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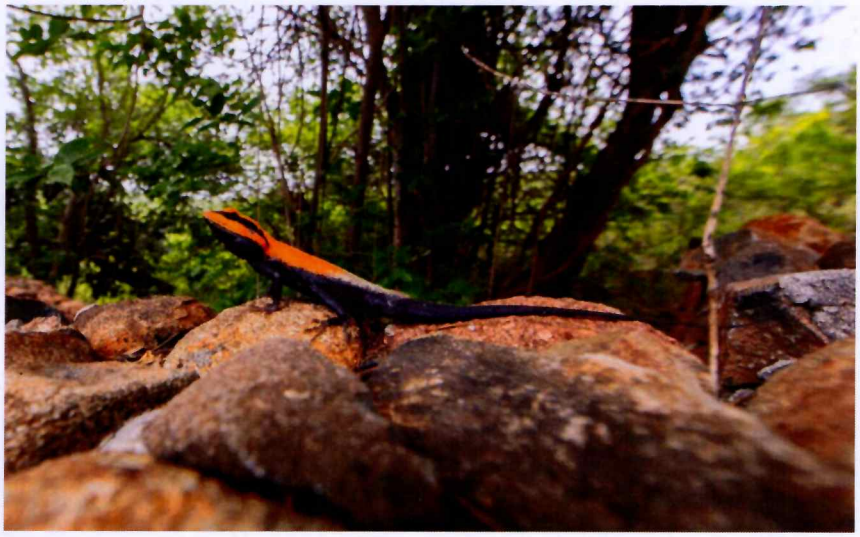

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Cover – Peninsular rock agama (*Psammophilus dorsalis)*

Photo: Mr. Aditya Diwakaran

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CONTENT

Snake Biomimicry or Biomimetics

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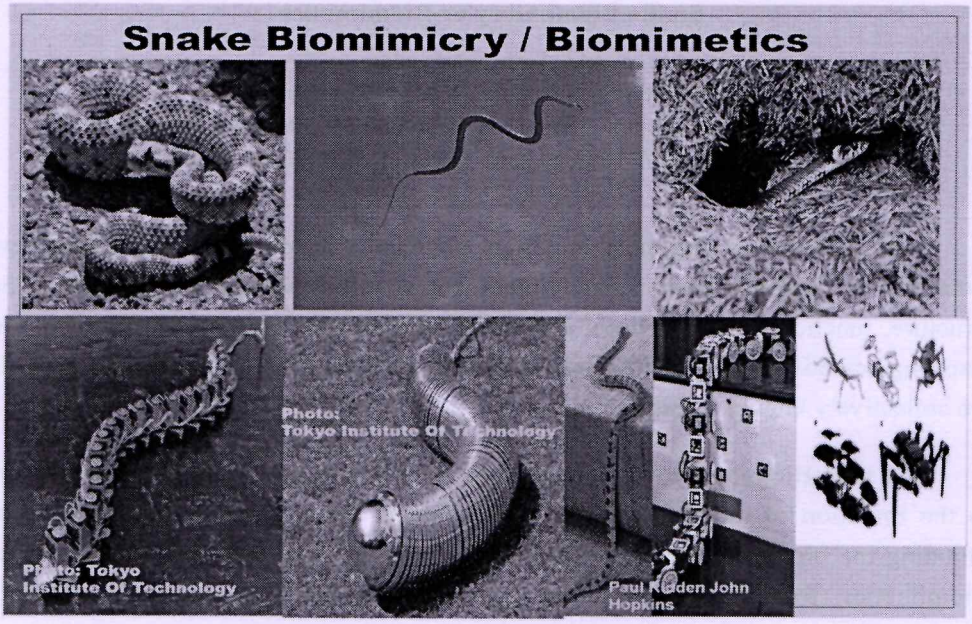
Nature is one of the most important sources of inspiration for creating new technologies, superior designs, and intelligent solutions to human problems. The structure, function, and behavioral aspects of wild animals play a significant role in inspiring scientists and technologists. The mimetic strategies found in wild animals are collectively known as Biomimicry.

The term Biomimicry was coined by Janine Benyus in 1997. Biomimetics refers to the imitation of models, systems, and elements found in nature. Mimicking or imitating the biological structures and functions of animals and plants is known as Biomimetics (from the Greek words bios, meaning "life," and mimesis, meaning "imitation").

Mimetic invention refers to the creation of new technologies or designs inspired by the biology of living organisms. Biomimicry, as a powerful tool, has inspired scientists and engineers to design and develop innovative technologies aligned with ecological principles. The main aim of biomimicry is to closely observe the designs of wild animals and apply these natural principles to human-made systems, technologies, and products.

Reptiles as a Source of Inspiration

Reptiles, particularly snakes, have inspired scientists and engineers to develop several innovations. Snakes, through their unique biological adaptations, have evolved to survive efficiently in diverse habitats. Engineers and technologists keenly observe these adaptations in the wild to derive insights that lead to the creation of new technologies, superior designs, and advanced technical intelligence. This clearly indicates a strong connection between snake biology and modern technology.



Snakes and Biomimetic Design

The concept of biomimetics demonstrates that snakes are among the best models for biomimetic study. Innovative technologists conduct field observations to understand various aspects such as body structure, movement patterns, flexibility, and speed. They also study the anatomical features of snakes to design mechanisms that replicate these traits through mechanical components analogous to a snake's anatomy.

Snakes can crawl efficiently through tunnels of varying diameters using undulating movements and flexible physical structures. These characteristics have inspired engineers to design objects and systems based on snake locomotion, flexibility, and architecture.

Aerodynamics – The Flying Snake as Biomimetic Inspiration

The locomotion of flying snakes is considered one of the most striking natural phenomena. These snakes utilize their bodies as aerodynamic surfaces without the aid of limbs.

Biomimetic designs inspired by flying snakes focus on two main features:

1. The concave, airfoil-like cross-sectional body shape, and
2. The undulating aerial motion, which provides stability and control during glides.

Engineers and roboticists study these mechanisms to develop efficient aerial vehicles capable of agile and stable movement. The flying snake flattens its body by expanding its ribs, generating significant lift comparable to that of a conventional aircraft wing. The snake performs rhythmic, side-to-side undulations in the air to control its flight path and maintain stability. Researchers have found that small changes in posture can significantly alter lift and drag.

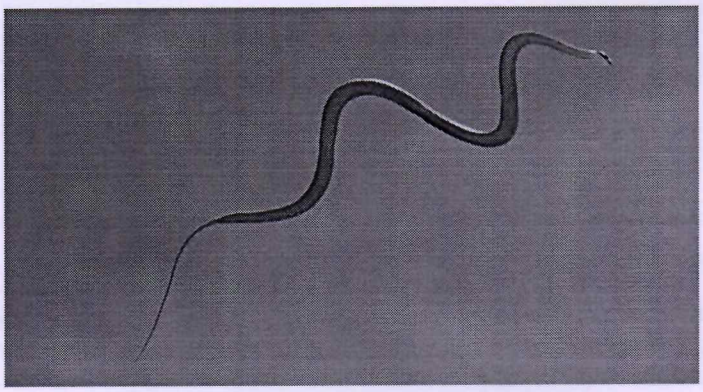


Photo Courtesy: *Chrysopelea paradisi,* Sabah, Borneo, Malaysia. (Alamy Stock Photo)

Robots Inspired by Snake Locomotion

Biomimicry of snake locomotion, flexibility, and physical structure has inspired researchers to design robots that imitate lateral undulation for movement through tight spaces and swimming in water.

Serpentine Robots

Mimicking snake behavior, technologists have designed search and rescue robots capable of navigating uneven and confined spaces. These robots are used in disaster situations—such as collapsed buildings—to locate victims and inspect hazardous environments.

The denning behavior of snakes has also inspired the design of energy-efficient buildings, partially buried underground for thermal regulation.

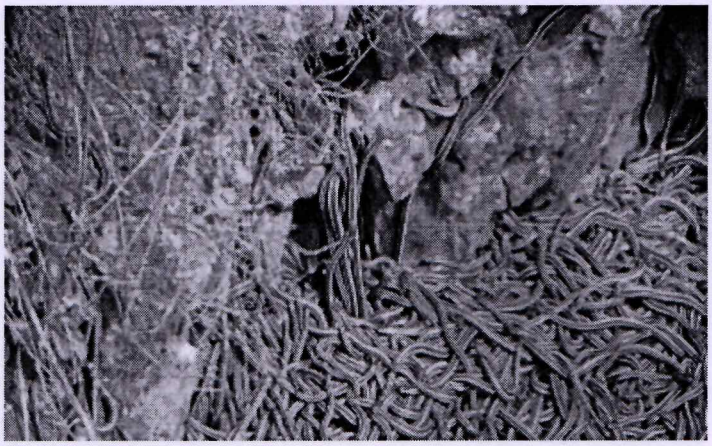


Photo courtesy: Rommel

The ability of snakes to constrict their prey has inspired the development of twisted-string and spiral-hose mechanisms for robotic grippers. Researchers have also developed modular aquatic snake robots with efficient underwater locomotion for environmental monitoring.

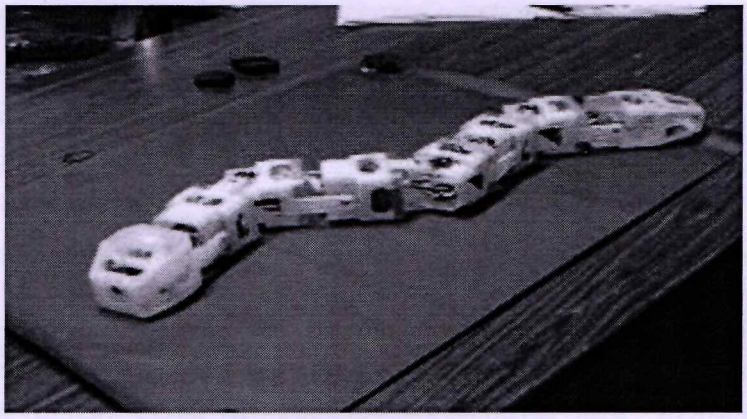


Photo Courtesy: CSIR-CMERI/IPMG/DR/2012/2

Snake-Inspired Robots

The cross-sectional shape of gliding tree snakes has led to the creation of efficient S-airfoils for aircraft, improving lift-to-drag ratios.

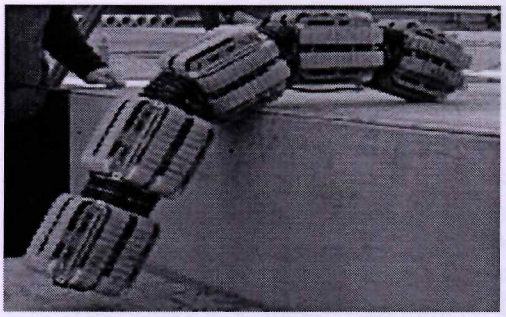
- Soryu-C is a slender, snake-like robot designed for remote navigation and inspection of confined, uneven, and unstructured environments. It can operate in mud, water, sand, and debris. Equipped with two high-definition

cameras, it enables precise remote operation. The robot's modular, flexible joints replicate the fluid motions of biological snakes.

- **Roboa,** developed by ETH Zurich (Eidgenössische Technische Hochschule – Federal Institute of Technology), is an expandable snake robot capable of extending up to 100 meters in length. It slithers smoothly into confined and complex spaces, using compressed air for movement, which minimizes the risk of sparks in explosive environments. Roboa is used in search-and-rescue missions and for inspecting inaccessible pipes, sewers, and tanks.

Photo Courtesy: ETH Zurich

- **OmniTread 4** is a tracked snake-like robot designed to explore unknown cave terrains. Inspired by gliding snakes, it applies aerodynamic principles to improve lift-to-drag performance in aerial designs.



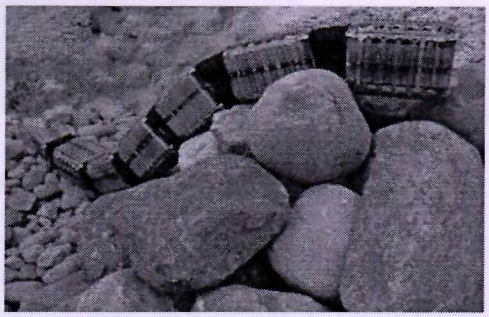
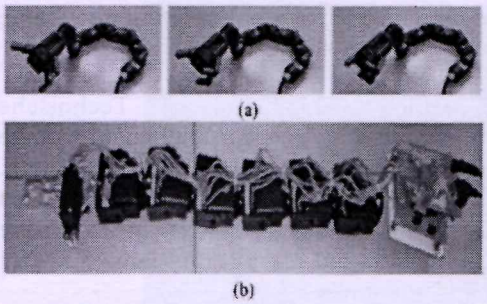


Photo Courtesy: Johann Borenstein

Grippers and Sensory Systems

A twisted-string and spiral-hose mechanism inspired by a snake's constricting ability enables robotic grippers to deform into helical shapes, allowing them to hold objects of various sizes and shapes.



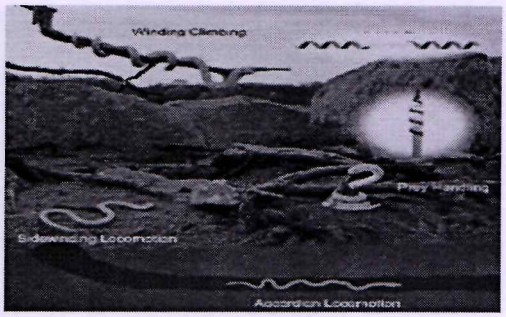


Photo Courtesy : Van Pho Nguyen *et al*

Photo Courtesy: He ChenZhong Chen *et al* Fig.grippers mimicking snakes

Pit organ of vipers and thermal sensor

The pit organ of vipers, known for its exceptional heat-sensing ability, has inspired engineers to design innovative thermal sensor technologies. Pit vipers can detect infrared radiation from warm-blooded prey even in total darkness. This biological system functions like a natural bolometer, and researchers have mimicked it to create artificial materials with pyroelectric properties, generating voltage in response to temperature changes.

