

ZOOLOGICAL SURVEY OF INDIA

6 AUGUST 2026

VOLUME 2

ISSN

CREATURE CHRONICLES

WILD HEARTS, WISE MINDS

On August 6th, we proudly present the second volume of our magazine to honour a groundbreaking achievement in the Zoological Survey of India (ZSI) — the appointment of Dr. Dhriti Banerjee as the first woman director in its illustrious history.

This edition features a collection of insightful and engaging articles penned by talented women scientists, each contributing their unique perspectives and expertise in the field of zoology. Join us as we celebrate not only Dr. Banerjee's remarkable leadership but also the voices of women who are shaping the future of science. Together, we are redefining the narrative of women in zoology.

EDITORS

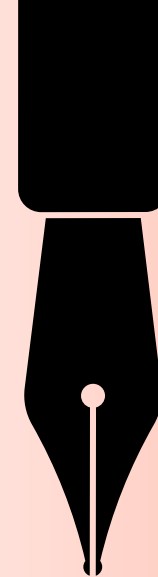
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Zoological Survey of India

Citation: Banerjee, D., Rizvi, A. N., Roy, D., Sengupta, J. 2026.
Creature Chronicles: Wild Hearts, Wise Minds, 2 : 1-258.
(Published by the Director, Zool. Surv. India, Kolkata).

ISSN :



EXTRAORDINARY

Wings of Wisdom

2.0



Preface

It is with great pride that I present the second edition of *Creature Chronicles: Wild Hearts, Wise Minds*—a new collection of scientific stories written by the women scientists and scientific officers of Zoological Survey of India. After the warm response to our first volume, this edition again celebrates the curiosity, dedication and skill of the women researchers working to understand India’s remarkable biodiversity.

The 48 articles take readers on a journey from the hidden, microscopic worlds of amoebae and dinoflagellates to spiders, wasps, red pandas, rhinos, and the ancient histories frozen in fossils. What unites these stories is the rare ability to turn meticulous research into beautifully lucid writing. It requires profound expertise to make complex science feel both vibrant and welcoming.

The title says it well. “Wild hearts” for the passion these scientists bring to their work, “wise minds” for the sharp thinking behind it. At a time when science needs good storytellers, they have become just that—opening biology up to students, teachers, policymakers, and anyone who is simply curious.

I have witnessed the dedication these scientists bring to their work—the long hours in remote field stations, the patience required for taxonomic identification, the innovative approaches to conservation challenges, and the commitment to mentoring the next generation of researchers. This magazine captures not just their scientific achievements but also their passion for discovery and their commitment to protecting India’s natural heritage for future generations.

I warmly acknowledge the Publication Division, for their dedicated efforts for bringing this remarkable compilation to life once again.

I invite you to embark on this second journey alongside most passionate and eloquent scientists in their respective fields. Whether you are a student, an educator, or simply a nature enthusiast, I trust their insights will inform, inspire, and foster a deep, enduring curiosity about the diverse life-forms sharing our planet.

Dr. Dhriti Banerjee
Director
Zoological Survey of India

Content

Sl. No	Title of the article Name of the Scientist/Scientific staff	Page No.
1.	The Climate Detective: A Tale of Testate Amoeba <i>Mrs. Srijani Biswas, Senior Zoological Assistant</i>	4
2.	Dinoflagellates: Small Wonders of the Aquatic World <i>Ms. Indrani Neogi, Senior Zoological Assistant</i>	9
3.	From the Cambrian to the Graeco–Roman to Modern Times – The Legend of Gorgonians <i>Dr. G. Sivaleela, Scientist - E</i>	14
4.	Channa punctata: Helminth Infection Store House <i>Mrs. Anindita Ghosh, Assistant Zoologist</i>	19
5.	Worms Without Borders: The Hidden Wonderland of Polychaetes <i>Ms. Madhurima Bose, Senior Zoological Assistant</i>	23
6.	Small but Mighty: How Prawns Shape Aquatic Life <i>Ms. Purnima Kumari, Senior Zoological Assistant</i>	30
7.	Exploring the World of Freshwater Prawns <i>Ms. Akriti Singh, Senior Zoological Assistant</i>	36
8.	Amphipods Many Legged Creatures in Different Places :Hidden Engineers of Ecosystems <i>Ms. Kahkeshan Perween, Senior Zoological Assistant</i>	42
9.	Spiders Decoded: From fear to fascination <i>Ms. Upasana Bhattacharya, Senior Zoological Assistant</i>	46
10.	Phoretic Mites as a Forensic Tool <i>Ms. Samarpita Gayen, Senior Zoological Assistant</i>	50
11.	Insects in Hindu Mythology <i>Dr. Jhikmik Dasgupta, Scientist - B</i>	55
12.	The Silent Puppeteers: Inside the Hidden World of Microgastrinae Wasps <i>Dr. Jayita Sengupta, Scientist - B</i>	60
13.	Tiny Pollinators: Diversity of Bees in Pollination <i>Dr. Dipanwita Das, Scientist - B</i>	63

Sl. No	Title of the article Name of the Scientist/Scientific staff	Page No.
14.	The World Within the Web: Unveiling the Interactions of Baeini (Scelionidae: Hymenoptera) and Spider Egg Sacs <i>Ms. Sushama V., Assistant Zoologist</i>	67
15.	Crores at Stake, Wasps at Work: Eco-Friendly Control of Cigarette Beetle <i>Ms. Sunita Patra, Assistant Zoologist</i>	71
16.	Chalcididae: A wonderful creature and a proficient bio control agent <i>Mrs. Nabasri Basak, Senior Zoological Assistant</i>	75
17.	Nocturnal and Neglected: The Moth Story <i>Ms. Ankhi Sarkar, Senior Zoological Assistant</i>	81
18.	Tiny Titans of Freshwater: The Story of the genus Amphiops <i>Dr. Deepa Jaiswal, Scientist-E</i>	86
19.	The Hidden Billion-Dollar Beetle Beneath Your Feet <i>Dr. Aparna Sureshchandra Kalawate, Scientist-E</i>	91
20.	Fascinating Ladybird Beetles (Coleoptera: Coccinellidae): Heroes of Biological Control <i>Dr. Ruquaeya Bano, Scientist-E</i>	94
21.	Tiny Beetles, Big Warnings: What Aquatic Beetles Reveal About the Health of the Indrayani River <i>Dr. Rita Deb, Assistant Zoologist</i>	97
22.	Sand Artist of Thar Desert: Ground Beetles <i>Ms. Sonal Yadav, Senior Zoological Assistant</i>	102
23.	Red Dots on White Fields: The Quiet Story of Cotton Stainer Bugs <i>Ms. Aakriti, Senior Zoological Assistant</i>	106
24.	Stink Bugs: A Friend or A Foe? <i>Ms. Archana Sagar, Senior Zoological Assistant</i>	110
25.	Marine Water Strider: The Insects That Conquered the Marine Ecosystem <i>Dr. Swetapadma Dash, Scientist - E</i>	115

Sl. No	Title of the article Name of the Scientist/Scientific staff	Page No.
26.	Under the Wax: Exploring the Hidden World of Mealybugs <i>Mrs. Rakhi Das, Senior Zoological Assistant</i>	118
27.	DNA Barcoding- a Double-Edged Sword in Taxonomy: Insights from Indian Cockroach Diversity <i>Ms. A. Shabnam, Senior Zoological Assistant</i>	122
28.	The Twisted Tale of Termite Mandibles <i>Ms. Sharmistha Das, Senior Zoological Assistant</i>	125
29.	Odonates of the Sundarbans: Survival in a Saline World <i>Dr. Suranjana Banerjee, Assistant Zoologist</i>	128
30.	Garden Sentinels: Life cycle and Diversity of Praying Mantids in India <i>Ms. Pallabi Priyadarsini, Assistant Zoologist</i>	135
31.	Centipedes: Nature's Fast, Fierce... and Misunderstood Neighbours <i>Ms. Thapasya K., Senior Zoological Assistant</i>	142
32.	Invasive Non-Marine Molluscs of India: Silent Threats to Biodiversity and Livelihoods <i>Dr. Sk Rehanuma Sulthana, Assistant Zoologist</i>	147
33.	Economic Significance of Mollusca: An Extensive Analysis <i>Dr. Abhijna Ghosh, Assistant Zoologist</i>	153
34.	Fish Diversity and Coastal Fisheries in India: Recognising Women's Underappreciated Contributions <i>Dr. Honey U.K. Pillai, Scientist - E</i>	159
35.	Beneath the Mud Lies a Mystery: The Hidden World of Eel Fishes <i>Ms. Veena Kumari, Senior Zoological Assistant</i>	165
36.	GloFish! A beauty pageant in the Aquarium <i>Mrs Swamarpita Mukherjee, Senior Zoological Assistant</i>	169
37.	Amphibians Beyond the Spotlight: Revealing the Secret Story of Caecilians <i>Mrs Sejuti Biswas, Senior Zoological Assistant</i>	176

Sl. No	Title of the article Name of the Scientist/Scientific staff	Page No.
38.	Sun, Sand and Toughies: Mammals of the Indian Desert <i>Dr. Indu Sharma, Scientist - F</i>	182
39.	Guardians of the Canopy: Primate Diversity in the Western Ghats <i>Dr. Ranjana Bhaskar, Scientist - E</i>	188
40.	Red Panda : A Magical Creature of Mountain <i>Ms. Swagata Dutta, Senior Zoological Assistant</i>	200
41.	When Rhinos Roamed The Mangroves: A Zooarchaeological Journey Into The Sundarbans <i>Dr. Supriya Nandy, Scientist - D</i>	203
42.	Echoes of the Tethys Sea: Unearthing Marine Fossils in the Heart of Central India <i>Ms Debashree Dam, Scientist - C</i>	213
43.	Spiny Survivors: Echinoid Fossils of Indian Subcontinent <i>Dr. Dola Roy, Scientist - B</i>	219
44.	Burrows, Tracks and Trails: Reading the Ancient Life through Ichnofossils <i>Mrs Anubarna Dutta Chowdhury, Senior Zoological Assistant</i>	226
45.	A Heritage Without Custodians: India's Fossils and the Search for Protection <i>Ms. Soma Das, Senior Zoological Assistant</i>	232
46.	Santragachi Jheel: The Changing Story of Wetland to Wasteland <i>Mrs. Susmita Khanra, Senior Zoological Assistant</i>	239
47.	Silent Witnesses: What DNA Reveals About Wildlife Crimes <i>Mrs. Sutithi Mitra, Senior Zoological Assistant</i>	243
48.	The Tale of Cities and the Linnaean Shortfall: How Urban Ecology, Sustainability and Conservation interplay <i>Ms. Florence Suganya R, Senior Zoological Assistant</i>	251



The Climate Detective: A Tale of Testate Amoeba

Srijani Biswas

Whenever you have strolled through a marshy patch or observed a forest puddle, you were likely standing over a secret, thriving microscopic community. Testate amoebae are the most fascinating inhabitants in this community. They are free-living, single-celled amoeboid protists that can craft their own house, known as test or shell. These tests are conserved well in peat, lake sediments even after the death of the amoeboid cell, and record the climatic history of the peatland. To science, they act like nature’s micro historian.

Historical Journey of Testate Amoeba Research

The story of testate amoeba research stretches back to the early 19th century, when Leclerc (1815) first described a “new type of amorphous polyp” and introduced the genus *Diffugia*. Thereafter, Joseph

Leidy (1879), Penard (1890–1911), Cash, Hopkinson, and Wailes (1905–1921) laid the groundwork and disclosed the diversity of testate amoeba to the upcoming generation. Joseph Leidy’s research work “Fresh water rhizopods of North America” (1879) served as a foundational reference for generations of researchers. To

pay a tribute to his significant research contributions, “The Joseph Leidy Award” was established in 2023 by the International Society for Testate Amoeba Research (ISTAR), and this award is presented to scientists to acknowledge their exceptional and remarkable research contributions in the field of testate amoeba study.



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In mid-19th Century, Léo Lesquereux (1884) very mindfully conveyed the significance of peatlands and the urgent need for protection of this ecosystem against exploitation. However, it took more than a century for his suggestions to get implemented, and legal protection of peatlands got acceptance in 1987 through the Rothenthum popular federal initiative in Switzerland (Grünig 1994). In tribute to his vision, a genus of testate amoeba was later named *Lesquereusia* in his honor.

Fast-forward to the 20th century, researchers revealed the important role of testate amoeba in peatlands as bioindicators, paleoecological indicators, while the second half of the Century saw significant increase in research studies showcasing this charismatic organism’s dynamic capability to provide insights into water table depth reconstruction, restoration ecology, forensic ecology, and ecotoxicology.

At present, the 21st Century has seen a tremendous leap in the number of research studies and publications on testate amoeba diversity and distribution across the globe. Scientists around the world are using both morphological and molecular tools to unlock

the secrets of this protist. The dynamism of this organism to address numerous questions of microbial biogeography has gained the attention of researchers worldwide, and so they have become a very ideal model organism.

