout history, animals have been integral to warfare, exemplifying their unique roles in various ways. In ancient times, animals such as horses and elephants were utilized for mobility and shock tactics, while birds like pigeons served as messengers, ensuring vital communication amidst conflict. The contributions of animals in military endeavours were not only tactical but also symbolic, enhancing the capabilities and prestige of armies. As warfare evolved, so did the integration of animals in defense strategies. In modern times, biomimicry emerged as a powerful concept, drawing inspiration from animal adaptations for technological innovations. Military camouflage, influenced by the adaptive coloration of animals like chameleons and



cuttlefish, led to the development of advanced camouflage materials that enhance stealth and survivability in diverse terrains.

The design of aircraft, inspired by the flight mechanics of birds, sought to enhance maneuverability and fuel efficiency. Sonar systems, vital for maritime security, took cues from marine mammals like dolphins and bats, whose echolocation abilities inspired the creation of active sonar and ultrasonic sensors. Surveillance and reconnaissance, cornerstones of defense strategies, were historically aided by animals like dolphins trained for underwater tasks. However, technological advancements have largely replaced these roles, with drones, satellites, and sensors providing superior accuracy and range. This chapter culminates with the understanding that animals have significantly influenced defense strategies, from ancient times to the modern era. Animal adaptations, behaviours, and natural abilities have paved the way for technological advancements, biological detection methods, and innovative defense solutions.