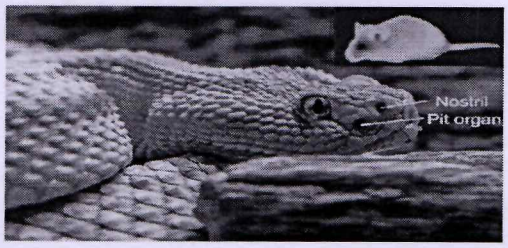


Photo Courtesy: F. Darbaniyan *et al.*

Snake-Inspired Synthetic Surfaces (Hydrogels and Biomimetic Materials)

Researchers have developed synthetic hydrogel surfaces that mimic the anisotropic friction of snake ventral scales—different friction levels depending on movement direction. The micro-fibril structures on snake scales (e.g., Chinese cobra) allow efficient movement and strong adhesion to various surfaces.

Technologists have replicated these microstructures in shape-memory polymers and elastomers, enhancing robotic movement efficiency.

Inspired by the superhydrophobicity and anisotropic friction of snake scales, engineers have also created bionic superhydrophobic stainless-steel surfaces using laser precision engineering. These surfaces enable directional control of water movement and improved surface efficiency.

Biomedical Applications

Biomimicry has significantly influenced the medical field—from surgical instruments to pharmaceuticals.

Hydrogel

Snake venom components have inspired innovative biomedical applications, such as hydrogels used for hemostasis (stopping bleeding). The venom enzyme Batroxobin (reptilase) from Bothrops atrox acts as a potent blood coagulant. Scientists have incorporated Batroxobin into peptide hydrogels that rapidly activate clotting, providing effective solutions to prevent surgical bleeding.

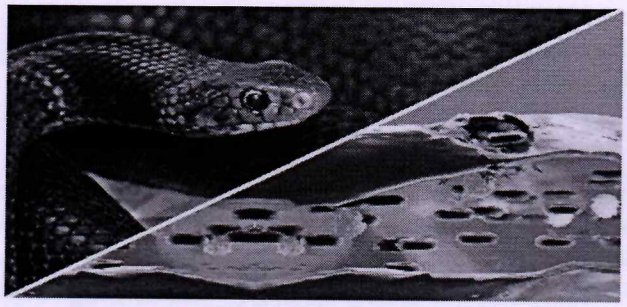


Photo Courtesy : Ramanathan Yegappan_*et al.*

Hypodermic Needles

The design of modern hypodermic needles was inspired by the fangs of rattlesnakes.

Both structures are hollow, enabling the delivery of liquid—venom in snakes, and medication in medical applications. The internal channel and tapered design of the fang serve as a natural model for precise and minimally invasive needle systems.

Summary:

The study of snake biomimicry demonstrates how nature's evolutionary designs—particularly those of reptiles—can inspire technological innovations in robotics, aerodynamics, materials science, and medicine. From flexible robots to advanced sensors and surgical tools, snakes exemplify how biological intelligence can guide sustainable and efficient engineering.

Acknowledgement

I express my sincere gratitude to Prof. Jaydev Babu for having edited the manuscript.

Reptiles of Anaikatti Reserve Forests, Periyanaickenpalayam Range, Coimbatore, Tamil Nadu

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Abstract

Anaikatty, located in the Western Ghats near Coimbatore, Tamil Nadu, is a biodiversity-rich zone facing anthropogenic threats. This study provides a comprehensive checklist of reptilian fauna recorded from the Anaikatty Reserve Forests under the Periyanaickenpalayam Range. A total of 37 reptile species across 14 families were documented, indicating significant herpetofauna diversity in this transitional dry deciduous–thorn forest region.

Introduction

The rapid pace of urbanization after post-Indian independence has led to the degradation of several natural habitats, including ecologically sensitive areas like Anaikatty. Located approximately 30 km west of Coimbatore city, Anaikatty has witnessed extensive surface soil mining severely impacting traditional agriculture and local biodiversity. Bounded by the Periyanaickenpalayam Range (north), Periya Thadagam (south), Silent Valley National Park Kerala (west), and Chinna Thadagam (east), Anaikatty forms part of the Western Ghats, a global biodiversity hotspot.

Study Area

Anaikatti Reserve Forests located in the Periyanaickenpalayam Range of Coimbatore District, Tamil Nadu. Approximate latitude and longitude are 11.1°N, 76.7°E. Altitude is ranging between 450 and 900 meters above mean sea level.The region comprises undulating terrain, hillocks, and is drained by perennial streams like Kodungarai Pallam. Vegetation types are predominantly tropical thorn and dry deciduous forests, dominated by *Acacia nilotica, Albizia amara*, *Hopea parviflora*, and *Mesua ferrea.*

Materials and Methods

Field observations were conducted using visual encounter surveys, dead roadkill specimens and opportunistic sightings during both day and night hours across multiple seasons. Identification was carried out using standard field guides and taxonomic keys. The checklist was validated through photographic evidence and expert consultation. This study was conducted between 2008 to 2016 to document the reptilian diversity of the area.

Results

A total of 37 reptile species belonging to 14 families and 2 orders were recorded.

Order: Testudines

Family: Geoemydidae

1. *Melanochelys trijuga trijuga* – Indian Pond Turtle

Family: Trionychidae

2. *Lissemys punctata punctata* – Indian Softshell Turtle

Order: Squamata

Family: Gekkonidae

3. *Hemidactylus frenatus* – Common House Gecko
4. *Hemidactylus brookii* – Brook's Gecko
5. *Hemidactylus leschenaultii* – Bark Gecko
6. *Hemidactylus triedrus* – Tamarind Tree Gecko
7. *Geckonella collegalensis* – Kollegal Gecko

Family: Agamidae

8. *Calotes versicolor* – Garden Lizard
9. *Calotes calotes* – Green Calotes
10. *Calotes grandisquamis* – Large-scaled Green Calotes
11. *Psammophilus dorsalis* – Rock Lizard

Family: Chamaeleonidae

12. *Chamaeleo zeylanicus* – Indian Chameleon

Family: Scincidae

13. *Eutropis carinata* – Common Skink
14. *Riopa punctata* – Red Skink

Family: Varanidae

15. *Varanus bengalensis* – Bengal Monitor

Family: Typhlopidae

16. *Indotyphlops braminus* – Brahminy Blind Snake

Family: Uropeltidae

17. *Uropeltis ellioti* – Shield tail Snakes

Family: Boidae

18. *Gongylophis conicus* – Common Sand Boa
19. *Eryx johnii* – Red Sand Boa

Family: Pythonidae

20. *Python molurus* – Indian Rock Python

Family: Colubridae

21. *Ptyas mucosa* – Rat Snake
22. *Boiga trigonata* – Cat Snake
23. *Lycodon aulicus* -Wolf Snake
24. *Lycodon flavicollis*- Yellow collored wolf snake
25. *Oligodon arnensis* -Kukri Snake
26. *Coelognathus helena* – Trinket Snake
27. *Ahaetulla nasuta* – Green Whip Snake
28. *Ahaetulla pulverulenta*- Brown whip snake
29. *Dendrelaphis tristis* – Bronze-back Tree Snake
30. *Xenochrophis piscator* – Checkered Keelback
31. *Atretium schistosum* – Olive Keelback
32. *Macropisthodon plumbicolor* – Green Keelback
33. *Amphiesma stolatum* – Buff-striped Keelback

Family: Elapidae

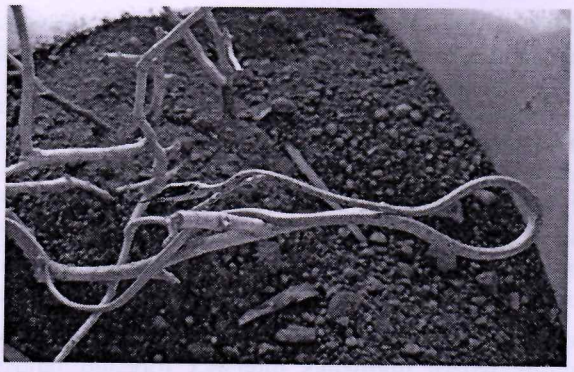
34. *Naja naja* – Indian Cobra
35. *Bungarus caeruleus* – Common Krait

Family: Viperidae

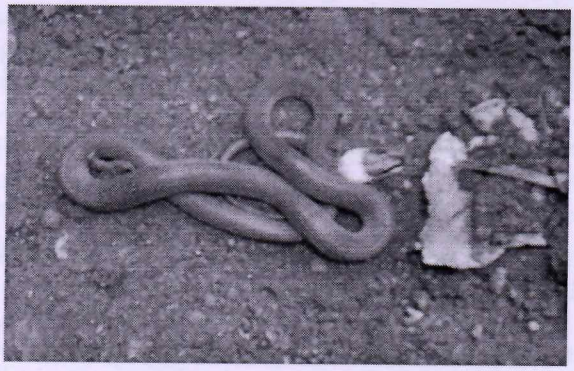
36. *Daboia russelii* – Russell's Viper
37. *Echis carinatus* – Saw-scaled Viper

Discussion

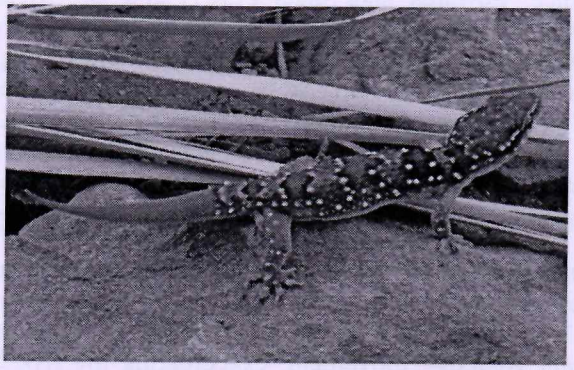
The checklist highlights the ecological richness of Anaikatty, indicating the presence of both generalist and habitat-specialist reptile species. Anaikatty Reserve Forests support a diverse assemblage of reptilian fauna, underscoring the need for immediate conservation action and habitat restoration. The presence of forest-dependent species such as Brown Whip Snake suggests that patches of undisturbed forest still persist. However, anthropogenic pressures like brick mining and land conversion pose significant threats to this biodiversity Long-term monitoring, habitat protection, and environmental education among local communities are recommended to safeguard this herpeto faunal diversity.



Brown Whip Snake



Yellow Collored Wolf Snake



Tamarind Tree Gecko

Mortality of Wild Animals Due to Vehicular Traffic Between Mangarai and Anaikatty State Highways, Western Ghats, Coimbatore, Tamil Nadu

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Abstract:

Vehicular traffic has been a significant threat to wildlife populations, particularly in regions where highways intersect forested landscapes. This study evaluates the impact of road traffic on wild animal mortality along the Mankarai-Anaikatti State Highway (SH 164) in the Coimbatore Division, Tamil Nadu. Data were collected over five years (2004–2008), documenting the species affected, frequency of incidents, and contributing factors. A total of 91 roadkill incidents were recorded, with reptiles constituting the majority. Analysis indicates that reptilian mortality is disproportionately high due to their slow movement and crossing behaviors during breeding seasons. Recommendations include traffic control measures, signage, awareness campaigns, and collaboration between forest authorities and transportation departments to mitigate wildlife-vehicle collisions.

Introduction

Habitat fragmentation and the proliferation of road networks represent critical challenges to biodiversity conservation globally. The construction and expansion of roadways disrupt ecological connectivity, leading to habitat loss, degradation, and fragmentation. These changes adversely affect wildlife populations by altering their natural behaviors, increasing mortality rates, and reducing genetic diversity.

Numerous studies have documented the detrimental effects of roadways on wildlife. For instance, Edwards and Slater (1981) and Brown and Brown (1986) highlighted the direct mortality caused by vehicular collisions, while Korhonen and Norminen (1987) and Khan (1990) emphasized the long-term ecological consequences, such as population declines and habitat isolation. In the Indian context, research by Gokula (1997), Vijayakumar *et al.* (2002), Vyas (2002), and Kannan (2007) has provided valuable insights into the specific impacts of vehicular traffic on reptilian populations in forested regions. These studies underscore the vulnerability of reptiles to roadkill incidents, given their limited mobility and reliance on specific habitats.

The Anaikatty region of Coimbatore District serves as a pertinent case study for understanding the frequency and implications of roadkill incidents. This area, characterized by its rich biodiversity and proximity to forested landscapes, has witnessed significant vehicular movement, exacerbating the risk to wildlife. Recent observations indicate that species such as elephants, gaurs, and various reptiles are

frequently affected by roadkill incidents, particularly along the Anaikatty ghat section. The Forest Department has proposed measures such as installing rumble strips, speed breakers, and caution boards to mitigate these impacts (Andrews *et.al.,* 2015)

Globally, the field of road ecology has advanced our understanding of the multifaceted impacts of road networks on biodiversity. Studies have categorized these impacts into direct effects, such as wildlife mortality, and indirect effects, including habitat fragmentation and behavioral changes. Furthermore, predictive models and mitigation strategies, such as wildlife corridors and underpasses, have been developed to enhance landscape connectivity and reduce roadkill incidents (Barthelmess & Brook 2010).