Global citizen of Microscopic World

Testate amoebae are true globetrotters. They have managed to spread across nearly every corner of the planet, from warmer tropics to the icy edges of the poles, they are thriving in a wide variety of habitats such as mosses, wet soils, lakes, lagoons, bogs, estuarine

environments, high-altitude mountains, deep ocean floors.

The global diversity of testate amoebae is quite extensive. Earlier studies described about 2,500 different kinds of testate amoebae globally. However, after the advancement of DNA sequencing and the introduction of DNA barcoding, a lot of cryptic diversity has been revealed, which means the actual number could be even higher. In a recent study, some scientists put together worldwide data on testate amoebae and concluded that 1187 testate amoeba species were recorded globally in the



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Nature’s Tiny Architect

Unlike naked amoeba, testate amoeba lives inside an intriguing, tiny protective shell. They built their tests by either accumulating tiny bits of sand, minerals, organic materials such as quartz grains, diatom frustules etc. from the environment, or secreting substances like silica or calcium. Tests come in a wide variety of shapes, some resembling delicate vases, tiny pots, some like tiny armored helmets. This protective shell has a small opening, called pseudostome, through which the amoeba protrudes lobose (rounded projection) or filose (thread-like projection) pseudopodia to hunt down bacteria, algae, and even smaller protozoa, shaping the microscopic food web beneath our feet.

Living Bio-sensor

Testate amoebae act as real-time biological sensors, helping researchers track the immediate

Over millennia, the tests accumulate and persist within peat layers. They indirectly influence the global carbon cycle and the pace of climate change. The spatial distribution of testate amoebae in peat layers is determined by species-specific preferences.

impacts of climate change on sensitive ecosystems. Even the subtle shifts in pH level, nutrient level, moisture content, can change the composition of their communities. Even a sudden drop in water table depth from draining or evaporating can rapidly alter which species dominate in that community. By monitoring this shift in the community, early ecological responses to climate change can be detected even before they are apparent in hydrology records.

Time Travelers in Peat

Peatlands are wet, swampy areas where the ground stays so soaked those dead plants don’t fully rot away. Because of this, layer upon layer of plant material builds up over time, forming a thick, spongy

substance called peat. They act as huge carbon sinks, locking away more carbon than all the world’s forests combined. Peatland vegetation is mostly dominated by *Sphagnum* mosses in colder regions, and in warmer areas, grasses and trees add most of the plant material. Testate amoebae show the highest abundance and taxonomic diversity within *Sphagnum* moss-dominated peatlands. Over millennia, the tests accumulate and persist within peat layers. They indirectly influence the global carbon cycle and the pace of climate change. The spatial distribution of testate amoebae in peat layers is determined by species-specific preferences. Some species are adapted to saturated, waterlogged environments, whereas others

thrive in moderately drier conditions. Through detailed analysis of species composition in peat layers, scientists can untangle the story of how wet or dry the landscape was hundreds of years ago, which can deepen our understanding of past climate shifts and help to anticipate future scenarios.

Masters of Recycling

Testate amoebae live mainly in moist environments (forest litter, *Sphagnum* moss, or freshwater ponds), feed on bacteria, algae, and tiny organic debris. In doing so, they regulate microbial populations and indirectly control the decomposition processes and contribute to nutrients recycling. They can slow down or alter the rate of organic matter breakdown, influencing the balance between carbon sequestration and carbon release. Their presence indicates a healthy, functioning ecosystem.

With the advancement of tools and techniques, the protists are emerging as crucial model organisms for addressing complex questions in ecology, climate change, and evolutionary biology. While much of the scientific spotlight

has long been on larger, more charismatic organisms, these microscopic life forms are expected to play a leading role in shaping our understanding of Mother Nature in the coming decades.

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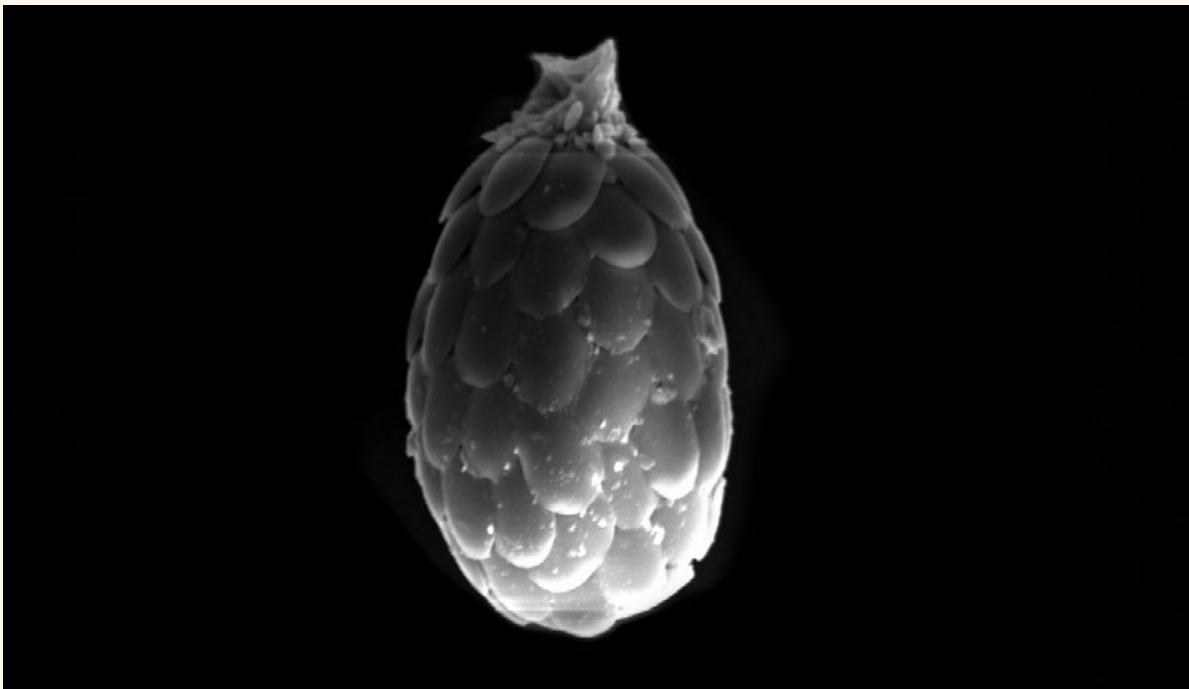


Fig. 1: *Sphenoderia minuta* Deflandre, 1931



Fig. 2: *Trinema enchelys* (Ehrenberg, 1838) Leidy, 1878



Dinoflagellates: Small Wonders of the Aquatic World

Indrani Neogi

A large group of aquatic protists is dinoflagellates, which display a remarkably wide range of unique genomic features, morphologies, nutritional types, behaviours, and ecological roles. They are considered important members of plankton communities and inhabit oceanic, coastal, and freshwater ecosystems. Some create their own sustenance, like plants, while others consume organisms or particles. Certain species are capable of performing both activities depending on the environment that surrounds them. All dinoflagellates at some stage of their life have two unequal flagella, which arise either from one pore or from two distinct pores. One unique characteristic of some of them is their ability to produce light, causing the seawater to glow at night. The bioluminescence phenomenon produces this glow. Certain species can

rapidly reproduce, producing blooms that can quickly colour the water, often red or brown in hue. They can produce toxins and reduce oxygen, harming the fish and other sea creatures.

Microscopic Protists with Surprising Survivability:

Dinoflagellates are tiny water-dwelling creatures with

characteristics of both plants and animals. Like plants, some contain pigments and use sunlight to make food with the aid of photosynthesis. Some organisms hunting others down and eating them like miniature natural predators. Around 50% of the planktonic dinoflagellates can produce their own food. However, since there is an

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increasing recognition of their heterotrophic abilities in a growing number of species, it is thus better to call them mixotrophs. The remaining half are heterotrophic and feed on other phytoplankton, microzooplankton, or other dinoflagellates, sometimes fairly pressuring other microbes. Some species ingest smaller cells in their entirety. Some of them use a tubular structure that pierces fleshy prey and sucks dry. Certain dinoflagellates developed a specialised feeding structure. They can release a veil-like structure that envelops and ensnares nearby prey. The feeding veil can drag along microscopic algae quickly so that it can digest them effectively.

The Tiny Drifters That Light Up the Sea:

Bioluminescence has beautiful properties, such as sudden bursts of light in the seawater at night. The tiny drifters that illuminate the sea. When the waves break on the beach or a boat moves through the water, the sea suddenly glints with light. Often, dinoflagellates are responsible for this glow. The organisms that can create light while floating in the water are known as bioluminescent. Many marine creatures have special chemicals and enzymes in their cells that react together to release a flash of light. Any footsteps in the water or splashes and swimming fish can light up the dark sea. The colour of the produced light

When the waves break on the beach or a boat moves through the water, the sea suddenly glints with light. Often, dinoflagellates are responsible for this glow. The organisms that can create light while floating in the water are known as bioluminescent.

is usually blue-green. Marine animals can easily detect it, as it travels well through seawater. The flashes are generally very short, but sufficiently bright to create an impression, especially when there are millions present. Scientists think this glowing might help dinoflagellates survive. A sudden flash startles predators or attracts larger animals that eat those predators. Thus, light acts as a kind of protection. Nonetheless, not all dinoflagellates can glow, which shows that it is an advantage rather than a necessity.

Dinoflagellates and harmful algal blooms (HABs):

Dinoflagellates are pretty, they are significant ecologically, but also responsible for harmful algal blooms (HABs). Some species manufacture potent natural toxins. Under certain situations, it will rapidly multiply to form a bloom in coastal waters. Similar events are often referred to as tides. The life of birds, mammals and man can be affected by certain toxin-producing dinoflagellates. One of the harm pathways commences when shellfish filter these organisms from the water when feeding. As a result, the toxins build up in the shellfish without harming them. Individuals or larger animals

consuming polluted clams may fall severely ill. Toxins from different dinoflagellates are associated with several seafood poisonings. Some can affect the system causing numbness, light-headedness, breathing troubles, while others may cause stomach problems. Certain dinoflagellates produce toxins in the location of coral reefs, whereby these toxins enter fish, and later cause ciguatera fish poisoning. The blooms can also kill fish, deplete oxygen, or stress coral reef communities, harming ecosystems as well. Severe dinoflagellate blooms can negatively impact fisheries and coastal tourism.

While not many species produce toxins, those that do can cause major problems. Scientists monitor water and seafood safety for this very reason. Small as they are, these tiny creatures show us how even the smallest life in the ocean matters for ocean health and human well-being.

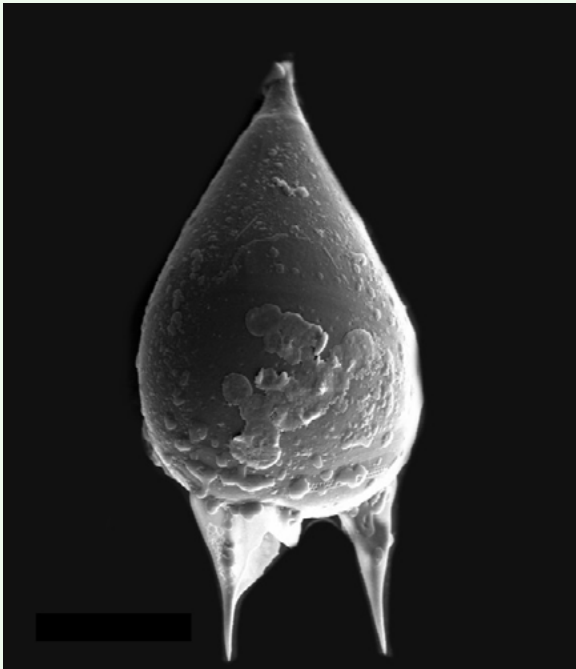
Can We Stop Harmful Blooms?

Yes, that is the answer. Avoiding harmful algal blooms from dinoflagellates, which can threaten marine life, fisheries, and human health, is therefore considered the most effective management option. When a bloom first appears in a section

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of water, it can be difficult and costly to manage. Scientists aim to improve water quality by reducing pollutants and excess nutrients from sewage, agricultural and industrial runoff that often stimulate nasty blooms. Scientists are also testing ways to suppress blooms after they form, like throwing clay or something similar to trap algal cells and cause them to sink out of the water, or filtration or water-mixing techniques etc. Researchers have attempted

natural competition or predation to come up with a method as well as safe chemical treatments. Nevertheless, these approaches should be used with caution as they can also harm fish, plankton and other helpful marine organisms. No one method is presently sufficient for solving the problem. A mix of prevention, constant monitoring, scientific research, and proper management of coastal waters is the best strategy.