The present study, conducted in the Anaikatty region of Coimbatore District, aims to assess the frequency of roadkill incidents and provide recommendations for minimizing animal mortality.

Study Area

The research was conducted along the SH 164 highway, spanning 10 km through the Anaikatty Reserve Forests in the Western Ghats. The study area lies between 10°13'-10°33' N latitude and 76°49'-77°21' E longitude, approximately 30 km west of Coimbatore city. The elevation ranges from 250 to 900 meters above sea level, and the region receives an average annual rainfall of 500-900 mm. The predominant vegetation consists of dry deciduous forests with species such as *Albizia amara, Acacia planifrons, Dendrocalamus strictus,* and *Ziziphus mauritiana.*

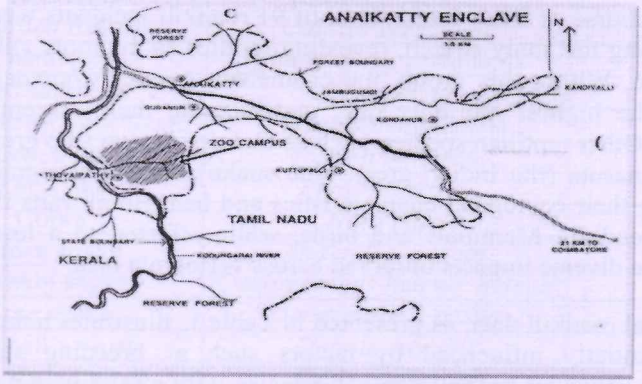

Fig.1 The study site between Anaikatty and Mangarai

Methodology

Field surveys were conducted between 2004 and 2008 to systematically document roadkill incidents. During this period, researchers meticulously recorded data along a defined 10 km road stretch, focusing on the spatial and temporal

distribution of mortalities. Observations included detailed identification of species involved, specific locations of roadkill events, and frequency of occurrences. The methodology ensured the integration of ecological and behavioral data to establish patterns linked to roadkill phenomena.

Complementary analyses of vehicular traffic were undertaken to assess the influence of traffic density and composition on roadkill rates. Data collection involved monitoring daily vehicle movements, categorized into buses, lorries, light motor vehicles, and two-wheelers. This categorization enabled a nuanced understanding of vehicular impact across different traffic types. Statistical tools such as regression analysis and spatial mapping were applied to correlate traffic patterns with mortality hotspots.

The study aligns with broader research on road ecology. For instance, Smith and Dodd (2003) highlighted the significance of traffic volume and speed in determining wildlife mortality rates, while Ramp *et al.* (2005) demonstrated that roadkill hotspots are often linked to high-traffic areas adjacent to wildlife-rich landscapes. In similar studies, Coffin (2007) and Loss *et al.* (2014) provided methodological approaches for documenting roadkill, emphasizing the importance of species-specific vulnerability assessments. These surveys are pivotal in advancing road ecology and conservation strategies. They provide baseline data essential for developing mitigation measures such as speed regulation, installation of wildlife crossing structures, and habitat restoration projects.

Results

Over the course of five years, a total of 91 roadkill incidents were meticulously documented along the study stretch, revealing reptiles as the most vulnerable taxa to vehicular traffic. Within this group, the chameleon species *Chamaeleon zeylanicus* demonstrated the highest mortality rate, underscoring their susceptibility to road-related threats. Other reptilian species, such as *Calotes calotes* (the green forest lizard) and Ahaetulla nasuta (the Indian green vine snake), exhibited significant mortality rates, reflecting their ecological characteristics and behavioral traits that increase the likelihood of roadkill. Mammals and birds, while affected to a lesser extent, also contribute to the diverse impacts observed across vertebrate taxa.

The annual roadkill data, as presented in Table 1, illustrates temporal patterns of mortality, potentially influenced by factors such as breeding seasons, climatic conditions, and vehicular traffic intensity. Species-wise mortality, detailed in Table 2, highlights the disproportionate impact on reptiles, which may be attributed to their slower movement, preference for basking on road surfaces, and inability to evade rapidly moving vehicles.

Scientific evidence corroborates the findings of this study. Studies by Andrews *et al.* (2008) and Beebee (2013) emphasize that reptiles are disproportionately affected by road networks due to their limited mobility and specific thermoregulatory

behaviors. Similarly, Meek (2009) demonstrated that reptilian roadkill incidents peak during warmer months when these species are more active near roadways. Research by Fahrig *et al.* (1995) and Woltz *et al.* (2008) further supports the observation that habitat fragmentation and road density exacerbate wildlife mortality rates across taxa.

These results underscore the urgent need for mitigation strategies tailored to the unique ecological and behavioral traits of affected species. Approaches such as the construction of species-specific wildlife crossings, habitat restoration adjacent to roads, and public awareness campaigns have been recommended in similar contexts (Clevenger & Waltho, 2000; van der Ree *et al.*, 2015).

Table:1. Data on Annual Roadkill from 2004-2008

S.No	Year	No. of days visited	No. of road kills
1	2004	36	14
2	2005	36	17
3	2006	36	21
4	2007	36	23
5	2008	27	16
		171	91

Table:2. List of animals killed in vehicular traffic during the study period

S.No	Common name	Scientific name	No. of road Kills
1	Green calotes	*Calotes calotes*	5
2	Garden lizard	*Calotes versicolor*	3
3	Chameleon	*Chamaeleon zeylanicus*	55
4	Red sand boa	*Eryx johni*	1
5	Common monitor lizard	*Varanus bengalensis*	1
6	Indian python	*Python molurus*	1
7	Rat snake	*Ptyas mucosus*	3
8	Cobra	*Naja naja*	1
9	Green snake	*Ahaetulla nasuta*	7
10	Trinket snake	*Coelognathus helena helena*	1
11	Tree snake	*Dendrelaphis tristis*	2
12	Russell's viper	*Daboia russelli*	2
13	Saw scaled viper	*Echis carinatus*	1
14	Palm squirrel	*Funambulus palmarum*	2
15	Small Indian civet	Viverricula indica	1
16	House crow	*Corvus splendens*	1
17	Jungle Babbler	*Turdoides affinis*	3
18	Hare	*Lepus nigricollis*	1
			91

Discussion

The findings of the present study highlight significant insights into the impact of road networks on biodiversity, specifically emphasizing the vulnerability of reptiles. The documented roadkill incidents (n = 91) over five years not only underscore the ecological consequences of vehicular traffic but also provide a valuable dataset for understanding species-specific mortality trends in fragmented habitats.

Reptilian Vulnerability and Mortality Patterns

Reptiles, particularly *Chamaeleon zeylanicus, Calotes calotes*, and *Ahaetulla nasuta*, accounted for the majority of roadkill incidents. Their higher susceptibility can be attributed to several factors. First, reptiles exhibit specific thermoregulatory behaviors, such as basking on open surfaces, including roads, which inadvertently increases their exposure to vehicular traffic (Beebee, 2013; Andrews *et al.*, 2008). Second, their relatively limited mobility and slower response times to approaching threats exacerbate their vulnerability (Meek, 2009). These behavioral and ecological traits make reptiles an important focal group for conservation strategies in road ecology.

Temporal and Spatial Trends

The annual data presented in Table 1 reveal fluctuations in roadkill incidents, likely influenced by seasonal variations in reptilian activity. During warmer months, reptiles are more active and exhibit increased movement across roadways (Fahrig *et al.*, 1995). Spatially, mortality hotspots along the 10 km stretch were identified, where roadkill incidents clustered near forested landscapes and high-traffic zones (Ramp *et al.*, 2005). Such spatial patterns align with global findings on roadkill hotspots, emphasizing the need for targeted mitigation strategies in areas adjacent to wildlife-rich habitats (van der Ree *et al.*, 2011).

Impact on Mammals and Birds

Although reptiles were the most affected group, mammals and birds also experienced roadkill incidents, albeit to a lesser extent. Their vulnerability is influenced by factors such as habitat fragmentation and reduced connectivity (Smith & Dodd, 2003). The documentation of mammalian and avian roadkill contributes to the broader understanding of the ecological impacts of road networks and calls for species-specific mitigation approaches.

Ecological and Conservation Implications

The disproportionate mortality rates observed among reptiles indicate potential cascading effects on local ecosystems. Reptiles play key roles in maintaining ecological balance as predators and prey, and their decline can disrupt trophic interactions (Beckmann & Shine, 2011). Conservation efforts must, therefore, prioritize species-specific interventions, such as the establishment of wildlife corridors, underpasses, and fencing to reduce roadkill incidents (Clevenger & Waltho, 2000; Jaeger *et al.*, 2005).

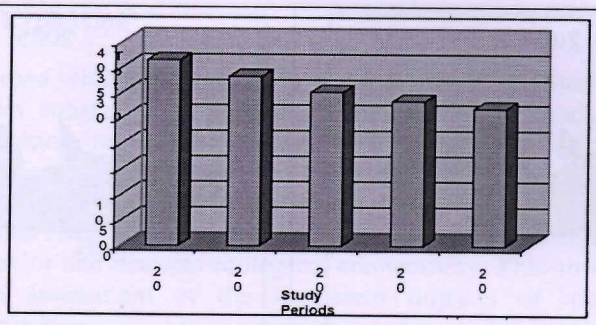

Fig-2. Overall Vehicles movement /day during 2004 to 2008.

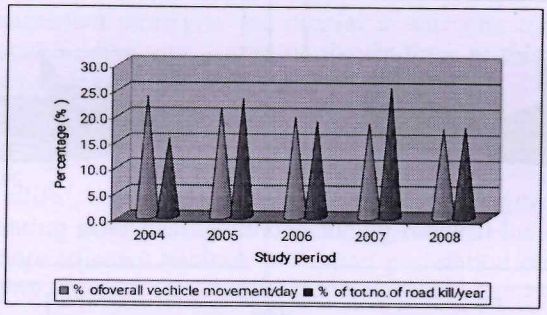

Fig-3. A comparison between the Percentage of Vehicular movement/ and percentage of road kill/year during 2004 to 2008.

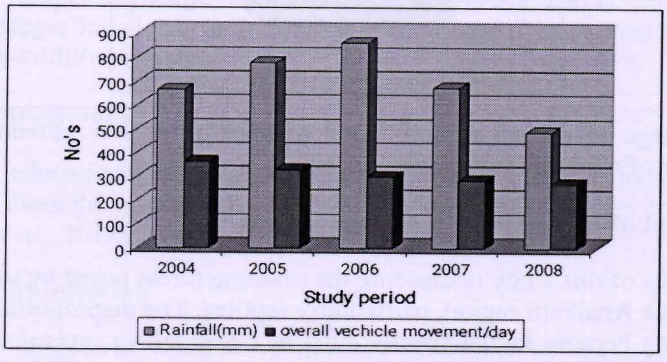

Fig-4. A comparison between overall rainfall (mm) and total number of vehicle movement during 2004 to 2005

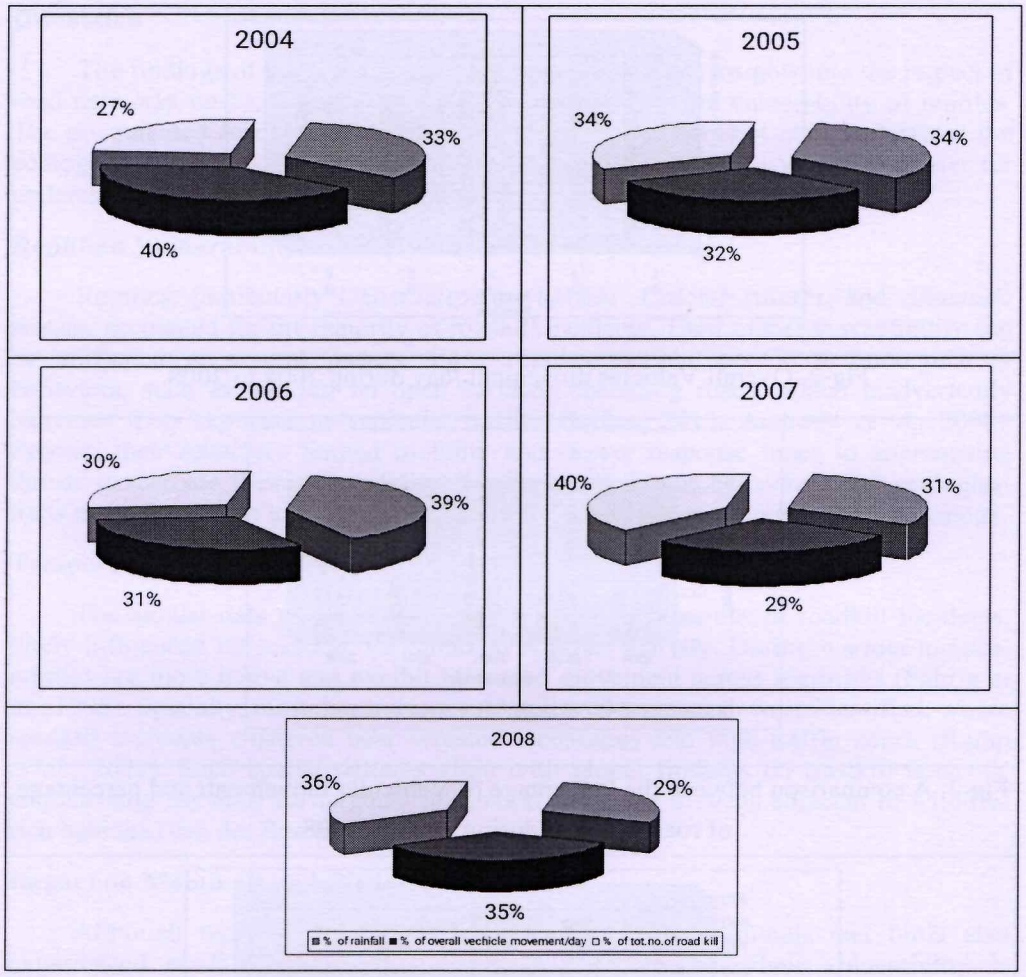

Fig-5 Percentage of overall rainfall, total number of vehicle movement and total number of road kill during 2004 to 2008

Conclusion and Management Recommendations

The results of this study underscore the pressing threat posed by vehicular traffic to wildlife in the Anaikatti region, particularly reptiles. The disproportionate mortality observed among herpeto faunal species such as *Chamaeleon zeylanicus* and *Calotes calotes* reflects their behavioral traits, habitat requirements, and limited ability to adapt to rapidly changing landscapes. Increased road width, coupled with rising vehicular movement, exacerbates challenges for herpetofauna, further isolating populations and impeding safe passage across fragmented habitats

Impact of Road Expansion

The recent road widening from 30 ft. to 46 ft., while facilitating greater human accessibility, poses substantial ecological challenges. Wider roads intensify habitat fragmentation, making movement across the roadway increasingly perilous for wildlife (Laurance *et al.*, 2009). Reptilian populations, which often rely on specific microhabitats, are particularly vulnerable to such disruptions. Studies by Forman *et al.* (2003) highlight that road expansion not only increases direct mortality but also alters local species behavior and disrupts ecological connectivity. This situation necessitates a comprehensive assessment of the long-term impacts of road expansion on biodiversity in the region.