Scanning Electron Microscope (SEM) image of dinoflagellate (*Podolampus bipes*)



Prtoperidinium divergens (dinoflagellate)



Dinoflagellate collection site; Naubag, Maharashtra



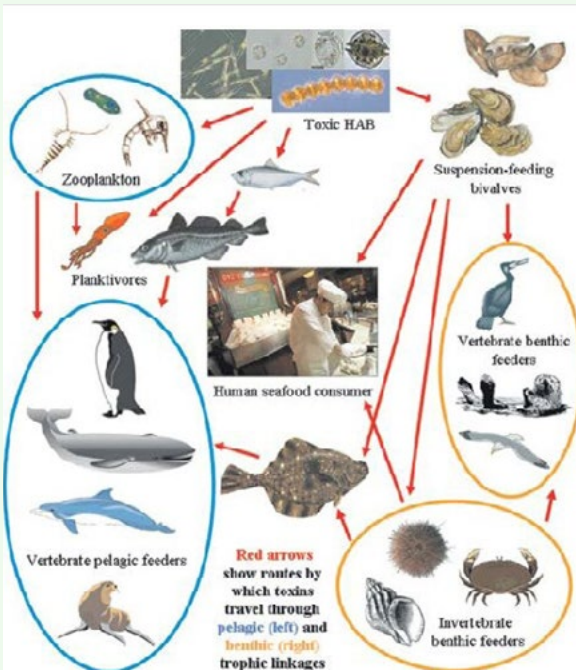
Bioluminescence, sparkle of light in seawater. Source: <https://www.animalsaroundtheglobe.com>



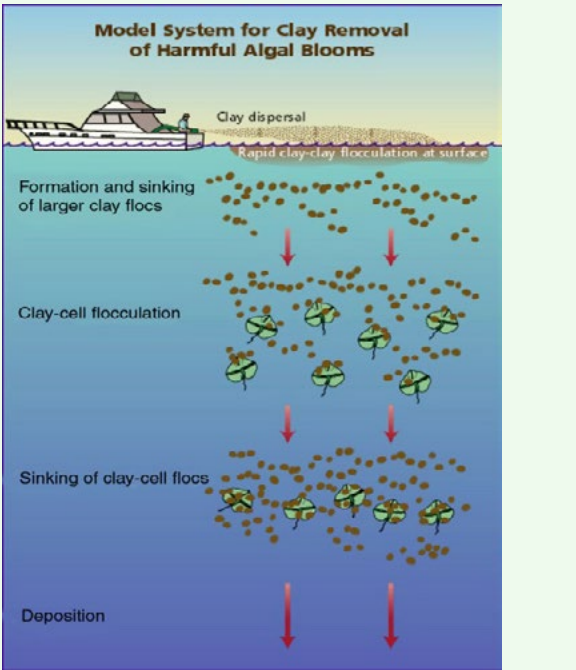
Dinophysis caudata (dinoflagellate)



Tripos muelleri (dinoflagellate)



Transfer of toxins through dinoflagellates. Source: Gary Wikfors; <http://www.whoi.edu/redtide/impacts/ecosystems>



Physical control of Harmful Algal Bloom. Source: <https://www2.whoi.edu/site/andersonlab/new-project-mitigation-of-red-tide-in-florida>



From the Cambrian to the Graeco–Roman to Modern Times – the Legend of Gorgonians

G. Sivaleela.

Everybody knows about the “**Jurassic Period**”, thanks to Steven Spielberg’s classic “Jurassic Park” of 1993 (but Dinosaurs actually evolved in the Triassic period, but that is a story for another day). It was every retro nerd’s dream to be a zoological researcher after that movie. But the period that deserves all the praise and adulation is the “**Cambrian Period**”. The Cambrian period is about 541 to 485 million years ago and is well known for the “**Cambrian Explosion**”. The Cambrian explosion is characterised by an increase in atmospheric oxygen, which meant animals could perform energy-demanding functions. This increased availability of oxygen triggered an evolution of the HOX gene, which plays an indispensable role in

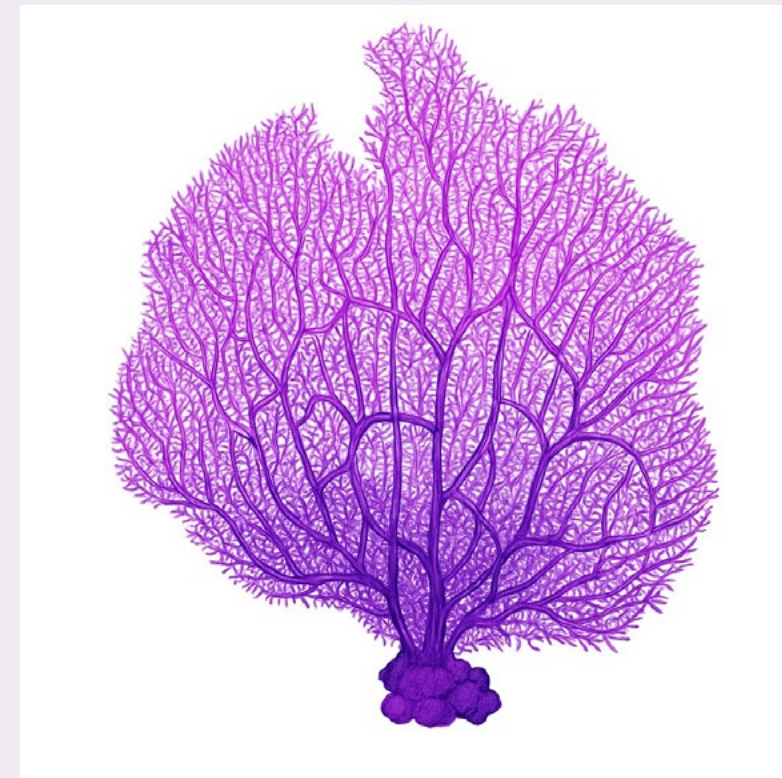
morphogenesis, which meant that animals could develop complex organs to perform these complex and energy-demanding functions. This resulted in a large-scale boom in multicellular organisms. Animals diversified, adapted, and evolved as they saw fit to form the ancestors of the animal kingdom. It is at this point that the cnidarians evolved from the austere poriferans. Poriferans were “**basic**” as the Gen Z kids would say. When the opportunity presented itself, the early animals evolved into cnidarians, multicellular animals that were not just a mass or ball of cells but coordinated to form organs that could perform functions aimed at reproduction and survival of the whole animal. Cnidarians are sister-species to the first-formed multicellular

organisms called poriferans. These bear-bearing animals are asymmetric and do not possess true tissues (a group of cells performing a singular function). Cnidarians, on the other hand, possess true tissues, although primitive, they can carry out extracellular digestion and even secrete chemicals to defend themselves against predators. The animal that we are going to talk about here is one such cnidarian called a gorgoniid or sea fan, and sea pens. They might very well be the first-formed cnidarians called “**Anthozoans**” or flower-like animals.

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From the Cambrian to the Graeco–Roman to Modern Times – the Legend of Gorgonians



A Gorgonian

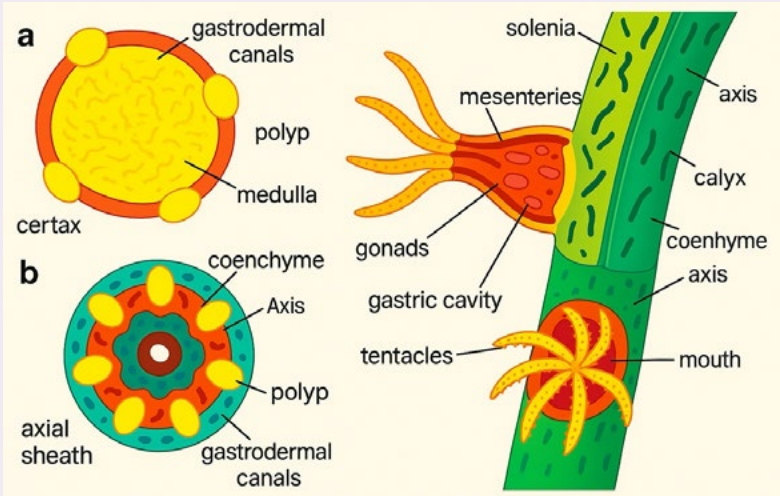
Credits: iStock

Gorgonians are fan-shaped cnidarians which are often perpendicular to the water current to capture more food. They have a holdfast at the bottom of the fan-shaped colony that helps in anchoring the animal to the substratum and a short stalk, almost like a peduncle, from which the animal branches out. The branches bear small polyps, which are the actual animal which has eight hollow tentacles, hence placed under octocorallia.

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to note here is that not all sea fans originated from a single lineage. The deep-water sea-fans had deep-water ancestors, and the shallow-water gorgonians had shallow-water ancestors. This is vital to know since it shows how well the animals studied their niche and diversified themselves from an early stage to successfully

colonize all parts of the ocean, which could support them. They had to individuate in a sense to be successful and thriving. Something very similar to what our adolescent naysayers have to go through to become true adults! They chose the tree-like form since that is what can withstand the strong currents



Anatomy of a Gorgonian

Credits: Kupfner Johnson, Selena & Hallock, Pamela. (2020). A review of symbiotic gorgonian research in the western Atlantic and Caribbean with recommendations for future work. *Coral Reefs*. 39. 10.1007/s00338-020-01891-0.

The trees act as a bulwark against strong air currents and reduce the rage of the tsunami by acting like a breakfront. This is a similar logic that the gorgonians followed.

and wave action of the oceans. Have you ever heard of coastal management against tsunamis using trees? The trees act as a bulwark against strong air currents and reduce the rage of the tsunami by acting like a breakfront. This is a similar logic that the gorgonians followed. Since they were the early formed metazoans, they also served as foundational species by fostering the growth of animals around them and sometimes even recruiting animals. It is fascinating to read that this was around the same time (Cambrian Period) when coral reefs were formed. So, did gorgonians have a part to play? Only research can answer these questions.

The beautiful colours of the gorgonians are due to the secretions of the animal itself. They are found in shades of purple, yellow, orange, red, brown and pink - like a kaleidoscope under the ocean. Sometimes the colours may be a result of their association with some kinds of algae. These animals never cease to amaze the scientific community. Apart from being keystone species, these animals are known for their pharmaceutical compounds. Due to this, they were being harvested in numbers. India has taken the proactive initiative and placed the animals under Schedule I of the Wildlife Protection (Amendment) Act of 2022.



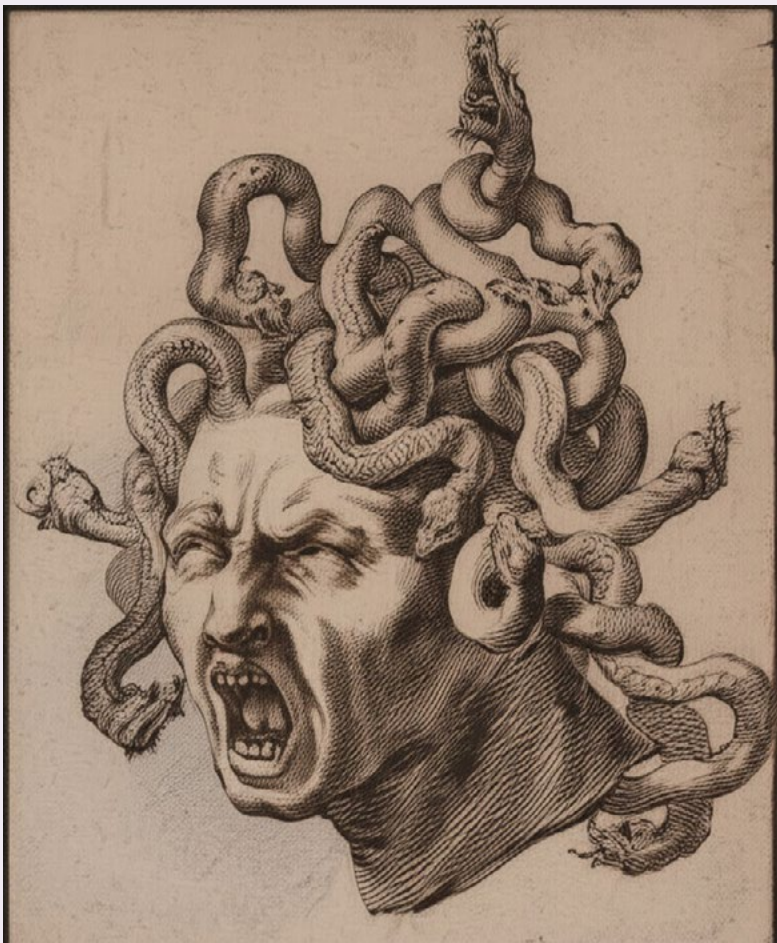
A Sea horse attached to a Gorgonian

Credits: Suwat Sirivutcharungchit

When asked about dives by any underwater diver, apart from their tales about the tangs and butterfly fishes of coral reefs, they cannot help but drone on about the marvel that is sea fans, sea whips and sea pens. These plant-like animals are a sight to sore eyes. Aesthetically pleasing in appearance and poetic in the

gentle manner in which they sway according to the ocean currents, gorgonians stand tall underwater and quietly exist, as if almost asking us to go with the flow. This seems contradictory to the origin of its name, “gorgon” from Greek mythology. Gorgon is a trio of three sisters with an ugly appearance and snakes for hair. The myth says that anyone who looks a Gorgon eye to eye would turn to stone. Apart from the unsightly physicality, there is a singular thing that one must accept about the irreproachability of the etymology of gorgonians: one does turn to stone upon looking at them directly, since one is stunned at their beauty and grace, we turn motionless and still.

This seems contradictory to the origin of its name, “gorgon” from Greek mythology. Gorgon is a trio of three sisters with an ugly appearance and snakes for hair. The myth says that anyone who looks a Gorgon eye to eye would turn to stone.



An Illustration of a Gorgon

Credits: Wikipedia



Channa punctata: Helminth Infection Store House

Anindita Ghosh

Fish is an essential food source for human, especially when it comes to high-quality proteins. These are easily digestible, thus acting as a supplementary source of protein, particularly for the people in developing countries. Fish constitute a significant element of the food for the people of India too. Helminth parasites pose a serious threat to both freshwater and marine fish all over the world, as they cause acute pathogenicity to the fish. It is a significant public health issue in both developed and developing countries. *Channa punctata* (Bloch, 1793) has high economic value, as it is one of the popular food fish in India. *Channa punctata* has great potential for usage as nutrients and medicines to treat illnesses and enhance human health. It is rich in Omega 3 and Omega-6 polyunsaturated fatty acids, thromboxane, and prostaglandins. Omega 3 and

Omega 6 PUFA have a significant role in the development of skin-related medications. It may be used pharmaceutically to treat or prevent conditions like diabetes, skin infections, and heart problems. In some areas, this fish is used as traditional medicine to heal wounds and lessen discomfort following surgery. That is why

the consumption of this fish is strongly recommended. This fish is also used as aquarium fish. This fish also has great market value because these are available in plenty and also of low cost and it is largely consumed by people of Asian countries. These fish are popularly referred to as ‘spotted snake fish’. In addition to roadside canals, paddy fields,

“ Helminth parasites pose a serious threat to both freshwater and marine fish all over the world, as they cause acute pathogenicity to the fish. It is a significant public health issue in both developed and developing countries. ”

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and swamps, they are typically found in freshwater bodies of water such as ponds, bheries, and beels. They can survive in muddy areas in stagnant water and aquaculture of this food fish is also very common in India and Bangladesh.



Channa punctata (Bloch, 1793)

These fish are popularly referred to as ‘spotted snake fish’. In addition to roadside canals, paddy fields, and swamps, they are typically found in freshwater bodies of water such as ponds, bheries, and beels. They can survive in muddy areas in stagnant water and Aquaculture of this food fish is also very common in India and Bangladesh.

Channa punctata are mostly carnivorous mud-loving fish and usually feed on molluscs, insects and crustaceans. Molluscs are intermediate hosts of most of the parasitic helminths, causing more infections of helminth parasites in this fish. Ectoparasitic helminths (Monogenea) prefer the gills and skin, whereas endoparasites (Trematoda, Cestoda, Nematoda and Acanthocephala) prefer the alimentary canal, particularly

the esophagus, stomach, and intestine. It has been observed that *Channa punctata* are infected with over 126 helminth parasites which restricts normal growth and increasing fish mortality of the fish. Helminth parasites have also been signified as being zoonotic importance, as eating these fish can also spread the infection to human.

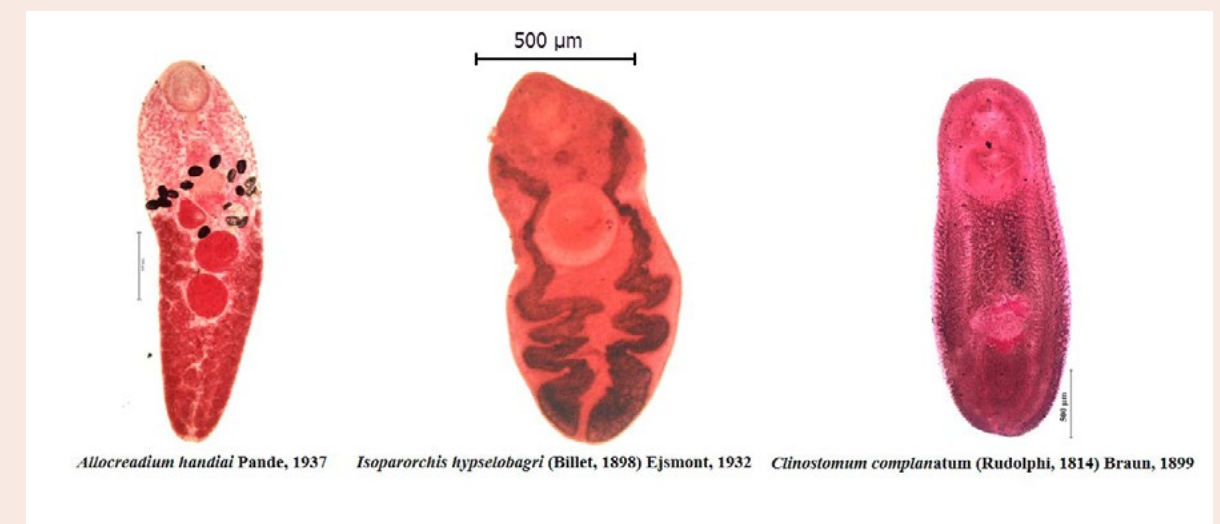
Helminth parasites that frequently infect *Channa*

punctata include monogenea of the genus *Gyrodactylus*, trematodes of the genera *Allocreadium*, *Asymphylodora*, *Azygia*, *Brahmaputratrema*, *Clinostomum*, *Eucreadium*, *Haplorchoides*, *Isoparorchis*, *Metaclinostomum*, and *Transversotrema*; cestodes from the genera *Bothriocephalus* and *Senga*; nematodes from the genera *Camallanus* and *Eustrngyloides*; and acanthocephala from the genus *Pallisentis*. White spots or cysts on the body, ulcers on skin and fins, excessive mucus production, decreased swimming activity, growth and weight loss, and, in excessive infection, body deformity are common signs of helminth parasite infection in *Channa punctata*. Severe infection of helminth parasites on *Channa punctata* may also cause internal organ damage and failure of the immune system. Infection is directly influenced by factors like age, nutrition, fish abundance, independent

parasite quantity within fish, and season. Several studies have been done by various scientists on seasonal variation, prevalence, pathogenic effects, parasitic intensity, and control of parasites infecting *Channa punctata*. Species of Monogenea, in addition to causing discomfort and excessive mucus production, monogenean infestations also induce bacterial invasion. *Gyrodactylus* sp. are mainly found in the skin and body surface of *Channa punctata* and occasionally in gills and causes damage to the epithelial tissue. The prevalence of these parasites is found to be highest in August and lowest in the month of January. Trematode infections in *Channa punctata* were found to be more common in the summer and winter, but they were less common in the monsoon due

to environmental conditions. Metacercarial infections of the trematode parasites were more in winter than in summer due to an increase in mollusk populations, which also act as intermediate hosts of these parasites. Metacercaria of clinostomatid trematodes, including individuals of *Clinostomum*, *Euclinostomum*, and *Metaclinostomum*, cause diseases and alter the host's behavior by infecting the skin, muscles, fins, skull, and viscera, resulting in financial losses in the aquaculture of this fish. Among all the species of *Allocreadium*, *A. handiai* Pande, 1937, is the most common trematode that affects *Channa punctata*. It has been observed that the maximum prevalence of cestode parasites in *Channa punctata* is in summer and moderate in the winter season. Prevalence of

the acanthocephalan parasite *Pallisentis* sp. is highest during March to May and lowest in winter. Prevalence of nematodes was also found to be highest from March to May. The seasonality of parasite infection is also influenced, either directly or indirectly, by the feeding habitat. It shows how ecological conditions influence helminths' occurrences in this host fish. Significant variations in infestation rates according to sex and weight categories are also found; infection rates were higher in male individuals of *Channa punctata* in the summer. Studies show that the infection level is higher in male individuals than female ones. It has been observed that in comparison to the lower and higher weight groups, the mid-weight snakeheads were often more susceptible to infection.



Zoonotic trematode parasites like *Isoparorchis* sp. and *Euclinostomum* sp. and zoonotic nematode *Eustrongyloides* sp. are very common in *Channa punctata*. Larval stages of nematodes and metacercarial stages of trematodes present in this fish can be transmitted to human and cause diseases.

Channa punctata (Bloch, 1793) are significantly infected with gastrointestinal helminth parasites; the risk of numerous helminth infections occurring at the same time can provide a zoonotic health risk to human also. Fish producers suffer significant losses because of parasite diseases that affect productivity, marketability, and mortality of these fish. Effective control measures and strategies

“ Zoonotic trematode parasites like *Isoparorchis* sp. and *Euclinostomum* sp. and zoonotic nematode *Eustrongyloides* sp. are very common in *Channa punctata*. Larval stages of nematodes and metacercarial stages of trematodes present in this fish can be transmitted to human and cause diseases. ”

must be developed immediately since *Channa punctata* (Bloch, 1793) is a highly popular food fish among the people in Asian countries, particularly in Bangladesh and India, and it also has high nutritional

value and pharmacological significance. To prevent risks to human health, people should be advised to follow healthy eating habits, such as avoiding raw or undercooked fish.



Worms without Borders: The Hidden Wonderland of Polychaetes

Madhurima Bose

Scene 1: During fieldwork in the Mangroves of Sundarban, I plunged my hand into the soft, squishy, muddy substratum, and I expected to find only silty sediments and decaying leaves but instead I discovered some movement beneath the mudflats.

Scene 2: Later, while conducting surveys in the coral reef region of the Gulf of Mannar, a similar moment unfolded. Once again, what appeared to be lifeless coral rubble and sponge masses revealed subtle activity within the rigid structures.

These two encounters, though separated by distance and strikingly different environments, led to an unexpected line of thought. What could possibly link the dark, silted mazes of the Sundarban mangrove forests and the sun — drenched expanse of the

Gulf of Mannar’s coral reefs — or, more specifically, what could a piece of submerged logwood in a muddy mangrove swamp possibly have in common with a discarded coral skeleton on a tropical reef? At first glance, nothing.

Here’s the answer: Beneath the surface of both, a hidden architect is at work: the “bristle worms”. These bristle worms are the unseen engineers of the coastline, equally skilled at navigating through the mucky mangrove forest floor to the hard, dying reef.

“ What could possibly link the dark, silted mazes of the Sundarban mangrove forests and the sun-drenched expanse of the Gulf of Mannar’s coral reefs —or, more specifically, what could a piece of submerged logwood in a muddy mangrove swamp possibly have in common with a discarded coral skeleton on a tropical reef? ”

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Bristle worms are a diverse group of marine segmented worms belonging to the phylum Annelida and class Polychaeta. The term polychaeta is derived from a Greek word meaning “many bristles”. In the benthic faunal community polychaetes are the most prevalent group accounting for around 80% of the microbenthic population.

What are Bristle Worms?

Bristle worms are a diverse group of marine segmented worms belonging to the phylum Annelida and class Polychaeta. The term polychaeta is derived from a Greek word meaning “many bristles”. In the benthic faunal community, polychaetes are the most prevalent group accounting for around 80% of the microbenthic population. Polychaetes are the most resilient and common metazoans in the marine environment and are distributed in a variety of habitats ranging from shallow coastal waters and mangroves to the abyssal depths of the ocean floor. They adapt their morphology according to their habitat. For instance, crawling polychaetes thrive on marine substrates such as the sea floor

or coral reefs, while burrowing polychaetes are developed for excavation in different substrates, including sand, mudflats, dead coral, sponges, and logs. Tube polychaetes, on the other hand, form calcareous tubes, parchment tubes, or tubes made of shell fragments and sand grains. Polychaetes are also found in sediments or clinging to submerged vegetation in freshwater settings, where they play a key role in the food web and nutrient cycling. Their presence enhances the overall biodiversity and ecological health of freshwater habitats.

Life beneath the Mud:

Polychaetes can survive in a variety of ecological conditions, including a wide range of salinities, pH, and dissolved

oxygen concentrations. Polychaetes are prevalent in estuarine environments, mangrove areas, and even in freshwater. The nutrient-rich estuarine waters and their bottom sediments, composed of a mixture of sand, silt, and organic matter, provide a favourable environment for a broad spectrum of polychaetes. In mangrove environments, polychaetes play a vital role as decomposers, breaking down organic matter and recycling nutrients that sustain the food web supporting larger animals. They live in a wide range of habitats within the mangrove ecosystem, from soft, silty, hypoxic, muddy areas to taking shelter in the dead logs cohabiting with other organisms like crustaceans and molluscs. Species belonging to families such as Capitellidae, Nereididae, Glyceridae, Phyllodocidae, and Eunicidae are commonly found in such habitats.

They also play an essential ecological role in the decomposition of organic materials and alteration of benthic sediments, a process called bioturbation. This in turn enhances oxygen penetration into the soil, boosts microbial productivity, and increases the influx of nutrients. Bioturbation also provides new food resources

to the benthic communities by making buried organic materials available to the deposit feeders.