Recommendation

Effective management strategies are crucial to mitigate the adverse effects of road networks on local biodiversity. Based on the findings of this study and scientific evidence, the following measures are proposed:

Habitat Connectivity

Establish wildlife corridors and underpasses designed specifically for herpetofauna, facilitating safer passage and reducing roadkill incidents (Clevenger & Waltho, 2000). Restore adjacent habitats to support population recovery and enhance ecological connectivity.

Traffic Regulation

Implement speed limits and install rumble strips in identified mortality hotspots to minimize vehicular-wildlife collisions (Ramp *et al.*, 2005). Erect cautionary signage at strategic locations, including near the Forest Check Post at Mangari, to alert drivers to wildlife presence.

Community Involvement

Conduct educational campaigns to raise awareness among local communities and motorists about the importance of wildlife conservation and safe driving practices (van der Ree *et al.*, 2015).

Research and Monitoring

Establish long-term roadkill monitoring programs to document trends and evaluate the effectiveness of mitigation measures. Investigate behavioral responses and genetic impacts on herpetofauna due to habitat fragmentation and vehicular disturbances (Jaeger *et al.*, 2005).

Policy Integration

Collaborate with forest officials, transportation authorities, and policymakers to integrate biodiversity conservation into infrastructure planning and development. Advocate for environmentally sensitive road designs that prioritize wildlife safety (Smith & Dodd, 2003).

Conclusion

Protecting wildlife from the adverse effects of road networks requires a multidisciplinary approach that combines ecological research, community engagement, and infrastructural innovation. Collaborative efforts among forest officials, road authorities, and local communities will be pivotal in safeguarding biodiversity in the Western Ghats, which is a critical global biodiversity hotspot. Continuous data collection and adaptive management strategies will be essential to address the evolving challenges posed by habitat fragmentation and vehicular traffic.

This study highlights the urgency of implementing evidence-based conservation measures to mitigate roadkill incidents and preserve the ecological integrity of the Anaikatti region. With committed efforts, the adverse impacts of road networks on wildlife can be significantly reduced, ensuring a harmonious coexistence between development and biodiversity conservation.

The Anaikatti forest region in the Western Ghats plays a crucial role in biodiversity conservation and ecological stability. However, increasing human interventions, including road networks and vehicular movement, pose significant threats to wildlife habitats and species connectivity. Effective road management strategies, including the design of wildlife-friendly roads, periodic vehicular movement monitoring, and ensuring corridor connectivity, are essential to mitigating habitat fragmentation and reducing the impact on native species.

Scientific studies have emphasized the importance of ecological corridors to facilitate genetic exchange and species movement, particularly in biodiversity-rich landscapes like the Western Ghats (Kumaraguru *et al.*, 2011). Additionally, research highlights how traffic regulation and impact assessments can reduce roadkill incidents and minimize disturbances to keystone species (Anuradha Reddy *et al.*, 2012). Implementing sustainable conservation policies aligned with existing ecological frameworks can ensure long-term habitat preservation while balancing human development needs.

Thus, prioritizing wildlife conservation through science-backed road management policies will enhance ecological resilience and ensure a harmonious coexistence between development and biodiversity preservation in the Anaikatti forest region.

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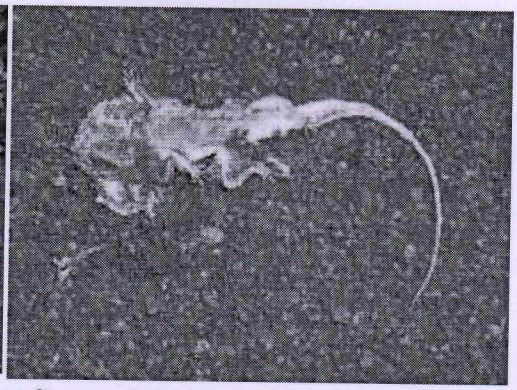
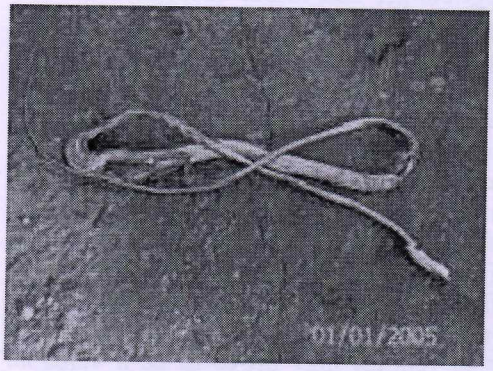
Photo of reptiles road kill observed at Anaikatti Road, Coimbatore

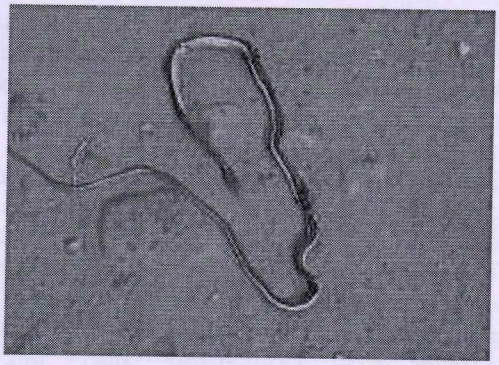
Rat snake (*Ptyas mucosus)*



Saw scaled viper *(Echis carinatus)*



Green Snake (*Ahaetulla nasuta)*



Tree Snake *(Dendrelaphis tristis)*

Herpetofauna Assemblages in Palacode Range of Dharmapuri Forest Division, Dharmapuri, Tamil Nadu

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Introduction

Herpetofauna in Eastern Ghats are distributed in a wide variety of habitats ranging from Dry thorn forest to tropical deciduous forest and almost found in all niches from rock crevices to tree bark. Some of them are endemic to particular habitat and some of them are very common, found throughout the hill regions. Amphibians and reptiles render incalculable services to agriculture and to our ecosystem. Insects occupy first place amongst pest that damage standing crops. Majority of frogs and lizards feed on insects which are destroying the crops and forest ecosystem. Snakes have an irreplaceable role in ecology as the natural predators of rats and agricultural pests. Snakes are singularly designed and equipped to hunt for rats in their narrow subterranean burrows and hiding places in the open and in the granaries, storages etc. Similarly, those snakes which regularly feed on insects have been responsible for destroying vast number of insects which are pests in our ecosystem. These groups of animals are mostly nocturnal in nature and some of them are active round the clock. They render great service by exterminating nocturnal and diurnal insect pests from our ecosystem. The significance of amphibian and reptiles for the biosphere of our planet consequently to mankind, is so great that it is difficult to equate it with that of another group of organisms. Snakes and other reptiles may prove to be a valuable indicator species in local ecosystems. Amphibian is the first "actor" in the evolution of life on land. Presence of good population of amphibian in a region is indicates a healthy environment. Amphibians are a very diverse type of animals, mostly found in wet areas and render incalculable services to our environment. Thus, frogs are the potential biological control agents for preventing undue growth of insect population and their breeding grounds. Moreover, they are staple food items for several fishes, reptiles, snakes and birds in the wild. Amphibians play an important role in the food chain. Loss and fragmentation of natural habitats due to invasive species is the immediate threat to amphibians in Eastern Ghats. In addition to this, most of the amphibian's dwell in regions that are being used for agricultural purposes, undergoing urban development, logging and industrialization that have resulted in a drop in stable amphibian habitats. Pollution and habitat fragmentation is playing a major role for the survival of herpetofauna.

Hence monitoring herpetofauna population is very urgent in most part our country. Herpetofauna have been the least studied among the vertebrates particularly in the Eastern Ghats. Any data on herpetofauna especially documenting the endemic

species is thus of both immediate and potentially broader interest because of the continued habitat loss due to development activities, intensified agricultural, plantation practices and invasion of Invasive alien species, could easily have led to species extinction before rediscovery and understanding their role in natural ecosystem. Most of the forest area has been converted into invasive plantation in most part of our country. Hence, studying herpetofauna in that habitat will give better understanding of their survival. The present study was taken up to examine the community structure, species richness, diversity and abundance of herpetofauna in response to invasive alien species such as *Prosopis* in the Palacode range of Dharamapuri Forest Division.

Objectives

To study the diversity and abundance of herpetofauna in Dharamapuri Forest Division

To develop a checklist of herpetofauna found in the *Prosopis* habitat of Palacode Range

To assess the impact of *Prosopis* on the diversity of herpetofauna community in Palacode Range of Dharamapuri Forest Division

Methods

Study area was selected in *Prosopis* invaded ecosystem in Palacode range of Dharamapuri Forest Division. Three surveys have been carried out in sample plot area, namely Pre - Monsoon, Monsoon and Post Monsoon seasons during 2013. The survey was conducted 2 to days in each season. Field surveys were conducted from 6.30am to 12.00pm and 3.00 pm to 6.30pm. Three methods were used for data collection such as, visual encounter survey, transect and quadrate sampling.

Visual Encounter Survey

This method involved searching for herpetofauna in an area or habitat (Cambell and Chirstman, 1982) and recording all animals visible on the surface (Corn and Bury, 1990). While walking we scanned the vegetation path, and other possible places for the recordings the herpetofauna observed within a 3 m distance from the path. Often, we searched the leaf litter as semi fossorial species emerge slightly when disturbed which allowed them to be recorded. The animal thus found is recorded in the data sheet such as species, time of the day, area, vegetations, altitude and location of the herpetofauna above the ground. Actual site of the herpetofauna when first observed was descriptively noted and later classified in to various micro habitats such as tree trunk, ground, leaf litter and rock. Sex, colour variation, height from ground upon sighting, micro habitat, injuries, defects, presence of any ectoparasites and threats. (Presence of predators, habitat changes etc). The sampling duration in each locality was largely depending up on the size of the area.

Picture.1. In searching of herpetofauna in the Sample plot area

Transect Sampling

Transect sampling is ideal for studying elevation gradients from low lands to uplands depending on the area of the study site. A transect line was laid in each study area and the same data was collected and entered in the field data sheet. The amphibians were identified by using the key of Daniel (1963 and 1975). The reptilian species were identified by using the key of Smith 1943; Whitaker & Captain 2004).

Quadrat Sampling

10×10 m plots were laid in *Prosopis* invaded habitats and the area searched. All the herpetofauna sighted were noted. Abundance was estimated as number of individuals per unit area.

Data analysis

The raw data which were collected in the study area were pooled together for statistical analysis. The season wise data are also pooled together and analyzed. Number of species recorded was considered as species richness (N) and Shannon-Weiner Index (H') as species diversity. Data generated by both methods were put together and results presented as number of reptiles per hour.

Herpetofauna density was estimated by using the simple formula:

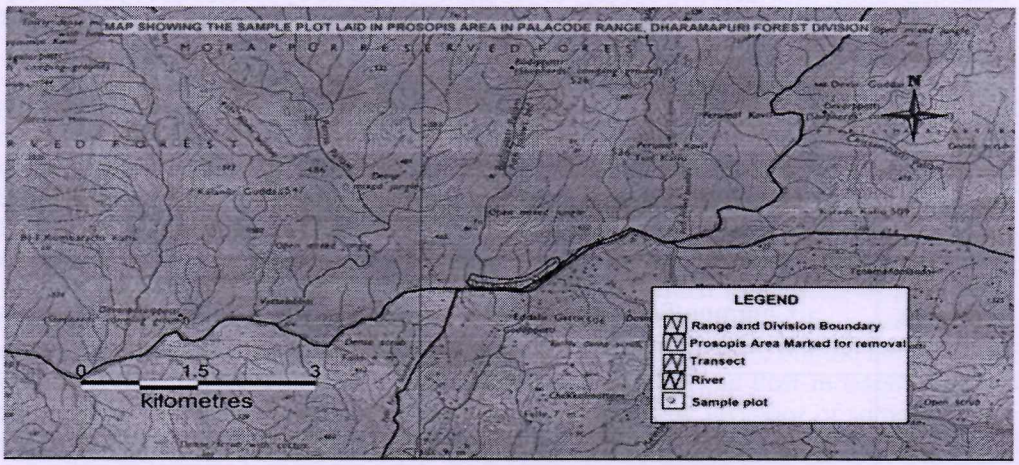
$$\text{Re}lativeDensity = \frac{No.of\ Individuals\ of\ a\ Species}{Total\ No.of\ Individuals\ of\ all\ species} \times 100$$

Study Area

Dharamapuri is an inland district, lies as the tri-junction of Karanataka, Andhra Pradesh and Tamilnadu state. It is located in the north Western portion of Tamilnadu lying between latitudes N11° 47' - 12° 53' and longitudes E 77° 28' – 78° 45'. It has a total area of 961.9km^2 which is divided into three taluks, altitude ranges from 380 to 1395 m above mean sea level. The forest of this region is coming as the part of

Eastern Ghats. Guttirayan is the highest peak in the division (1395.10 m above msl). The district is surrounded by Vellore, Thiruvannamalai and Villupuram district in the east, Salem district in the south, Karnataka in the west, Karnataka and Andhra Pradesh in the north. The Cauvery river bounds it on the west and is joined by the Sanatkumarnadi, which flows through the north-western portion of the district. Near the junction of these rivers are the falls of Hogenekal or the "Smoking rock". Dharamapuri forest division is divided into four administrative forest ranges namely Dharamapuri forest range, Pennagaram forest Range, Palacode Forest Range and Hogenakkal forest Range.