Engineers of Sandy Shore:

In the dynamic environment of the sandy seashore, where the sediments shift constantly, and temperature fluctuates rapidly, it may seem challenging for organisms to survive. However, some polychaetes have adapted to thrive in this environment. Most polychaetes found on sandy shores are infaunal, which means they reside within the sediments that provide them protection from desiccation and also from the predatory shore birds. Some of them construct burrows in the sediments, while some navigate through the sediments using their segmented bodies. Their elongated bodies, robust

parapodia, and strong muscular movements help them to anchor themselves within the grains against shifting tides and strong currents. Some polychaetes disappear during daytime low tides and emerge again when the water returns to capture organic particles or plankton, whereas some are nocturnal feeders. Despite being one of the most abundant inhabitants of the sandy seashore, they are often invisible to the naked eye.

The Architects: The tube-dwelling polychaetes:

Although polychaetes are mostly known as free-living marine worms, but some groups build their own homes — these are the tube-dwelling polychaetes. Instead of wandering freely, the tube dwellers construct their tubes with mucus, sand grains,

soft mud, shell fragments, or calcium carbonate. Species belonging to the families Serpulidae, Sabellidae, and Terebellidae are considered as tube dwellers. Sabellids, often called feather duster worms, are the most fascinating ones. They usually build soft tubes buried in sediments or attached to hard substrate. The Sabellids extend their elegant and vibrant fan-like crowns through their tubes to capture the suspended food particles, but with the slightest vibration, they instantly retreat inside.

Serpulids build hard tubes made of calcium carbonate, spiral or irregular in shape, attached to rocks, shells, mangrove roots, and coral reefs. They are mainly identified by their colourful feathery radioles and operculum. These tubes even persist after the worms die, providing shelter to other marine life.

Terebellidae, also recognized as “spaghetti worms” stay underneath the muddy substratum extending numerous thread like buccal tentacles over the sediments surface. All terebellids are deposit feeders and gather food particles through these buccal tentacles and transport them to the mouth via ciliated tentacular grooves. Most terebellids are tube

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dwelling creatures residing in sturdy tubes made of sand or sediment particles, either within the sediments or affixed to rocks or shells.

Hidden inhabitants of Coral reefs:

People often recognize coral reefs by their vibrant branching corals, sea anemones, sponges, or colourful fishes. But beneath this mesmerizing beauty lives another remarkable group of organisms — the polychaetes. They are among the most diverse and ecologically important organisms of the coral reef ecosystems. Coral reefs exhibit one of the most complex habitats in marine environment. In crevices, sandy patches, seagrass meadows, coral rubble, and reef lagoons polychaetes are found colonizing nearly every niche. Several species burrow in the reef sediments, contributing to the recycling and decomposition of organic materials, while some inhabit the fissures and cavities of the coral framework. Furthermore, some tube-dwelling polychaetes form parchment tubes or calcareous attached to the coral surfaces, rocks, or mollusc shells. Amphinomids, also known as the fire worms are the most notorious and most familiar motile polychaetes in the coral reefs. The stings of



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the fireworms cause painful sensations. Polychaetes of the families Polynoidae, Nereidae, Syllidae, and Eunicidae are often present in corals. In reef ecosystems polychaetes also serve as a major food resource for fishes, crustaceans and other invertebrates.

Thriving in Harsh Habitats:

Due to the ability of polychaetes to live in a wide range of habitats, some polychaetes can survive in very harsh conditions. They can inhabit various extreme habitats ranging from oxygen - starved mudflats to highly polluted harbours or zones with hazardous chemicals. Their rapid growth, short life span, and constant reproduction enable them to thrive in disturbed

environments, providing early signs of pollution impact and aiding in the assessment of organic enrichment. Polychaetes belonging to the family Capitellidae [ex. *Capitella capitata* (Fabricius, 1780)] are considered to be dominant in the polluted areas rich in organic wastes. Ecologists consider polychaete communities as an indicator to monitor environmental health. Polychaetes are highly sensitive to organic pollution and respond rapidly to changes in sediment and water quality, making them potential bioindicators. Their abundance and diversity make them suitable to be used as a marker to assess ecological health and stability. Variations in polychaete community structure indicate changes

in environmental factors like habitat degradation, sediment quality, or pollution levels. The disappearance of sensitive species and dominance of tolerant species indicate that the habitat might be under stress.

In the end, polychaetes remind us that some of the ocean's

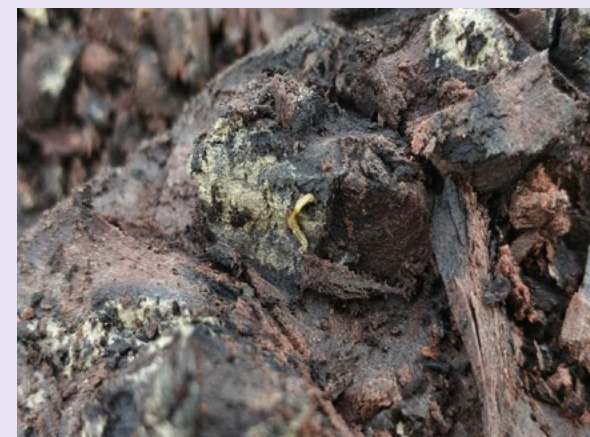
most significant creatures are often overlooked. Hidden within the intricate structure of coral reef ecosystems, burrowed beneath the mangrove muds, or traversing the sandy littorals, polychaetes keep working silently and continuously. From recycling the nutrients, enhancing sediment aeration, to

providing support to the marine food webs, polychaetes act as relentless workers of the marine ecosystem. Spanning from the coral reefs to the intertidal mudflats, the enigmatic lives of these small organisms reflect that even minute worms can also play a pivotal role in sustaining the marine ecosystem.

Different Microhabitats and Association of Polychaetes: -



Association with Sponges



Association with Sponges



Polychaete tube attached with logs



Within the muddy substratum



Associated with dead logs



Tentacles of Terebellidae extended over the sediment surface



Tubes attached to a broken pole



With coral rubble



Calcareous tubes of Serpulidae

Association of Polychaetes with Different Ecosystems:



INTERTIDAL SEA BEACH



CORAL REEFS



MANGROVE SWAMPS

Polychaete Species from Different Families



Serpulidae



Amphinomidae



Polynoidae



Small but Mighty: How Prawns Shape Aquatic Life

Purnima Kumari

Stand beside a quiet river at dawn. The surface looks calm—almost lifeless. A few ripples, reflections of trees, perhaps the distant splash of a fish. But beneath that stillness lies a world in motion—a bustling microcosm where some of the most important players are also the easiest to miss.

Among them are freshwater prawns—small, delicate, translucent, and ceaselessly active creatures that rarely capture attention. Yet these unassuming animals are the silent caretakers of aquatic ecosystems, shaping the health, balance, and productivity of the waters they inhabit.

In their understated presence, they function as ecosystem engineers, biological recyclers, and vital connectors within aquatic food webs.

From mangrove creeks to riverbeds and coastal waters,

their influence extends far beyond their size—subtle in appearance, yet profound in ecological consequence.

They are, quite literally, small—but undeniably mighty.

The life story of a prawn reads almost like an epic journey.

It begins with a mother carrying hundreds—sometimes thousands—of tiny eggs beneath her abdomen. She protects them carefully, ensuring they remain oxygenated until they hatch. But once released, the young are no longer protected—they drift as fragile larvae in open water.



To pay a tribute to his significant research contributions, “The Joseph Leidy Award” was established in 2023 by the International Society for Testate Amoeba Research (ISTAR), and this award is presented to scientists to acknowledge their exceptional and remarkable research contributions in the field of testate amoeba study.



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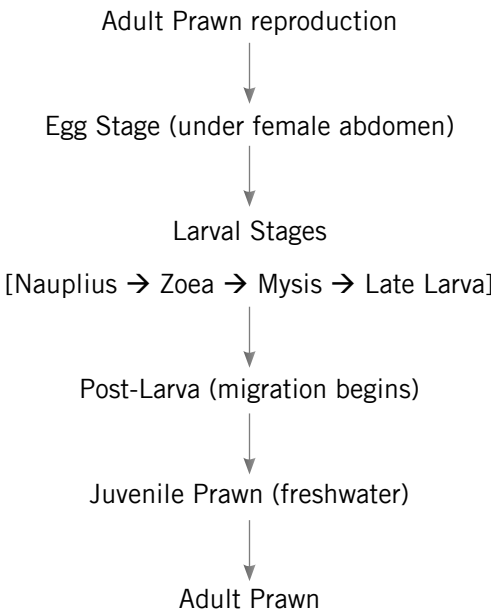
Here’s where things get fascinating: unlike most freshwater creatures, prawn larvae often need brackish water to survive. This means their earliest life unfolds in

estuaries—places where rivers meet the sea.

As they drift, they transform repeatedly, molting and reshaping their bodies through multiple stages. Eventually, they

become post-larvae—miniature prawns—and begin their journey back into freshwater, where they will grow, mature, and repeat the cycle.

Life Cycle of a Prawn



The prawn life cycle is a remarkable sequence of transformation, beginning as microscopic eggs and passing through several free-swimming larval stages—nauplius, zoea, and mysis—before becoming post-larvae that settle into bottom habitats. As juveniles and adults, prawns adopt a benthic lifestyle, contributing actively to aquatic food webs



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and nutrient cycling. The cycle is completed when adults reproduce, releasing eggs back into the water, continuing this dynamic and highly adaptive biological rhythm.

Nature’s Underwater Clean-Up Crew

If rivers had maintenance workers, prawns would be among the most hardworking.

Freshwater prawns, particularly those belonging to the genus *Macrobrachium*, are often described as “ecosystem engineers.” Through their daily activities—feeding, burrowing, and moving across substrates—they actively modify their environment. As omnivorous scavengers, they feed on decaying plants, algae, and organic debris—essentially recycling waste that would otherwise accumulate and degrade water quality. As they forage along the bottom, they stir sediments, improving oxygen flow and supporting microbial life.

This constant activity keeps aquatic ecosystems clean, productive, and balanced.

Without prawns, rivers and ponds could quickly become clogged with waste—losing their vitality over time.



Prawns occupy a unique and powerful position at the intersection of ecology and economy, where the functioning of natural ecosystems seamlessly connects with human well-being. In aquatic environments, they perform an essential yet often unnoticed service—breaking down organic debris, recycling nutrients, and maintaining the clarity and productivity of water bodies. Through these processes, prawns help sustain the health of rivers, estuaries, and coastal systems, indirectly supporting fish populations and strengthening the resilience of entire aquatic ecosystems.



Economic Importance of Prawns to Ecosystems and Mankind

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For humanity, this ecological efficiency transforms into substantial economic and nutritional value. Prawns are among the most highly valued seafood resources worldwide, forming a cornerstone of both traditional capture fisheries and modern aquaculture systems. Their rich nutritional profile—abundant in high-quality protein,

essential amino acids, and vital micronutrients—makes them an important component of food security, particularly in coastal and riverine communities where dependence on aquatic resources is high.

Beyond nourishment, prawns support an extensive and dynamic livelihood network. From small-scale fishers and hatchery workers to aquaculture farmers, processors, traders, and exporters, millions of people are economically linked to prawn-based industries. In many developing regions, prawn farming has emerged as a catalyst for rural transformation, generating employment, income diversification, and participation in global seafood trade.

Yet, this economic significance is deeply intertwined with ecological responsibility. Healthy prawn populations depend on intact habitats such as mangroves, estuaries, and wetlands—ecosystems that are increasingly vulnerable to overexploitation and environmental change. Unsustainable practices in harvesting and aquaculture can therefore disrupt not only prawn populations but also the ecological balance they help maintain.

In this delicate balance lies the true importance of prawns:

they are not merely a source of food or income, but living links that bind ecosystem health with human prosperity, reminding us that sustainable use is essential for enduring abundance.

Freshwater prawns are also deeply connected to human livelihoods.

They are widely farmed for food, valued for their rich nutritional content. In many regions, innovative systems like rice-prawn farming allow agriculture and aquaculture to coexist sustainably.

Such practices not only provide income but also make efficient use of natural resources—

demonstrating how humans and nature can work together.

More Than Meets the Eye

Look closer, and prawns reveal surprising abilities:

- » They can regrow lost limbs over time
- » Some species can change color to blend into surroundings
- » Males may form dominance hierarchies, influencing growth and reproduction
- » They are highly sensitive to environmental changes, acting as bioindicators of water quality. These are not simple creatures—they are highly adapted survivors



More Than Meets the Eye

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Fragile in a Changing World

Despite their resilience, prawns face serious threats from human activities.

Pollution, habitat destruction, overexploitation, and climate change are altering the delicate balance they depend on. Changes in river flow, salinity patterns, and water temperature can disrupt their life cycles—especially during their vulnerable larval stages.

Because prawns are so closely tied to environmental conditions, their decline can signal deeper ecological problems.

Freshwater prawns may be small in stature, but their influence on aquatic ecosystems is immense.

As recyclers, regulators, and resources, they form a vital thread in the intricate web of life beneath the water’s surface. Recognizing and protecting their role is not only a matter of ecological interest but also a step toward sustaining the health and productivity of freshwater environments for generations to come

Protecting these organisms, therefore, is not merely about conserving a single group of species—it is about preserving the integrity of entire aquatic systems.

The Big Impact of a Small Creature

Freshwater prawns may not command attention—but their influence is everywhere.

They clean, recycle, connect, and sustain. They are the unseen workforce that keeps aquatic ecosystems alive and functioning.

In a world that often celebrates the large and visible, prawns remind us of a quieter truth:

Even the smallest creatures can shape entire worlds.

Final Thought

Next time you look at a calm river or pond, imagine the hidden life beneath. Among the pebbles and plants, countless tiny prawns are at work—feeding, growing, transforming, and sustaining life.

Small? Yes.

Mighty? Without a doubt.



Collection of Prawns and Fish from pool.



Fig 4: Dorsal view of *Macrobrachium sankolli* Jalihal & Shenoy in Jalihal, Shenoy & Sankolli, 1988 of family Palaemonidae.



Exploring the World of Freshwater Prawns

Akriti Singh

Beneath the slow-moving rivers or streams some small engineers are tucked in the roots of aquatic plants. they are the vital component of our ecosystem and they are also known to impact the ecology. They are well known as cleanup crew as they generally feed on

dead's, leaves, driftwood etc. the armoured engineers act as the primary decomposers for the environment. How do they do that? How do they split up the resources? How do they end up cleaning the whole stream and so our environment? Well, they all have their job, feeding,

they're filter feeding, they're taking particles out of the water, they're picking on all of the things that they can feed on. So, let's dive into a busy tropical stream ecosystem to know how prawns are creating a nutrient-rich environment for wildlife to flourish and humans to enjoy.



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Akriti Singh

Exploring the World of Freshwater Prawns

The aqua cleaner

In the wild, freshwater prawns act as the primary decomposers of their environment. They are constantly on the move, using their specialized appendages to pick at rocks, driftwood, and leaves. They graze on various forms of algae, break down decaying organic matter, recycling nutrients back into the food chain.

A Spectrum of Feeding Strategies

Most people think of prawns as scavengers, but their methods of finding a meal vary wildly across species.

The Scavengers (Neocaridina & Caridina)

Most species are constant foragers. They possess tiny claws (chelae) equipped with microscopic hairs that help them grab and taste tiny particles of food from the substrate.

The Filter Feeders (Atya & Atyopsis)

Species like the Bamboo Shrimp have evolved away from claws. Instead, their front legs have transformed into delicate, umbrella-like fans. They find a spot with a high-water current, deploy their fans, and “filter”

“

In the wild, freshwater prawns act as the primary decomposers of their environment. They are constantly on the move, using their specialized appendages to pick at rocks, driftwood, and leaves. They graze on various forms of algae, break down decaying organic matter, recycling nutrients back into the food chain.

”

microscopic organisms and particles directly out of the water column.

The Art of the Molt

One of the most fascinating features of shrimp biology is ecdysis, or moulting. Because they wear their skeletons and later, they shed their rigid shells to grow. The process starts from the absorption of calcium from its old shell, making it brittle. Then the shrimp leaps out of its old skin with a sudden muscle contraction. After moulting the shrimp's shell is as soft as paper so they hide under the rocks or in dense vegetation to get its Armor hardens.

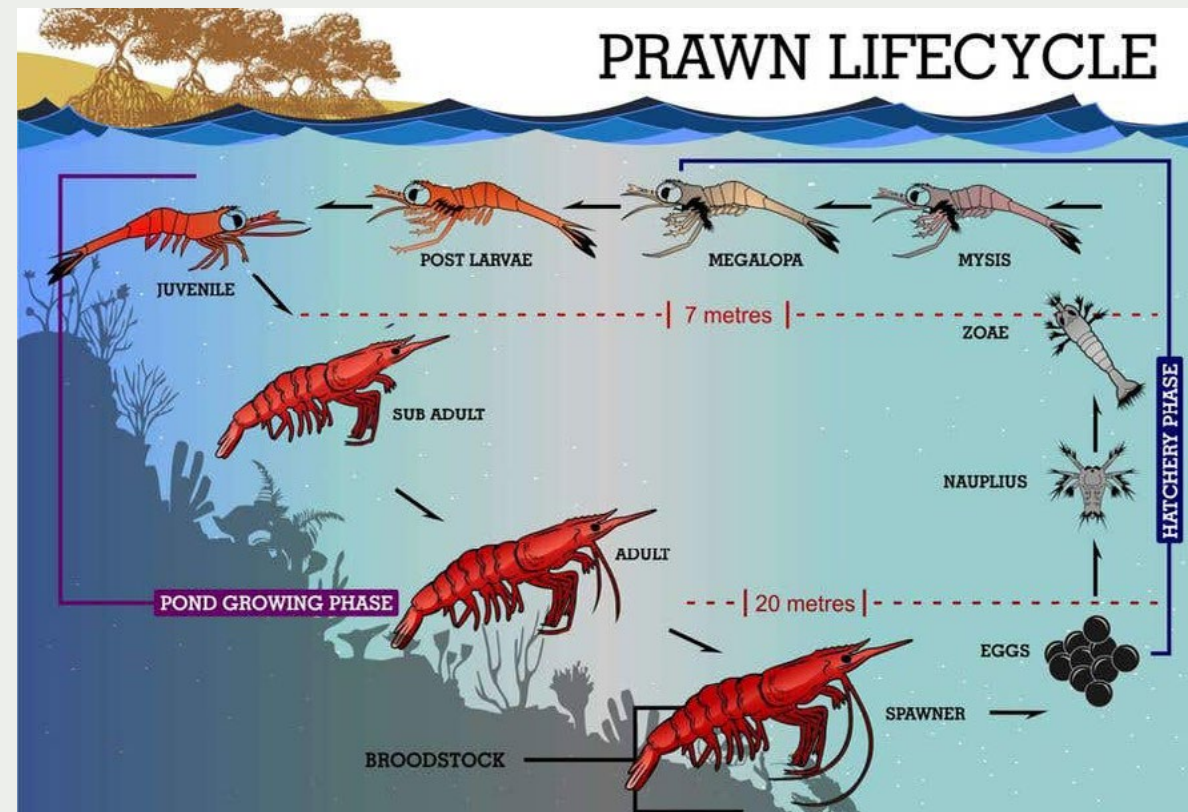


A Complex Life Cycle: From Salt to Stream

Generally, all the species of Prawns are marine/freshwater

at some point of their life cycle. most of the species of genus *Macrobrachium* and *Caridina* are marine or estuarine but they

also require freshwater for egg laying and mating. Although the adults live in pure freshwater, many are amphidromous.



One of the most fascinating biological “marathons” involves the reproduction of many freshwater prawn species.

When a female’s eggs hatch, the larvae are swept downstream into brackish estuaries where the water is salty. The larvae require this salinity to survive their early developmental stages. Once they transform into “post-larvae” (miniature versions of the adults), they

begin a gruelling upstream migration—sometimes traveling miles against the current—to return to the freshwater homes of their ancestors.

The shrimps are generally smaller cousins of prawns. They are not only important as ecological point of view but they are also important as the good source of quality protein after fish and also have the great place in the aquariums.

Order Decapoda belongs to subphylum Crustacea comes under the class Malacostraca is divided into two suborders namely Dendrobranchiata and Pleocyemata. The suborder dendrobranchiata comprises exclusively the prawns of the superfamilies Penaeoidea Rafinesque, 1815 and Sergestoidea Dana, 1852. Whereas the suborder Pleocyemata with

its 11 infraorders comprises the remaining commercially important crustaceans like prawns, mudprawns, lobsters, crabs and cray fishes (Valarmathi, 2024). About 655 species of Caridean prawns. Among them, 118 species of prawns (Valarmathi et al., 2017) had been reported in India.

The prawns are well known as “Long-Arm” creature because of their second pair of walking legs also known as chelipeds. In males, these can grow to be significantly longer than their entire bodies, and often appears in vibrant shades of blue or orange.

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Macrobrachium rosenbergii (De Man, 1879) (having blue or orange chelipeds)

These striking features aren't just for show. They are tools for defence, mating rights (A dominant "Blue Claw" male will use his reach to protect a harem of females), Food Acquisition, and Versatile Appetites.

Unlike the delicate filter-feeding habits of some specialized prawns, freshwater prawns are largely opportunistic omnivores. They are the cleanup crew of the river, possessing a diet

that shifts based on what the environment provides.

Sustainable Giants: The Rise of Prawn Farming

Beyond their ecological importance, species like the Giant River Prawn (*Macrobrachium rosenbergii*) have become a cornerstone of sustainable aquaculture. freshwater prawn farming is often integrated into agricultural systems. Rice prawn culture

allows farmers to grow both crops in the same field. The prawns provide natural fertilizer for the rice and eat pests, while the rice provides shade and protection for the prawns. Prawn culture is one of the most productive and dynamic in India that play a vital role in nutrition, employment, developing economical condition and earning foreign currency.



Integrated farming paddy with prawns

Conservation Notes

Despite their popularity, many wild populations are under threat. Habitat destruction, pollution from agricultural

runoff, and the damming of rivers disrupt their migratory breeding patterns. Protecting our freshwater systems isn't just about the fish we see; it's about

the tiny, translucent scavengers that keep those waters life-sustaining in the first place.



Freshwater Prawn collection at ken river, Panna Madhya Pradesh



Amphipods Many Legged Creatures in Different Places

Kahkeshan Perween

Hidden Engineers of Ecosystems
Dwelling under the seas, tucked among tangled mangrove roots, drifting through quiet rivers, or hiding in moist forest floors - you'll find tiny creatures that not everyone notice: amphipods. Not big, but built with many legs, they belong to a group called Amphipoda, part of the larger family of joint-legged animals, specifically under Arthropoda and grouped as Malacostraca - working without praise, holding nature together in places far and near.

Looking at them closely, amphipods seem like shrimp - those crustaceans called decapods - but really they're quite different underneath. Without a hard shell covering their head, these creatures bend easier than true shrimp do. Their limbs have different functions; as the first two pairs

of legs are modified to perform specific role: grabbing food, or fending off threats. What sets them further apart shows up how they reproduce - female have specialized thin plate that extends from their thoracic legs to form a pouch and the

young ones are hatched in the pouch and so they don't have an independent larval stage. The presence of brood pouch in amphipods place them under superorder Peracarida.

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Body Shape and Physical Traits

Starting at one end, an amphipod's shape shows surprising detail. Some are tiny - only about a millimeter across - while others grow much larger; take *Alicella gigantea*, stretching nearly 34 centimeters. Their body is divided into three segments: front section called cephalon, middle known as pereon, then rear labeled pleon. Up near the front, two antennae stick out, each with a small extra branch, also there are some parts for eating - a upper lip, jaw-like mandibles, two sets of mouth limbs, and helper appendages named maxillipeds. Seven pairs

of simple walking legs, called pereopods, attach to the thorax area. First among these two sets modified into gnathopods.

Gnatho= jaws, pods=legs. The meaning justifies that it is used for feeding activities.

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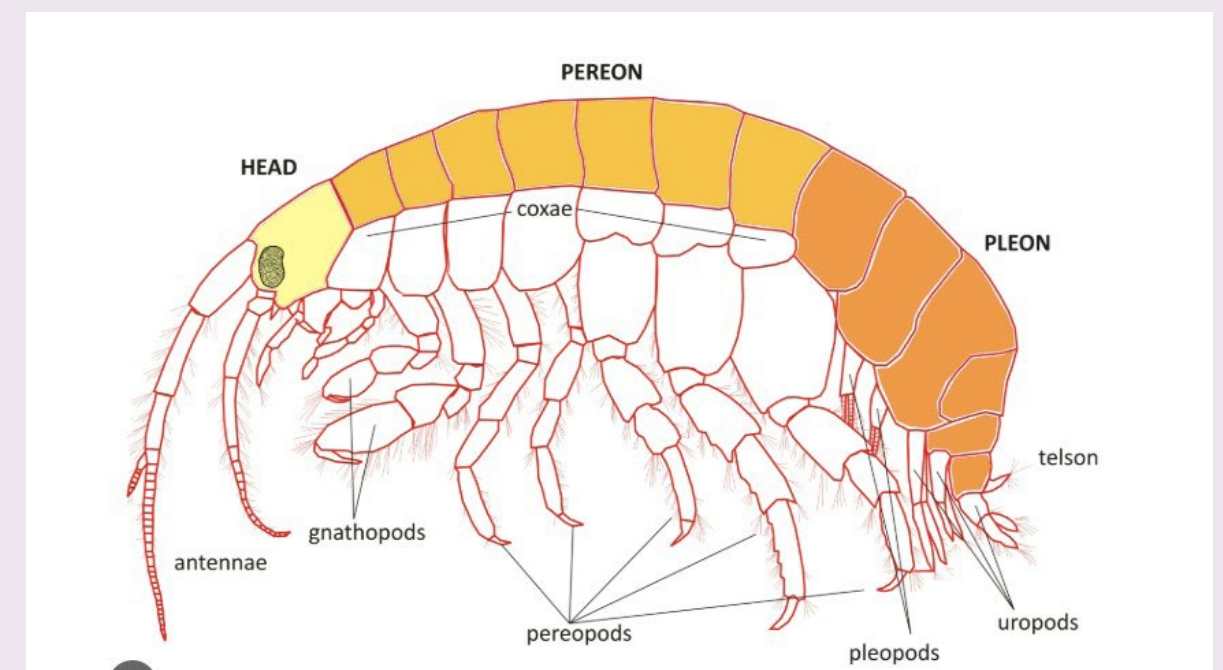


Image Credits - Google Images

Behind the front part, the body splits into two sections called pleosome and urosome. One after another, these parts bear limbs that branch out - known as pleopods on the first section, uropods at the back. Swimming gets a boost from pleopods; sudden leaps come from uropods instead. Quick turns through water happen thanks to how each limb works in its own way.