Map 1. Showing the Sample plot at Palacode Range, Dharamapuri Forest Division



Observation and Results

A total of 15 quadrates, a transects lines was laid the length of 1200m and 20 man- hours of Visual Encounter surveys were conducted in *Prosopis* area. Data from quadrate sampling was used for estimating the species density and quantify the impact of habitat alterations on herpetofauna. Data obtained from these methods were pooled for all other analyses including opportunistic observations. During the pre-monsoon survey, four species of reptiles have been recorded in *Prosopis* invaded areas of Dharamapuri Forest Division. This includes Common Garden Lizard (*Calotes versicolor),* Fan-throated Lizard (*Sitana ponticeriana*), Common Skink (*Mabuya carinata*) and Bark Gecko (*Hemidactylus leschenaultia*), were recorded during the pre- monsoon survey, we did not encounter any amphibian species during the survey.

Table.1. Reptiles recorded during the pre-monsoon survey in Palacode Range, Dharamapuri Forest Division

S.No	Common/Scientific Name of the Species	No. of Individuals	Relative Density (%)
1	Garden Lizard (*Calotes versicolor)*	3	33.3
2	Bark Gecko (*Hemidactylus leschenaultii*)	1	11.1
3	Keeled grass skink -*Eutropis carinata*	2	22.2
4	Fan-throated Lizard (*Sitana ponticeriana*)	3	33.3

During the monsoon survey, five species of herpetofauna in the *Prosopis* area of Palacode range, of which two species of amphibians and three species of reptiles were recorded. Two species of amphibians namely Indian Toad (*Bufo melanostictus)* (66.67%) and Indian Bull Frog (*Hoplobatrachus tigerinus)* (33.33%) were recorded in study site. In the case of reptiles Fan-throated lizard (42.86%) was most abundant species followed by Snake- eyed Lizard (28.57%) and Garden Lizard (28.57%) see table 2.

Table.2. List of herpetofauna recorded during the monsoon survey at Palacode Range

S.No	Common/Scientific Name	No. of Individuals	Relative Density (%)
	Amphibian		
1	Indian Bull Frog (*Hoplobatrachus tigerinus*)	2	33.33
2	Indian Toad (*Bufo melanostictus*)	4	66.67
	Reptiles		
3	Fan-throated lizard (*Sitana ponticeriana*)	3	42.86
4	Snake eyed lizard (*Ophisops leschenaultii*)	2	28.57
5	Garden Lizard (*Calotes versicolor)*	2	28.57

During the post-monsoon survey there is variation of abundance of herpetofauna recorded in the *Prosopis* area. Two species of amphibians namely Common Indian Toad (81.8%) and Common Tree Frog (18.2%), in the case of reptiles we observed three species namely Common Garden Lizard (21.4%), Indian Fan-throated Lizard (67.8%) and Keeled Grass Skink (10.7%). It is interesting to note that the, during the post monsoon survey we have encountered more number of *Sitana ponticeriana* than pre-monsoon and monsoon survey.

Table.3. List of Herpetofauna recorded during the Post-monsoon survey at Palacode range

S.No	Common/Scientific Name	No. of Individuals	Relative Density (%)
	Amphibians		
1	Common Indian Toad- Bufo *melanostictus*	9	81.82
2	Common Tree Frog - *Polypedates maculatus*	2	18.18
	Reptiles		
1	Common garden lizard-*Calots versicolor*	6	21.43
2	Fan throated lizard-*Sitana ponticeriana*	19	67.86
3	Keeled grass skink -*Eutropis carinata*	3	10.71

Discussion

Overall, five species of reptiles and three species of amphibian were recorded, among the reptile species recorded *Calots versicolor* and *Sitana ponticeriana* is the most common species recorded across the seasons. Bark Gecko was encountered once in the study site. The abundance of reptiles species recorded is very poor compare to that of study by Baskeran *et al.* (2010), they were reported 32 species of reptiles in the Hosur and Dharamapuri Forest Divisions. Similarly, they recorded 10 species of amphibian in the landscape. In the present study shows that only three species of amphibians were encountered in the three surveys, of which *Bufo melanostictus* was the most common species recorded in the *Prosopis* area. Overall, the present study shows that the diversity of herpetofauna is poor across the season, but the number has increased in some species of herpetofauna during Monsoon and Post-monsoon survey this may be due to availability food resources and breeding behavior of some species would increase the numbers. Studies suggested that the abundance of herpetofauna was greater during monsoon and post monsoon season, this may be due to foraging and mating activity of amphibian and scouting, of dry hideouts and basking of reptiles. The poor diversity of herpetofauna found in the *Prosopis* habitat is causes for concern, therefore removal of invasive species would improve the diversity and density of herpetofauna community in that area.

Plate 1. Amphibians recorded in the *Prosopis* area of Palacode Range

Common Indian

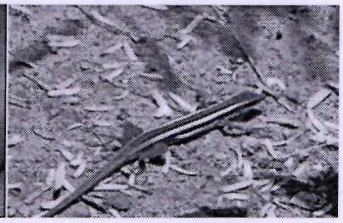
Toad Indian Bull Frog

Common Tree Frog

Plate 2. List of reptiles recorded in the *Prosopis* area of Palacode Range

Sitana ponticeriana

Adult Male, Juvenile



Ophisops leschenaultii

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Evolution of Sign boards in Chennai Snake Park

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2.Director, Chennai Snake Park, Chennai-22 KK
3.Exectuve Chairman, Chennai Snake Park Trust, Chennai-22
4.Biologist, Chennai Snake Park, Chennai-22

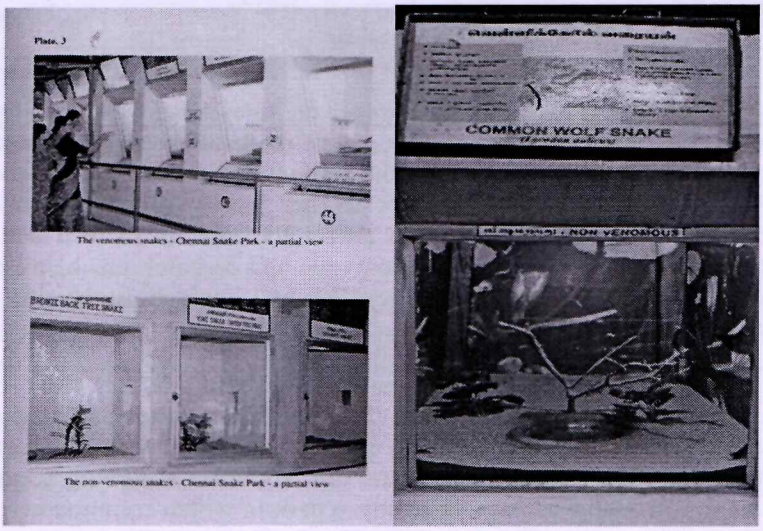
Display boards in a zoo play an important role in convey message about the animal and its role in the ecosystem . It is one of the education tools in conservation. The visibly placed display boards attract the visitors and convey message very easily. Preparation of patters for display board is an art. Similarly, the materials in which painted and placing it also important to attract the visitors to read and grasp the message conveyed in the boards. Many surveys and research are being carried out across the world. Based on the visitor's reaction and interaction, the sign boards are keep on changing time to time

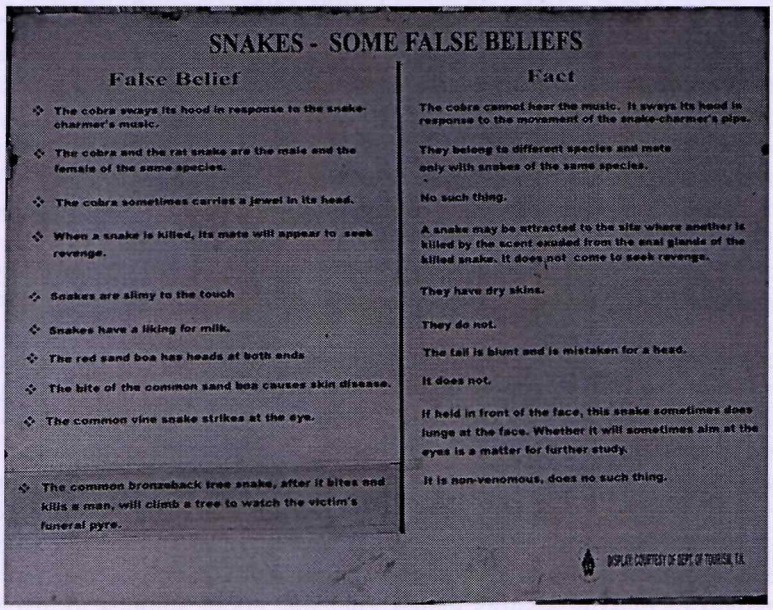
The Chennai Snake Park established in the year 1972 with one of the objectives to promote knowledge among the public on reptiles and amphibians and dispel the widespread misconceptions and wrong belief about snakes in particular. To achieve the above objective various means of activities are being conducted. Till 2014 live demonstration was popular in snake park in which common non venomous snakes such as Rat snake, Checkered Keelback, Common Tree snake , Common Green vine snake and a venomous snake Common cobra taken out and handled by trained animal keeper in the demonstration centre along with pre-recorded audio messages about myth and scientific facts about snakes in three languages (Tamil, English and Hindi). Apart from the live demonstration, to educate the public simple display boards placed in front of the snake enclosure for each species made out of framed wooden blank till 1990. Display boards have been put up at strategic location in the park giving valuable information, in a reader- friendly style about the description and habit of the reptiles. Present paper dealt with changes in preparation of the display board from early 1990s to till date in Chennai Snake Park

The wooden boards are replaced by metal boards having name, description of morphological feature and habit of each species and hanged over the cages /enclosures during 1990-2000. After technological development reptile name board consist of common name, scientific name, distribution, morphological features feeding habit and breeding biology with animal the photo. these boards are in bi-lingual and multicolours. After 2020, reptiles' boards were prepared in visitor friendly way with more information such as distribution, body size, food and feeding, breeding and amazing fact and special features. All information boards were redesigned and information has been made attractive. Some information boards were made interactive so that the visitors are immersed in learning. Interactive play is another method of making visitors gain knowledge about animals to dispel any fear and to create love for animals especially reptiles.

Display boards during 1990

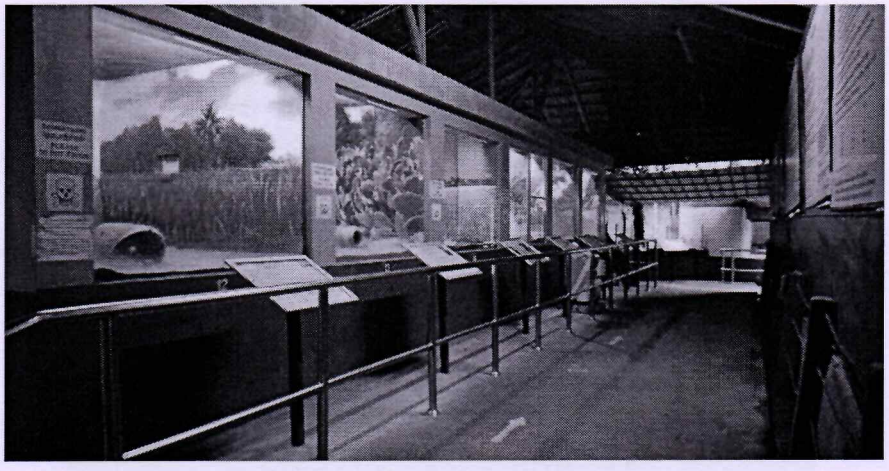
The board with too many information and not readily understandable by average literate persons.





A comparative view of Park enclosures during the 2000 period and 2020 period.

The Chennai Snake Park Venomous snake enclosures during the period of 1990s.



The Chennai Snake Park Venomous snake enclosures during the period of 2020.

The Central Zoo Authority of India prescribe some norms for displaying Educational signages in their Guidelines for the scientific management of zoos in Schedule 4 (10) as follows:

Appropriate educational signage:

(i) Signage boards should be made of weather proof, durable, tough and strong material which can last for reasonably long durations and can be reused and repainted.

(ii) The signboards should be attractive but due care should be taken to ensure that this should not obstruct animal viewing, legible from reasonable distance and should highlight details about the biology, behaviour, distribution and conservation status of the species. Interesting information like animal diet and longevity should also be highlighted.

(iii) Signboards should not be loaded with too many information. Signboards should be understandable to a child/ average literate person.

(iv) Appropriate graphic illustrations should be provided on sign boards to explain ecological linkages, taxonomical relationships and evolution of species.

(v) Signage should also provide information on the conservation efforts being made in the country and the role being played by zoos in this regard.

(vi) Signage should be designed in such a way that they catch the attention of the visitors and the visitors are tempted to read them.

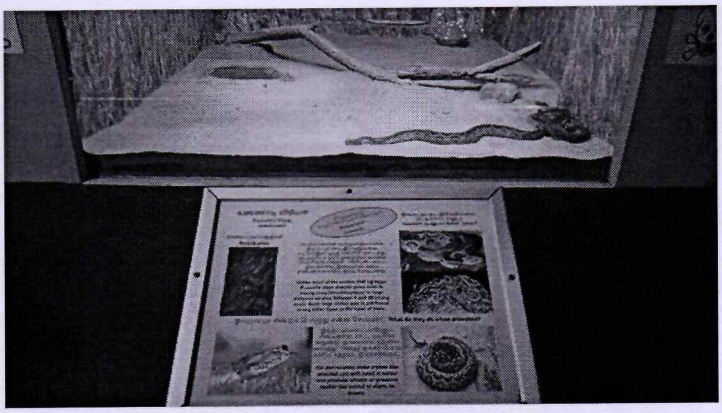
(vii) Negative signages like the animal being cattle lifter/ man eater should not be displayed as these dilute the message of conservation.

(viii) Signages should be monitored and evaluated regularly and updated constantly.

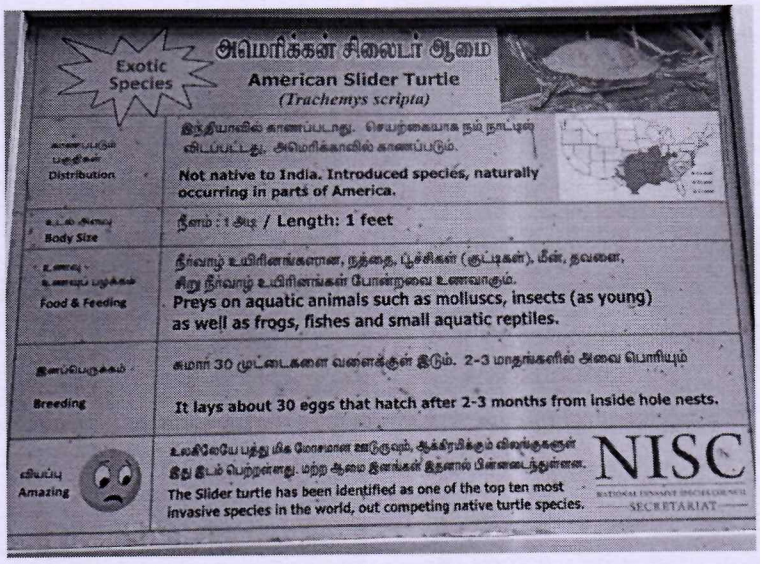
The above guidelines have been taken into account while designing our information boards.

Display board after 2020

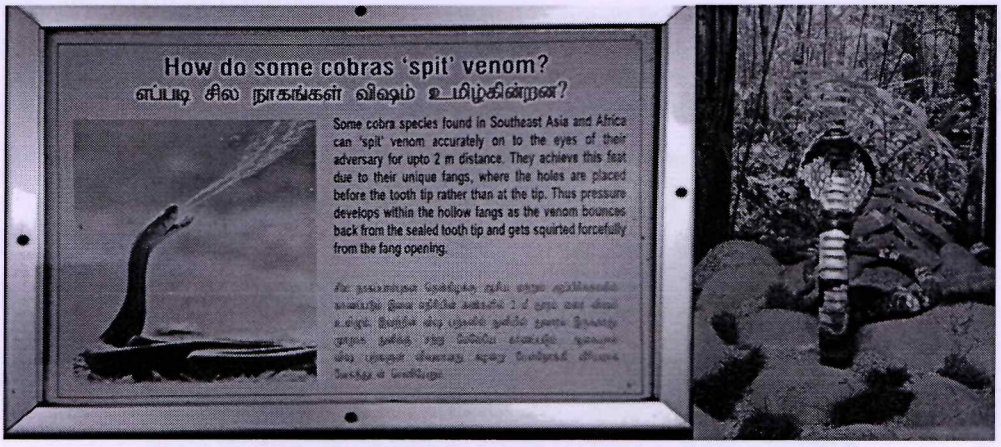
"(ii) The signboards should be attractive but due care should be taken to ensure that this should not obstruct animal viewing, legible from reasonable distance and should highlight details about the biology, behaviour, distribution and conservation status of the species. Interesting information like animal diet and longevity should also be highlighted." (CZA Guideline)



"(iii) Signboards should not be loaded with too many information. Signboards should be understandable to a child/ average literate person." (CZA guidelines)

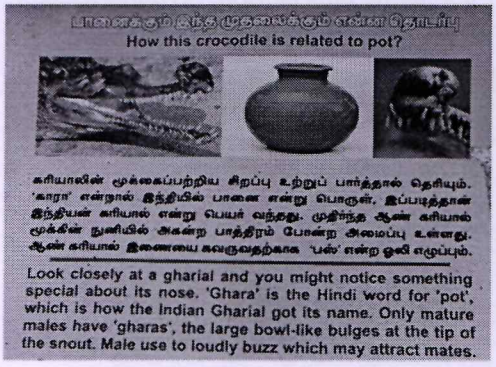


Special morphological facts are prepared and fixed adjacent to regular information boards. Special display board depicts special features.

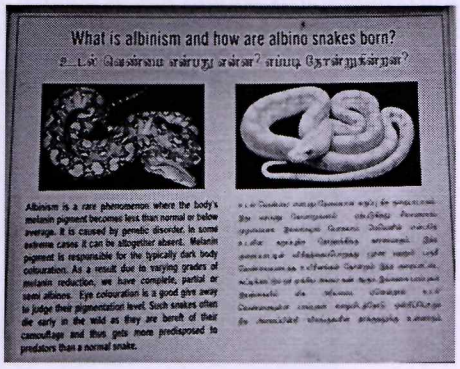


Special board about spitting cobra.

The imitating model of spitting cobra, showing spitting mechanism, pot like structure of Gharial and albinism in Python is also exhibited nearby.



Special Board about Gharial



Special Board about Albinism

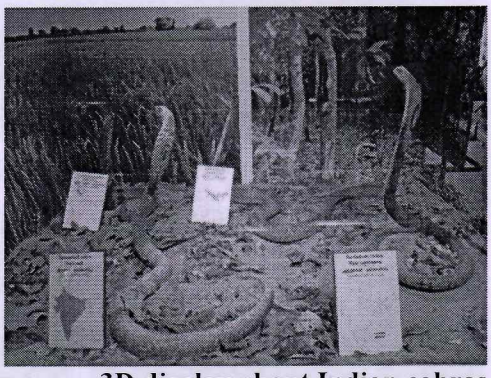
"(iv) Appropriate graphic illustrations should be provided on sign boards to explain ecological linkages, taxonomical relationships and evolution of species." (CZA guidelines).

3D Display Sign Board

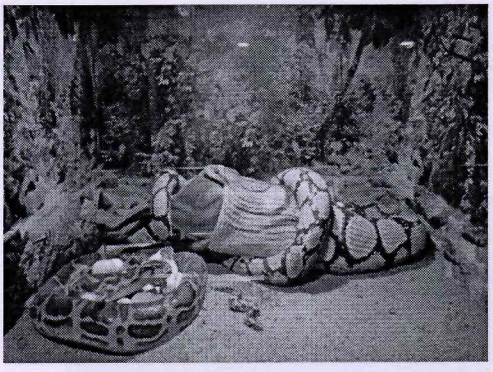
Some of the reptile's natural behaviours in wild could not see by the common visitors. To fill the gap some 3D models were prepared in the Chennai Snake Park

with some special features such as the Indian python swallowing full grown deer, types of cobras in India, nesting habit of king cobra, combat dance in rat snakes, tree dwelling Western ghats reptiles and combat dance of water monitor

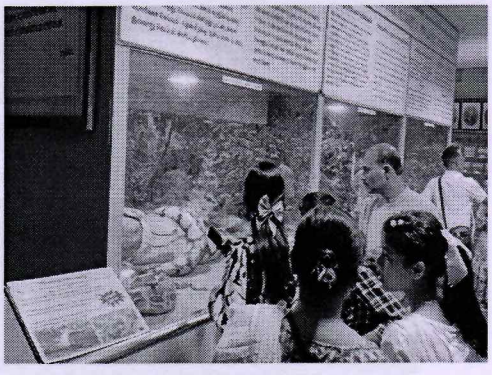
3D display about rat snakes combat dance



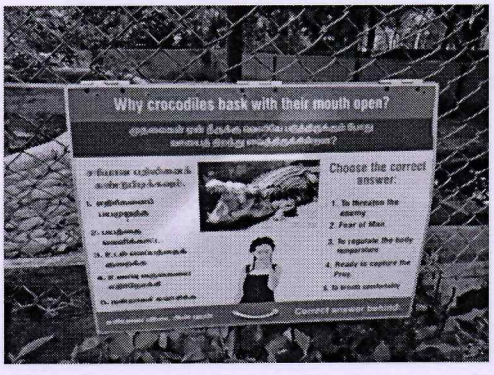
3D display about Indian cobras



3D display about the reticulated python swallowing deer



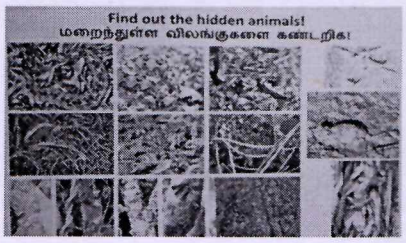
Interactive display boards

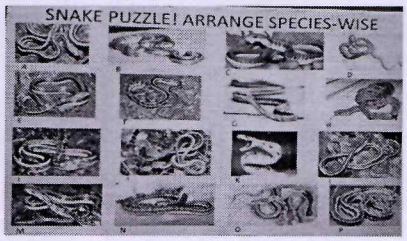


Boards with flaps to lift and reveal the hidden information

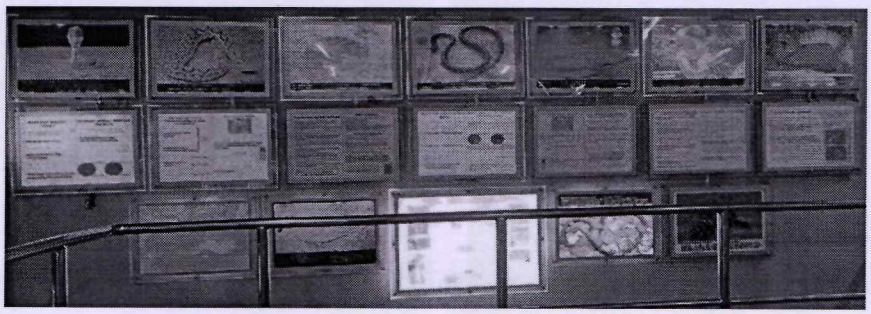
"(vi) Signage should be designed in such a way that they catch the attention of the visitors and the visitors are tempted to read them." (CZA guidelines)

Many visitors may not find time to read all messages given in the board. Therefore interactive display boards are now very popular in zoos because it stimulates the visitor to know the fact, shape, morphological feature and actively learn about the animal. In Chennai Snake Park has some interactive display boards were fixed in the selected point to actively learn about the fact about the animals.

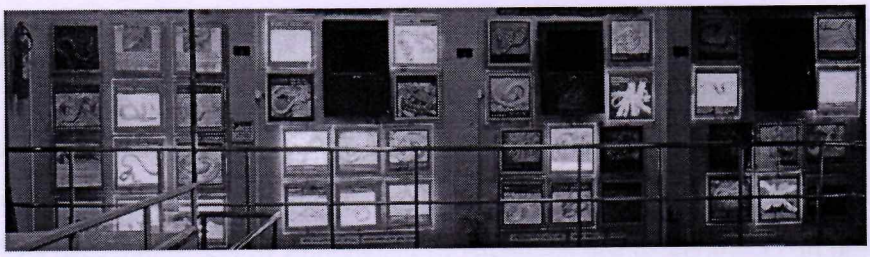




Audio-visual: Digital Board in Chennai Snake Park, Photos of rare reptile present in the wild are exhibited light illuminated LED boards. Some audio-visual films are also depicted here. It is best display to convey the animal morphological feather more effectively.