Diversity and Global Spread

Even tiny, amphipods come in wildly different forms. Across the Earth, scientists have documented 13,312 kinds - yet just under ten thousand hold official status, while hundreds lack recognition. From salty seas to muddy mangroves, clear streams to damp soil, they turn up nearly everywhere. Within India alone, researchers count 266 types spread across 133 groups and 56 families. Location details for these Indian varieties were checked through the online GBIF database. Surprisingly, more kinds of tiny sea creatures show up on India's eastern shore than its western one - probably because scientists have looked harder there. In the south, Tamil Nadu leads in counts followed by Kerala.

Taxonomic Classification

Some amphipods fall under Amphilochidea, others land



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in Colomastigidea, a few belong to Hyperiidea. Each group lives where it thrives best. While Gammaridea spreads across oceans and rivers both, Senticaudata also shows up in saltwater and streams. But Caprellidea - it stays only in the sea. Same goes for Hyperioidea; never

seen far from deep water. Pseudogammaridea is restricted to freshwater alone. Out on slender stems of seaweed, skeleton shrimps stretch thin and it forms the part of Caprellidae, built like twigs that move. Their look surprises most who spot them swaying.



Image Credits - Google Images

Skeleton Shrimps (Caprellidae spp.)

How living things connect through Feeding:

In the cold zones, tiny crustaceans are food for ocean hunters like squid, seals and whales. Moving down south near coral thickets, these small creatures keep reef fish fed beneath warm tides. They bridge gaps where energy flows from one eater to another across sea layers. When ice glimmers on water edges, life depends heavily on their presence below. Their bodies fuel survival for many who cannot live without such meals.

How Animals Eat and Stay Alive

Feeding habits differ widely among these creatures. While some live at the expense of others, certain lysianassid species parasitize onto

foraminifers, brachiopods, even fish. Whale lice - Cyamidae by name - get their meals from huge ocean dwellers such as cetaceans. Down in deeper waters there are many dead matters, so numerous amphipods survive by clearing away fallen organic matter. As they consume debris, nutrients get returned to the environment, quietly supporting balance within underwater communities.

Some amphipods eat plants or algae instead. While eating through these materials, they increase their numbers. That increase in number feeds many different animals looking for a meal. This quiet control helps balance life beneath the surface.

Knowledge Gaps and Future Views

Even though they matter a lot to nature, amphipods don't

get much scientific attention - especially near the equator. Because of this gap, we might be missing how many different kinds actually live there. Found tucked inside coral reefs, tangled in mangrove roots, drifting through seagrass meadows, these creatures support countless others simply by being part of the menu. When their numbers drop, animals depending on them often struggle too.

Conclusion

Most folks overlook them, still amphipods quietly shape nature's rhythm. Because they move energy between food layers while recycling key nutrients, life stays steady in waters far and wide. Even so, we're only starting to grasp how deep their role runs - a quiet push toward learning more about these many-legged creatures lingers.



Spiders Decoded: From fear to fascination

Upasana Bhattacharya

“Will you walk into my parlour? said the Spider to the Fly”- wrote Mary Howitt in a widely read poem of our childhood. That same sinister ‘vibe’ is what most of us associate with spiders, even as adults. From their association with Halloween to fictional portrayals such as “Aragog” (J.K. Rowling’s Harry Potter and the Chamber of Secrets) or “Shelob” (J.R.R. Tolkien’s “The Lord of the Rings”), popular culture has mostly held spiders as ‘poster-arthropods’ of all things spooky and creepy. Research on arachnophobia suggests that the fear associated with spiders largely stems from their unpredictable, stealthy and agile movements and foremost, the very obvious eight legs. As researchers working on these intriguing creatures, we are often faced with the question, “Aren’t you scared/disgusted?” The answer is as simple as it is

fundamental, knowledge dispels fear, and we are no exceptions. The very characteristics of these arachnids that make them scary happen to be the ones that make them fascinating.

Do they bite?

In a classic case of judging a book by its cover, the general perception is that spiders, true to their intimidating form, must deliver a deadly bite loaded with

venom of fatal proportions. But that, in fact, is very rarely the case. Out of the 53000 known species, only a tiny fraction have fangs strong enough to penetrate human skin. A mere 0.4 per cent of all spiders are known to be venomous enough to cause serious harm to humans, with life-threatening bites attributable to only four genera, namely, *Atrax* O. Pickard-Cambridge,

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Out of the 53000 known species, only a tiny fraction have fangs strong enough to penetrate human skin. A mere 0.4 per cent of all spiders are known to be venomous enough to cause serious harm to humans, with life-threatening bites attributable to only four genera, namely, *Atrax* O. Pickard-Cambridge, 1877, *Latrodectus* Walckenaer, 1805, *Loxosceles* Heineken & Lowe, 1832, *Phoneutria* Perty, 1833 (Diaz, 2004; Isbister *et al.*, 2003).

1877, *Latrodectus* Walckenaer, 1805, *Loxosceles* Heineken & Lowe, 1832, *Phoneutria* Perty, 1833 (Diaz, 2004; Isbister *et al.*, 2003). The primary function of venom, in the case of spiders, has been found to be immobilisation of the prey, mostly insects, prepping them for digestion, with the secondary effect of fatality in some cases (Friedel and Nentwig, 1989). Most spiders have venom glands in the prosoma (anterior part of the body), decked out with their own network of musculature and innervation, enabling rapid release of venom. Thus, despite being ace predators at their own level, spiders clearly pose no threat to humans, most of the time, with the after-effects

of bites being limited to a mild allergic reaction at best.

Too many legs!

To those suffering from mild to severe arachnophobia, the scariest thing about spiders is apparently their habit of sudden movements in curvilinear paths (Grill & Haberkamp, 2023). The ability of spiders to move in all three dimensions is backed by complex mechanics engineered for efficient hunting and prey capture. While vertical movements consist mostly of jumping, climbing up vegetation or their own silk, walking constitutes the horizontal. The third kind of movement is the most interesting, in which the spider, almost like a trapeze

artist, casts a line of silk that ‘carries’ it through the air, leveraging the wind (Eberhard, 1987). During the fast and abrupt spurts of movement, each set of legs of a spider moves alternately to the other in perfect sync, so much so that this rhythm can be adjusted even to the loss of one or several legs, never coming in the way of the spider’s agility. Each bout of movement is followed by a change in direction, resulting in the unpredictable trajectories that trigger much of the fear associated with spiders. The bristles on their legs help them minimise the surface of contact with the sticky silk, allowing them to move effortlessly on the very web that traps their prey. Besides the usual terrain, some spiders, such as *Carpurachne aureoflava* Lawrence, 1966, are also adapted to moving on sand by doing consecutive cartwheels (Henschel, 1990), while some others (nursery-web spiders) can even walk on water.

The death stare

Few can deny being taken aback by a close-up frontal view of a spider’s eyes, especially the anterior median eyes, often emulating the feeling of a sniper’s scope focusing in. Unlike the compound eyes of insects, the spider’s main eyes (such as in jumping spiders) can

be compared to telephotographic lens, producing high-resolution images, with highest visual precision at the centre of the retina. While the responsibility of form perception lies primarily with the main eyes, the secondary eyes detect prey movement (Duelli 1978; Komiya *et al.*, 1988). The eyes usually lie in pairs, arranged in two to three rows, and are accordingly named anterior median eyes (AMEs), anterior lateral eyes (ALEs), posterior lateral eyes (PLEs) and posterior median eyes (PMEs). The arrangement of the eight eyes and their relative size is highly significant in the case of spiders, often serving as family identifiers. However, depending on the use-case, there may be a reduction in eye number and/or size (Howarth, 1972), with cave-dwelling spiders such as *Adelocosa anops* Gertsch, 1973, lacking eyes altogether.

The ultimate trap

The menacing reputation of spiders is also rooted to some extent in the concept of luring prey into the web before sucking the life out of it from the inside out. Contrary to common belief, not all spiders make webs or use them for prey capture. However, all spiders produce



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silk from specialised structures called spinnerets throughout their lifespan, a feature that contributed to the evolutionary demarcation of spiders from other closely related species. Other than building webs, spiders use silk for wrapping prey and making egg sacs. Spider silk is proteinaceous in nature and possesses tenacity close to that of nylon, while being twice as elastic (Lucas, 1964), with tensile strength higher than most natural materials (Foelix, 2011). These extraordinary properties of spider silk have facilitated applications in traditional medicine, as wound dressing, with prospects in biomedicine, including peripheral nerve and cartilage regeneration (Allmeling *et al.*, 2008; Gellnyck *et al.*, 2003). Spider silk actually outperforms many of the synthetic fibres

we currently use in ballistic protection.

The journey from terrifying to interesting

In the path to overcoming the fear psychosis associated with spiders, busting the common misconceptions surrounding them may be considered baby steps. Through the spread of awareness and knowledge about these creatures, we hope to help them secure their rightful place in citizen science, true to their roles in agriculture and ecosystem monitoring, while making a positive impression on young minds, encouraging future research and conservation. For, in the mysterious world of Araneae, countless marvels linger unseen, waiting to be revealed.



Frontal view, jumping spider



Huntsman spider



Phoretic Mites as a Forensic Tool

Samarpita Gayen

Introduction: Tiny witnesses to a crime scene!

The phenomenon of phoresy is an interesting evolutionary aspect where small organisms piggyback on larger ones in order to leave an unfavourable habitat and get to a resource-rich environment. The majority of arthropods that are discovered on corpses and carcasses are probably phoretic mites. They are more numerous and more diverse than their scavenger carriers. Numerous phoretic mites are highly specialized; they only land on one type of host, no other, and they travel on scavenging insects. They might therefore be helpful as traces of their carriers even in the event that their carriers are not present.

Mites as Timekeepers

Phoretic mites are useful chronometers, i.e., trackers

of the passage of time. They are typically discovered in a transitional transport or dispersal stage, where they frequently moult and become adults soon after landing on a carcass. Many have faster generation cycles and rates of development than their carriers. Many phoretic mite species are

of Mesostigmata, which include phoretic mite species from the Parasitidae and Macrochelidae families. While some of these mesostigmatids are linked to tiny mammals that enter during the early phases of decomposition, the majority are connected to certain kinds of flies or carrion beetles.



ImageSource: A dung beetle so covered in phoretic mites https://www.jungledragon.com/image/114543/chock_full_omites.html

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Phoretic Mites as a Forensic Tool

Astigmata members are more common during dry decay with many species that are phoretic on scavengers, and most of these travel on late-arriving scavengers such as moths, hide beetles, and skin beetles. A dead

body can be visited by multiple species of carrion beetles at once, and each species may carry one to ten different species of phoretic mites. At any given time, a decomposing carcass may contain an instructive

diversity of phoretic mites. The make-up of the phoretic mite assemblage on a carcass may reveal important details regarding the circumstances surrounding and duration of the death.



ImageSource: https://commons.wikimedia.org/wiki/File:Osmia_bee_with_phoretic_mites_01.jpg

Travel Diaries

The relationship between the phoront and the carrier usually ends when the phoront detaches, and the carrier settles in a new habitat on a new carcass. Phoresy, from an evolutionary perspective, can be understood as a transitional or temporal stage in a species'

life history, marking the change from a potentially advantageous to a parasitic relationship between the phoront and its host. According to several studies (Farish and Axtell 1971; Houck and OConnor 1991; Athens-Binche and Morand 1993; Siepel 1994; Sivinski et al. 1999), this mechanism is a

rather fixed life history feature in the majority of Acari.

Phoretic mite-carrying flies may be the first invertebrate scavengers to settle on a dead body. Soon after arriving, the flies lay eggs, and the young hatch, going through the entire life cycle on, within, and outside the body. The mites separate

from the flies that carry them and consume the fly eggs and other microorganisms or microarthropods that are on the decomposing body.

The mites can provide important information about when the carcass was colonised since they reproduce far more quickly than the flies that carry them. Even when the carrier is no longer present, the presence of a particular phoront on carrion can be verified at some point in time.