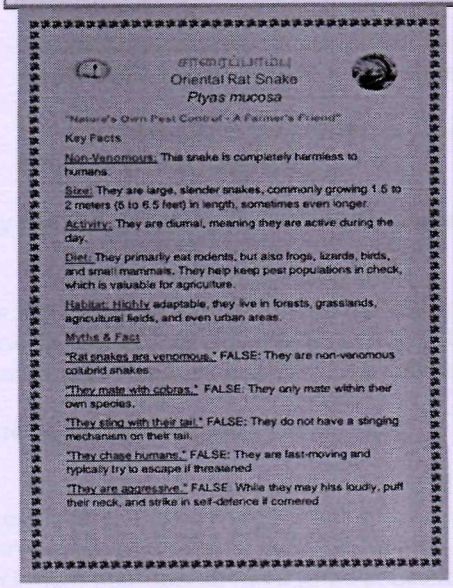
LED display boards

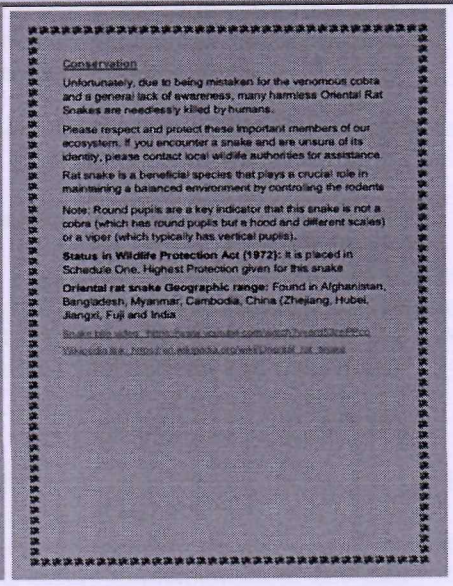


LED display boards

Information with 'Barcode' – the latest interactive technique:

Recently, Chennai Snake Park has added attractive boards to the enclosures with advanced digital information about the reptiles displayed for the visitors. The visitors can scan the barcode and get the information of the reptile instantly on their phone.





According to the widely circulated (though unsourced) statistics associated with the Learning Pyramid model from the National Training Laboratories, the average retention rates after 24 hours for various methods are:

a) Reading: 10%; b) Audio-visual: 20% and c) the highest is the various levels of interactive messages: 50% to 75% of retention.

In our above educative signages, we try to improvise the signages system aiming for a maximum rate of retention by adopting various levels of interactive messages by replacing the old 'less-effective' methods.

Enrichment Techniques for Reptile Enclosures in the Chennai Snake Park.

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Introduction:

The basic objectives of Enrichment of an animal enclosure are: 1). to provide a simulated condition inside the enclosure which ideally suited to the animals' natural life and 2). to make the visitors observing the animals as if they are seen in their original habitat. Modern zoo management emphasizes the need for providing a sufficiently large enclosure along with simulated natural environmental conditions as a part of zoo management. Providing a spacious enclosure alone will not suffice meeting the natural needs of the animal. Here come various enrichment techniques:

Why the zoo animals need a simulated wild condition?

1. Physical / psychological needs: Many wild zoo animals possess some habits of their own while freely living in their respective habitat. When they are kept in a captive condition, they tend to modify their original habits / behavior as; the conditions in captivity are not suited to their life style. This results in some erratic behaviuors including some stereotypic behaviuos. Ex: constant stereotypic body movements of elephants / monkeys in captivity.

2. Physiological needs: Many zoo animals for better health and survival need some basic conditions that are easily available in their natural habitats. For example, exposure to natural sunlight, ideal temperature, natural food items etc., are some basic needs for all captive wild animals in their enclosures.

3. Breeding needs: Many wild animals breed only when a simulated natural environment is provided.

Why the visitors should observe the animals in the simulated conditions?

Visitors' point of view also there is a need for providing simulated conditions. Now days, zoos act as not only a recreation place but also as the place for learning and education. By seeing the animals in a simulated environment, the visitors will correctly understand the original habitat of the animal and also their natural behavious.

Enrichment techniques:

Enrichment does not mean to provide a colourful and decorative settings inside the enclosure. It goes with what the animal requires and feels. For example, for a desert lizard, providing a sand bed with desert plants like cactus will do. Further, our enrichment plan should have some concepts before implementation. The following are some enrichment category:

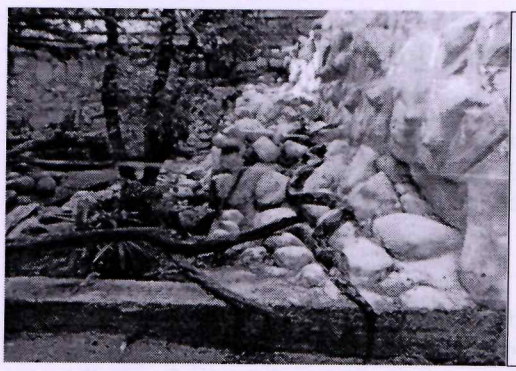
1. Physical enrichment
2. Physiological enrichment
3. Psychological / behavioral enrichment
4. Environmental enrichment
5. Ecological enrichment
6. Ecosystem enrichment
7. Informational Enrichment:

1. Physical Enrichment

This refers to physical needs of the animal species. The physical needs deal with size of the animal and number of animals in the enclosure. In addition, the physical activity patterns are to be considered. Bigger the animal bigger will be the enclosure size. Similarly, more the animal number more the space to be considered. In this respect the Central Zoo Authority (CZA) has issued clear guidelines on the enclosure size for various animal species. This type of enrichment is essential for free moving active animals so as to enable them to move freely and active inside the enclosure. If their movement is restricted, they are likely to develop some abnormal / stereotypic activity. One can observe this behavior among the caged animals like, big cats, monkeys, elephants etc.

Physical Enrichments for Reptiles

Here reptiles include all snakes, lizards, crocodiles, turtles etc. Generally, all reptiles are idle and less active. However, the size of the reptile species should be considered for fulfilling the physical needs. Among snakes, pythons need larger enclosure and among other reptiles, crocodiles need larger enclosure. Visitors' point of view, small animals like snakes if kept in large enclosures, it will be difficult for viewing. In such cases, the snakes may be provided with off-exhibit enclosure in addition to exhibit cage for closer and better viewing.



By seeing the animals in a simulated environment, the visitors will correctly understand the original habitat of the animal and also their natural behavious.

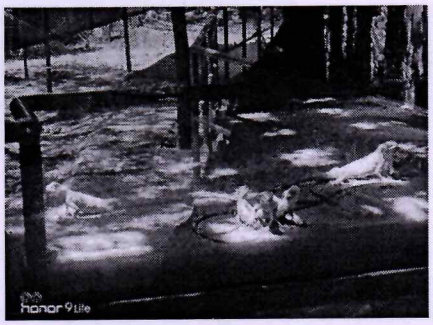
2. Physiological enrichment

This deals with physiological needs of the animals. Presence or absence of some factors inside the enclosure will affect the physiology of the animal. The physiology of the animal which likely to be affected are: Reproductive physiology, Feeding physiology, growth physiology, health physiology etc. For providing this enrichment, one has to understand all physiological needs of the animals concerned.

Physiological Enrichment for Reptiles:

As far as reptiles are concerned, they are all cold-blooded animals. Their activities mainly dependent on natural light and temperature. Many lizards require direct sunlight as their reproductive requirements. In the case of open enclosures, there will not be any problem for getting sunlight. The problem will be for closed cages / enclosures where there is no scope for sunlight entrance. Under such conditions, the animal may not breed although other factors are provided. Similarly, providing optimum temperature inside the closed enclosures is a must during extreme summer and winter. Water spaying system may be provided during hot days in order to reduce the temperature. Similarly, during cold seasons, heating system should be provided inside the covered enclosures. (see picture)

Heating system for the reptiles is essential for the cold-blooded animals like reptiles.



Direct sunlight provided inside the enclosure is a basic requirement for reptiles

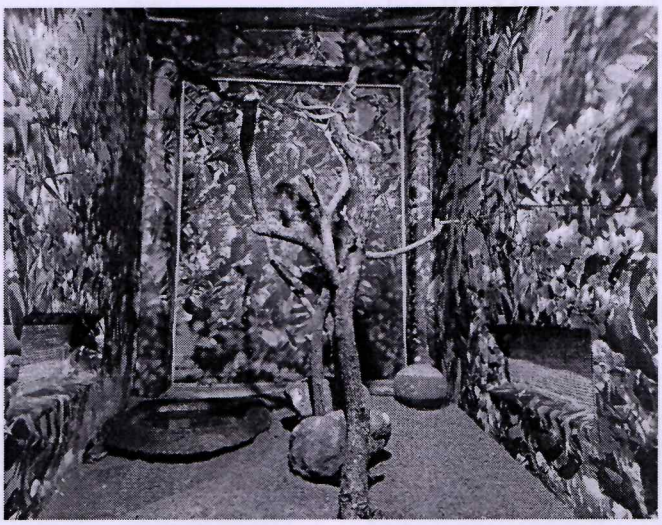
3. Psychological / Behavioral Enrichment

This refers to providing enrichment devises in order to meet the animal's behavioural requirements. For this purpose, one must understand the normal wild behaviours of the animal and their activities in their wild habitat. For example, an arboreal animal may require trees or tree brances and a burrowing animal may require sand bet etc.

Behavioural enrichments for Reptiles:

Most of the snakes are kept in closed enclosures and hence, providing some tree branches may help the animal to climb on it and use them. In Chennai Snake Park, most

of the enclosures for the snakes are small. However, some dead tree branches are effectively used by the snakes. Similarly, Sand boas like burrowing animals are provided with sand beds that are used for burying / hiding. Similarly, the Varanus lizard which is kept in a open enclosure is provided with a live tree to fulfill its tree climbing behavior. It likes to hide most of the times. Therefore a hallow dead wooden log is also is provided which is used for hiding and also as a shelter. For a green whip snakes, we provided a green bush which the snake often used as its shelter. (see pictures)



4. Environmental Enrichment

This is a new concept in which the enclosure's enrichment represents most of the natural environment of the animals inside. The best example is the walk- though aviary / walk-through butterfly park etc. Here, all the environmental factors are provided including natural light, wind flow, rain, temperature variations are available. Apart from these, natural vegetation terrain, stream like water flow systems, etc are also supplemented. Here, the visitors feel as if they are walking inside the natural habitat of the animals exhibited. The whole area may be big enough that the birds may get their natural feeds from the ground as well as from the native vegetation.

Environmental enrichment in Reptile Enclosures:

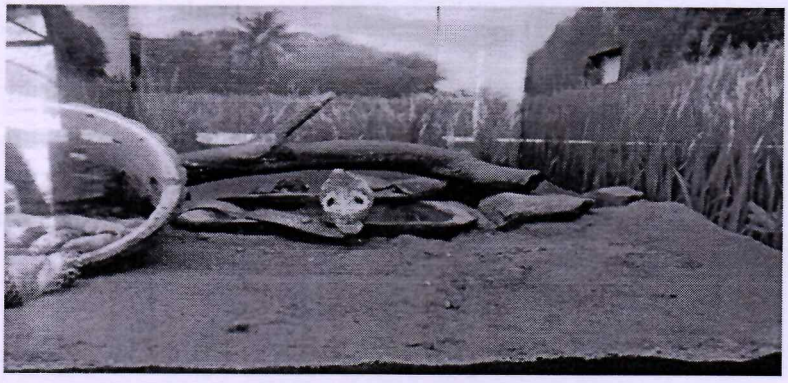
Make use of the walk-through concept, the Chennai Snake Park made a walkthrough reptile enclosure for some exotic animals. Here we exhibited pet wild animals like Iguanas, slider turtles, etc. Although the enclosure is small, we made artificial forest scenery. Being an open enclosure with mesh roofing, the enclosure is exposed to natural light and other weather conditions. Apart from the reptiles, we also introduced some exotic birds as biological enrichment. This makes the visitors to feel as if they are inside a mini forest. (see pic.)

5. Ecological Enrichment

This enrichment method slightly differs from the environmental enrichment. In the latter, the whole environmental factors are taken into account. Whereas, in the Ecological enrichment, only the essential ecological factors such as habit and habitat that are essential for the animal life. Burrowing habit, arboreal habit, nocturnal habit, Desert habitat, aquatic habitat, etc., are examples.

Ecological Enrichments for Reptiles

Many animals like snakes have the habit of hiding themselves inside the enclosure. Here, the enrichments include, providing small bushes, small stone heaps, water troughs etc. Providing a warm condition during cold seasons is an essential ecological enrichment for small reptiles like snakes and lizards. (see pictures).



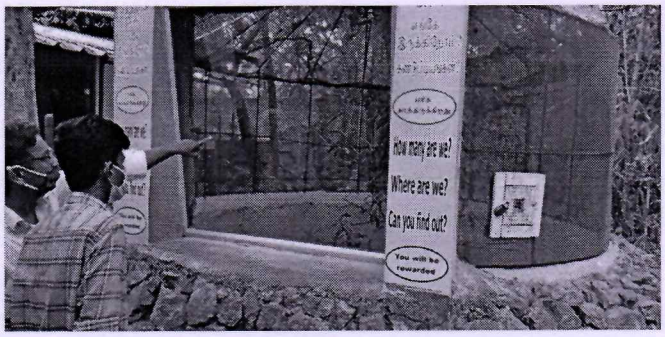
6. Ecosystem Enrichment

This is a new concept developed by me. This is more of Educative value. When we talk of any wild animal, one should aware of the ecosystem in which it lives. In that way, the animal has some role to play in its ecosystem. We created two types of Ecosystem for our Reptiles. One is for aquatic reptiles and another is for Terrestrial reptiles. In the wild no animal can live alone. In the aquatic ecosystem enclosure, we exhibited aquatic reptiles like water snakes, turtles, small crocodiles etc. Along with we also provided fishes, frogs and aquatic plants. Here, one can observe a small food chain. The frogs eat small insects inside the enclosure and the frogs in turn are consumes by water snakes. We also observed a symbiotic relationship between the turtles and the fishes. The fungus grown on the turtle shell are being eaten by the fishes and thus make the shell surface clean. There is a cycle of activities going on as in the case of natural aquatic ecosystem. Similarly, in the terrestrial Ecosystem, we are exhibiting, terrestrial reptiles like snakes, lizards and semiaquatic turtles and terrestrial tortoise. We provided artificial scenery of a terrestrial ecosystem inside the enclosure. A small water falls is also created. Both the above Ecosystem enriched enclosures are of mode educational value. We provided also information boards depicting the functioning of both Ecosystems which will give a clear picture of the natural ecosystem to the public especially to the students. (see pictures).

The terrestrial ecosystem is created here showing various vegetation, water body etc. A mixture of animals is displayed to show how these animals co-exist in a particular ecosystem. A small water flow system showing a small hillock.

7. Informational Enrichment

This is another new concept developed by me which emphasizes the need for providing necessary information about the animals exhibited in the respective enclosure. The latest and one on the major objectives for any zoo is Education and awareness creation about the wildlife. In that respect, there is a need for enriching the animal enclosures with suitable information. Providing information is an art itself. It starts with simple information boards in front of the enclosure stating the name and other vital information. But, one should see that the information provided reach the visitors. There are so many techniques to make our information to reach the visitors. Any information conveyed through in an interactive form will reach the visitors easily (see picture). Apart from these information techniques, good interpreter adds more value to the information conveying techniques. All animal keepers must act as a good interpreter by knowing all vital information of the respective animal. This requires good training for the animal keepers. All animal keepers should have up to date knowledge about their animals. Thus, it is imperative for enriching your animal enclosure by providing good and knowledgeable animal keepers.



In this chameleon enclosures, the visitors are encouraged to locate and count the animals. This animal is known for camouflage and the visitors will find difficult to locate the animal at the same time they will be able to understand the adaptive features of the animal.

A Visitor Survey in Chennai Snake Park

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Introduction

A visitor survey is a research tool used to gather information about individuals who visit a specific place or participate in an activity. It helps understand visitor demographics, behaviours, motivations, and satisfaction levels, providing valuable insights for improving experiences and optimizing services. These zoos are categorized as large, medium, small, mini, and rescue centers. All zoos are visitor friendly and are important places for awareness generation. on the importance of protection of wildlife. In India there are 156 zoos recognized by the CZA. There are 17 large category zoos,23 medium zoos,34 small zoos, 63 mini zoos, 19 rescue centres. Zoo education involves using tools to living laboratories to educate visitors about animals, their habitats and conservation,

Zoo visitors are looking at one of three types of animals: alive, preserved and animated models. The spontaneous comments of visitors at animal exhibits provide an indication of which animals interest them and what attributes receive attention as well as manner and extent to which visitors estimate the specimens. (Tunnicliffee ,1997).

Zoos helps children cultivate a sense of empathy for animals. In the long run, this helps them become kinder, more compassionate members of society.

Study Area

Snake Park is a well-known tourist destination and established in the year 1972 The Chennai Snake Park (GPS: 13.004'N, 80.238'E) is part of Gundy National Park and is a modern mini zoo involved in spreading awareness to the general public about snakes and other reptiles by exhibiting them in enclosures in semi-natural conditions. The park also is involved in breeding of endangered species of reptiles. research and education.

The park exhibits a total of 34 species, including 20 species of Indian snakes. All three species of Indian and 2 exotic species of crocodiles,3 species of Indian tortoises and turtles, one species of exotic turtle, one species of exotic lizard, one species of Chameleon and one species of Monitor lizard. (Rajarathinam, 2022) in 19 open enclosures and 28 closed enclosures.

Methodology

A visitor survey on was conducted for six days between March 1st to March 11^{th,} 2024 in Chennai Snake Park around 11 am to 2.00 pm. A total of 100 visitors were interviewed and data was collected Oral interviews were enumerated from the visitor population in the form of a questionnaire. Mostly adults were interviewed

Various parameters collected from the oral interview are

Report

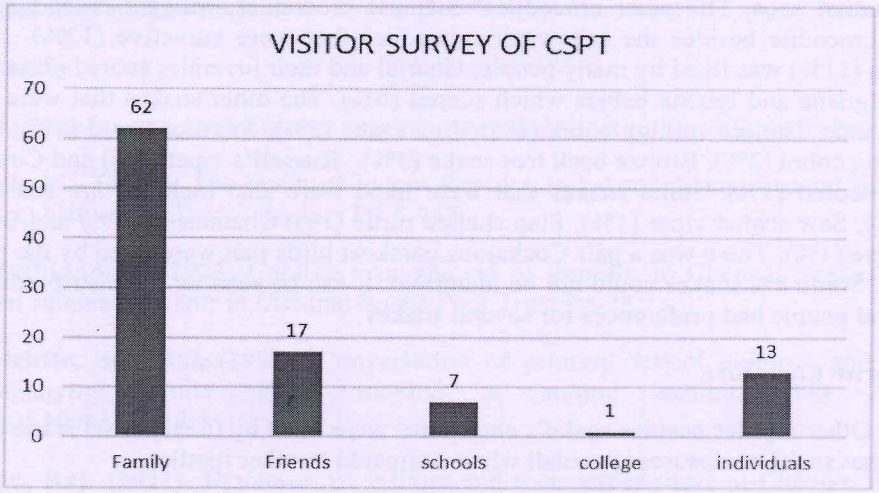
1. Gender,
2. Age
3. Groups (family, friends, individuals, schools, and colleges where the people are counted or individual
4. Whether first visit to the park or not
5. State from which the individual belonged
6. Favorite animal in the snake Park
7. Favorite enclosure in Snake Park

Results

Gender: Out of 100 visitors surveyed, 67 were males and 33 are females.

Age: Age limit ranged from 16-84 people

Groups: According to the survey, family group is the highest (62%) and the lowest is college groups (1%) The friend's group, individuals and School groups are moderate i.e. 17%, 13% and 7% respectively. Based on the survey, People came in family groups to the park as they considered Snake Park as an amusement park for children and also an educative experience or time pass.



First Time Visitors

It was interesting to note that the first-time visitors were large in numbers (78%) people. This could be because of the attractions of snakes and to know more about them. Some considered the park as a place for amusement and recreation. Post covid renovation is responsible for this increase in numbers. Certain visitors had come before (22 %.). First time visitors consider coming for a second time visit. People who come mainly for amusement (67%) and others for education (33%).

Place of Visit

The State that scored the maximum number of people in the sample was Tamil Nadu (77%) Other States were not in large numbers. Andhra Pradesh scored 5% along with West Bengal which also scored (5%). Karnataka had the score of (4%) and was placed in fourth place. There were few tourists from other Countries from Australia (2%), England (1%) and Russia (1%) The rest were from other states of India.

Favorite Animal

The snakes are favorite animals form (49%) of the visitor sample. besides other reptiles that were liked by the people (51%).

The male Saltwater crocodile is the largest crocodile in the Chennai snake park, because of the size the maximum visitors liked it (19%). This was followed by Albino python (14%) which was liked for its beautiful coloration and rare snake exhibited in the Indian zoos. The other crocodiles' Siamese crocodiles, Mugger crocodiles and Nile crocodile besides the salt water crocodiles that were attractive (12%). Indian Cobra (11%) was liked by many people, Gharial and their juveniles scored (7%) along with Iguana and Iguana babies which scored (6%). The other snakes that were liked were Indo Chinese spitting cobra (6%) Vine snake (2%), Monitor lizard (2%), Black spitting cobra (2%), Bronze back tree snake (2%). Russell's viper (1%) and Common krait scored (1%). Some snakes that were liked were also included are Rat snake (1%),), Saw scaled viper (1%), Flap shelled turtle (1%) Chameleon (1%) and Starred tortoise (1%). There was a pair Cockatoos parakeet birds that were liked by the public (2%). Some 8% snakes could not be identified. It can be seen by the distribution that several people had preferences for several snakes.

Favorite Enclosure

Other reptiles besides snake's enclosures were liked by (62%). This is too due to fact that snake enclosures are small when compared to other reptiles.

The Iguana Garden was fascinating for many people. It was a thrilling experience for many at close quarters with the Iguana. 27% of public liked the Iguana enclosure. The crocodile enclosure was liked by many because it was clean and neat (20%). Albino reticulated python enclosure was elected as a preferred enclosure due

to its uniqueness and beauty and also because it provided a place for the beautiful Albino reticulated python. (17 %).). This was followed by Gharial and Gharial babies' enclosure (6%), Venomous snake enclosure was liked by 6%. Flap shell enclosure, monitor lizard, non-venomous enclosure, Pond turtle, Reticulated python enclosure was all represented by 2% each. Chameleon, Cobra, Rock python, Salt water crocodile, spitting cobra, Starred tortoise was liked by 1% of the population. Some people liked the snakes but could not identify 8%.

Discussion

Vishnu (2021) documented 51.4% visitors belonging to Chennai and the rest other cities. Previous survey showed 46.8% as first-time visitors to the snake park conducted during 2018- 2019. (Vishnu,2021. But the present survey percentage of first-time visitors is (78%) compared to previous visits.

The survey sample recorded that the 78% of visitors are from Tamil Nadu and the rest of them from other states and other countries, the present survey documented 63% of visitors from Tamil Nadu. It shows that snake park attracted local people only.

From the survey about favorite animals confined that the size of the animal is a major criterion of their choice. In the same line the size of the enclosure determining the favorite enclosure.

During the survey purpose of snake park visit is amusement purpose only rather than their education, The snake park does various education activities and other facilities from time to time.

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World Snake Day in Chennai Snake Park - 2025

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World Snake Day is a day dedicated to the understanding, appreciation, and conservation of snakes. It is an opportunity for individuals, communities, and organisations worldwide to learn about the diverse species of snakes, their habitats, their role in the ecosystem, and how to protect and conserve them.

While snakes are threatened by many of the same issues that affect all wildlife, such as habitat loss, climate change, and disease, negative attitudes toward snakes may be the biggest barrier to their preservation because it often impedes efforts to address other threats.

Although the ecological values of snakes overweigh their negative values (as venomous creatures) the latter had been strongly embedded in the minds of the people and persist over thousands of years. Only through intensive awareness creation programmes, the negative mind-set of the people be changed slowly.

It was with that intention the World Snake Day was started in the year 2009 and continued to be observed since then every year on 16th of July to increase understanding and awareness about snakes. Over the years, the day has gained international recognition, bringing together snake enthusiasts, conservationists, and communities to celebrate and protect these remarkable creatures.

World Snake Day 2025 not only recognises the importance of snakes in the ecosystem but also highlights fun and interesting facts about them. On this day let us understand some of the fascinating facts about the snakes which may help to evade the negative thoughts about them by the people.

Like any wild animal which has got some role in the ecosystem, the snakes too have some important role to play in the ecosystem. As small predators, they hunt on their major prey species rodents and keep their population under control. Thus, the prey-predator balance is maintained in the ecosystem.

Another very important ecosystem service which is unheard of by many of us is their role in seed dispersal. One may wonder how a carnivore animal could involve in seed dispersal! Nature does it in an indirect way. The major prey species have a behviour of keeping the wild grain eaten by them in their stomach chamber for some time. If the snakes happen to feed on them, the whole body of the prey reaches the snake's stomach along with the undigested grains. The grains get excreted along with the poo of the snake. The excreted grains using the poo as fertilizer, germinate and start growing.

Another exciting fact about the snakes is their moulted skin sheds. All we know about snakes' skin sheds is that they are waste products discarded by the snakes after every moulting. If exposed to sun and rain they will disintegrate and disappear soon. But if we keep them protected, they keep well and may be used for ornamental purposes.

But Nature provides different values for them. Birds use snake sheds in their nests, something people have noticed since at least the 1800s. Although birds cannot smell, ornithologists wondered whether the shed skins helped protect eggs or nestlings by deterring predators.

Recently, two experiments helped determine which predators might be frightened off and whether the strategy works. Ecologists from Arkansas State University conducted a study to test whether snake skin is an effective deterrent to predators.

They found that flying squirrels, a major nest predator, ate the eggs out of 20% of nests without sheds but did not depredate any nests with sheds. Because flying squirrels are themselves vulnerable to predation by snakes, this makes intuitive sense.

However, ornithologists in Slovakia found opposing results. Nests of great reed warblers decorated with snake sheds were no more or less likely to be depredated by birds and small mammals.

If sheds were not deterring predators, what were they for? Researchers suggested that because snake skins were mainly incorporated by female birds early in the nest-building process, they may have functioned as a signal to male reed warblers that the nest-builder was good at finding rare nest materials, which might lead the male to invest more heavily in helping share the duties of parental care later in the nesting season.

Apart from these ecologically valuable services, there are some values of snakes which are of high economic value. The venom from snakes, although considered as a

dangerous and harmful product, its value as a medicine fetches several million dollars in the international market.

According to a recent Market Research Report, the global snake antivenom market generated USD 314.86 billion revenue in 2023 and is projected to grow at a CAGR of 7.69% from 2024 to 2033. Snake farms in countries like Brazil. Thailand, Kenya, China etc are doing profitable business with snake farming.

In addition to various therapeutic uses, the application of snake venom peptides (small molecules of proteins) in cancer therapy is also highlighted by recent research findings.

Let us popularise the above conservation values of snakes in all our awareness programmes which will help to neutralize the negative attitudes of people on snakes and there by all our conservation efforts will bring desired results. Let this year's World Snake Day be a step towards achieving our Snake Conservation Goals.

Cobra, the bi-annual journal of the Chennai Snake Park Trust, invites articles and notes on reptiles and amphibians, their ecology, biology, natural history, conservation or other aspects. These may be of scientific or popular interest. Black and white photographs are also welcome.

Authors are advised to consult a recent issue of Cobra to check for stylistic requirements of the journal and then submit their manuscripts through e-mail to cspt1972@gmail.com

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