Mites have evolved special behaviours that rely on the movement and distribution of larger scavenger animals by exploiting them as carriers to quickly colonise transient sites like carcasses (Siepel 1994). Phoresy, aerial migration, and wind dispersal are the main factors influencing long-distance dispersal of phoretic mites (Mitchell 1970; Hawes et al. 2007; Szymkowiak et al. 2007). According to Athias-Binche (1994), mites have undergone remarkable phoretic modifications in both morphology and tactics.

Carrion: An excellent ecosystem

Humans and dead animals make excellent instances of transitory environments. Founder phoronts are the initial

source of the majority of acarine fauna found on or in carcasses (Méglin 1894; Goff 1991). Phoretic mites can be carried by any animal scavenger that comes into contact with dead bodies, including humans and the mites themselves. One or more species of phoretic mites are present on the bodies of almost all arthropods (Colloff and Hopkin 1986; Pugh et al. 1997; Błoszyk et al. 2006).

Antonio Berlese navigated among the microfauna of deterioration almost a century ago. His research served as the foundation for the thorough identification of the coprophilous and necrophilous mite fauna. The bulk of the worldwide species of ephemeral habitats in the order Mesostigmata were described by Berlese, with particular attention to the Macrochelidae family, which inhabits animal decomposition and excrement, such as carcasses and corpses.

Scavenger succession on carrion indicates the succession of phoretic mites

The initial mites will be brought to a carcass by the first insects that arrive, whether they are just passing through or intend to stay and start a new colony. Forensic entomologists connect the stages of decomposition

with the dominating or prevalent insect fauna, whereas forensic investigators characterise a corpse's condition based on its stage of decomposition. According to Goff's description (2009), there are five recognised stages of decomposition for both visible and concealed carcasses. Jean Pierre Méglin was likely the first to use insect fauna to discuss the stages of decomposition. His 15 years of experience working in a Paris morgue gave him the knowledge to identify eight distinct "waves" of arthropods, including mites that are found in human corpses that have been examined at various stages of decomposition.

The presence of phoretic mites, which are carried by the initial colonists, typically flies, can account for the mite incidence during the first wave. Regretfully, Méglin did not provide information on the variety of the acarine fauna at this point. Macrochelid mites account for the bulk of mites discovered on corpses and carcasses that are carried by flies.

Since most of these mites prefer to hide in shadows away from the sun, it might be difficult to find them in natural or artificial light. There, they both breed and feed on the immature instars

of flies and other microfauna. As Perotti (2001) notes, some even make their home beneath the substrate where their victim is hidden.

In the phoretic succession, the later stages appear to include the bulk of mites. Méglin wrote of a whole wave, the sixth, that was made up entirely of mites. In this instance, he recognized mites from two orders and five families; nevertheless, several of his identifications are currently under dispute (Braig and Perotti 2009). This sixth wave's most notable characteristic is probably how closely it follows two waves of insects that are known to carry the majority of the mites in Méglin list. While the mite list is extensive, Me'gnin's first observations lack one significant group: the Parasitidae (Mesostigmata) mites that feed on carrion beetles, primarily Silphidae and Staphylinidae species.

Phoretic mites are predicted to come in close succession with each new wave of insects that arrive at the carcass, beginning with the Macrocheles brought by the early scavenger flies during the first wave, based on the combined records of mites and carriers. Along with (many) other macrochelid mites that are phoretic on beetles, these mites are followed by species of

Parasitus and/or Poecilochirus (Parasitidae) that arrive on carrion beetles.

The process of disintegration ends much later, during a dry stage, with the appearance of numerous astigmatids and a few distinct mesostigmatids. At this stage of decomposition, astigmata are the most significant in terms of species richness, with 19 species being carried on skin, carcase, and hide beetles, as well as moths.

Phoretic mites are directly dependent on carrier scavengers that visit or arrive on a carcass. Scavengers differ based on local and regional variety as well as environmental factors. Phoretic mites predominate, according to a thorough literature analysis that covers more than a century's worth of data on the forensic fauna of animal and human decomposition (Braig and Perotti 2009).

Carrion as hosts of wandering ticks

Ticks are blood-sucking parasites that, should their host die, will instantly transform into wandering insects by waving their first set of legs, which contain sense receptors (Haller's organ). Other bloodsucking arthropods have also been shown to exhibit wandering behaviour. Nuttall (1917) collected several

fascinating cases of head lice that were seen all over a dead body; the insects, both nymphs and adults, gathered around the mouth corners, nose, and eyes.

In certain circumstances, people are so neglected that they are on the verge of death, and *Pediculus capitis* swarms from the scalp over the face and body. Large numbers of body lice have been observed crawling around a body for a few days on the sheets and blankets of patients who have died or have a fever (Nuttall 1917). Any wildlife inspector or officer is fully aware of the dangers posed by dead animals or carcasses. Tick infestation is most likely to happen if ticks are roving on and around a carcass.

Ticks can wait to leap on scavengers and investigators visiting an outside corpse, or they can utilise it as a jumping-off point. The corpse serves as the ticks' mode of transportation rather than being phoretic dispersal, or their transitory host (McNemee et al. 2003; Carroll 2002; Szabo' et al. 2007).

Can acarofauna be a unique identification?

Humans are carriers of predatory mites belonging to the family Cheyletidae (Prostigmata) as well as skin mites from the families Pyroglyphidae and

Glycyphagidae (Astigmata). Although follicular mites are necessary symbionts of human epidermis, humans also harbour mites in their follicles (Desch 2009). The skin flakes we shed are a source of food for Pyroglyphidae and Glycyphagidae skin mites, whereas Cheyletidae feed on these mites. They proliferate in our upholstered furniture and clothes without our knowledge (Colloff 1988; Arlian 1989; Arlian et al. 2003). Due to this phenomenon, humans are now the primary dispersers of a few increasingly cosmopolitan species. Despite not being phoretic mites, Pyroglyphidae and Glycyphagidae mimic human phoresy by their mode of dispersion to new human habitats.

Dust mites are among several types of dust, fibres, and detritus that clothing gathers. Skin mites are present in used clothing in such large quantities that unique techniques are constantly being developed to remove them from clothing that people wear or come into contact with because some people have developed allergies to them (Miller and Miller

1996; Bischoff et al. 1998; Arlian et al. 2003; Cieslak et al. 2007). Because they are so common, mites are starting to play a significant role as trace components in forensic investigations.

A suspect may leave behind earth mites clinging to shoes, socks, and the lower regions of trousers in addition to their own skin mites. Perotti and Braig (2009) provide a review of the applicability and value of human mites in forensic investigations. Research is being conducted on the population genetics of human skin mites with the aim of creating practical instruments to characterise the personal acarofauna and track its movement or dispersal between human individuals and their surroundings.

Long Way Ahead

The diverse data regarding phoretic mite prevalence on insects of forensic significance, or those connected to large animal or human carcasses, have been compiled to shed light on the wide variety of phoretic mites related to decomposition, talking about the kinds of mites that can be retrieved from

arthropods and small mammals that scavenge, as well as the kinds that can be anticipated to appear on decomposing substrates as phoronts. We can only be as knowledgeable about phoretic mites as we are about forensically significant carriers, particularly insects. Regrettably, contrary to popular belief, the diversity of arthropods that frequently visit carcasses is inversely correlated with the size of the carcass.

Most of the studies undertaken were largely concentrated in USA, Canada, Spain and Austria. In the Indian context, forensic studies of phoretic mites seems to be largely falling behind. This is likely due to lack of outlook, resources, logistics and, for lack of a better word, inclination. India is a densely populated tropical country where studies on phoretic mites and ticks, in the context of carrion, are possible, in theory. However, such studies are yet to become mainstream in the scientific research arena of India.



Insects in Hindu Mythology

Jhikmik Dasgupta

Have you ever wondered about the significance of the tiny six-legged creatures in the epics like the Ramayana and Mahabharata? You will be surprised to know that these minute creatures had already made their way into the oldest religious scriptures and folklores of the world. These have been lying dormant inside the ancient tales and rugged scriptures for decades.

Most of the Hindu deities have got a “vahana” or an animal entity to support them in many ways. While we all know about the big animals like lion, tiger and elephants for their association with various gods and goddesses, the relevance of insects in Hindu mythology is insufficiently explored. Henceforth, an attempt has been made to compile the ancient stories related to insects and their role in influencing various mythological events.

Bhramari Devi

Some of the popular mythological stories in Hindu mythology revolves around the “bees”- the tiny creatures with powerful sting! One such deity is “Bhramari Devi” of Mallikarjuna temple in Andhra Pradesh. The story revolves around a demon or “asura” named Arunasura who wanted immortality by repeatedly asking the gods for protection from all creatures



Fig. 1: Bhramari Devi temple in Maharashtra (Photo obtained from <https://www.discovermh.com/devibhramari/>)

Most of the Hindu deities have got a “vahana” or an animal entity to support them in many ways. While we all know about the big animals like lion, tiger and elephants for their association with various gods and goddesses, the relevance of insects in Hindu mythology is insufficiently explored.

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having no legs to four legs as a boon which meant protection from all big animals like fish, reptiles, birds or mammals which could kill him. Troubled by his constant threat, the gods prayed to Goddess Adi Parashakti, also known as Durga to incarnate “Bhramari Devi” to emanate six-legged insects (bees) from her body that could surpass the boon. The bees attacked the asura and eventually killed him. Thus, the story depicts how gods can outsmart the demons by creating creatures like the insects to defeat the evil forces. This brought the insect world into limelight. The story of Bhramari Devi, an incarnation of Goddess Adi Para Shakti is mentioned in the Devi Bhagavata Purana as a powerful force believed to protect against diseases and natural calamities. She is worshipped in many forests and villages and is offered honey as a symbol of sweetness of life. Bhramari Devi Temple (Trisrota) in Bodaganj in

The story of Bhramari Devi, an incarnation of Goddess Adi Para Shakti is mentioned in the Devi Bhagavata Purana as a powerful force believed to protect against diseases and natural calamities.

Jalpaiguri district of West Bengal is one of the 51 Shaktipeethas. Even in Yoga, there is pranayama named Bhramari which is a type of breathing through nose and making a humming sound like the bees.

The bees are also mentioned in the famous Bhavar Geet of Krishna lore. It is said that Krishna used to come and visit Radha in the form of a bee. However, since the bee moves from one flower to next flower, Radha used to complain that unlike Krishna, her role is like

the static flower stuck on a branch from where it cannot move like the bee does. This became a theme for Baramasi songs of the Gangetic plains depicting women longing for their vagabond lovers.

Kamadeva

In Hindu mythology the honeybee holds much prominence as it is



Fig. 2.: Kamadeva (Photo taken from <https://melissabeenaturalmagic.com/2016/02/13/holy-desire/>)

In Hindu mythology the honeybee holds much prominence as it is connected with Kamadeva, the god of love.

These ants are also associated with Lord Ganesha, Lord Shiva and Lord Vishnu. These are believed to be messenger insects of Lord Ganesha.

connected with Kamadeva, the god of love. It is believed that his bow is made of sugarcane and its string is made of bees. Since the honeybee visits flowers and produces honey, the bees have become the symbol of romantic love.

Black ants in the Erumbeeswarar Temple

Unlike other ants, the small black ants are considered as harmless as they do not bite others like their red counterparts. In Hindu mythology, black ants are considered auspicious and their occurrence symbolizes presence of Goddess Lakshmi bringing prosperity, increase in wealth and end of all sufferings. These ants are also associated with Lord Ganesha, Lord Shiva and Lord Vishnu. These are believed to be messenger insects of Lord Ganesha. In many places in India, especially in rural Odisha, there was a tradition where

people often prepared modakas at home and offer those to the black ants in their houses if they gather in large numbers.



Fig. 3.: Painting depicting black ants in the Erumbeeswarar Temple (Photo obtained from <https://x.com/KalaForTemples/status/1787712711700144212>)

Shri Paramacharya of Kancheepuram, black ants are the divine insects which never causes harm to humans.

As per the Erumbeeswarar Temple Legend, there was a demon named Tarakasura, who was attacking the gods or devas. Oppressed by the asura, Lord Indra and all the devas in order to prevent detection, took the form of ants. These ant-mimicking devas carried sticky lilies as offerings to Lord Shiva but were unable to climb. Lord Shiva appeared in the form of ant hill-shaped lingam and bent towards the side to accept worship from his devotees. The Erumbeeswarar temple is only few kilometres away from Trichy in Tamil Nadu. It is believed that the black ants present in the temple are the devas worshipping Lord Shiva in their mortal form. Hence, the devotees who visit the temple offer sugar and grains to the black ants. It is believed that these ants travel back to heaven in their original form after some time. Hence, it is believed that killing any black ant is a sin.

Before becoming a sage, Valmiki was a notorious robber named “Ratnakar” with his ancestry tracing back to the family of Bhrigu Rishi.

It is also believed that if black ants march in your house, it is a symbol of prosperity coming your way.

Shri Paramacharya of Kancheepuram, black ants are the divine insects which never causes harm to humans. If you find these accumulating in your house, it is better to feed them with some sugar and blessings will come your way from the heaven. He also said that even if we cannot offer food to thousands of guests, if we can at least offer a small quantity of sugar to these ants, it would be equivalent to food offering to thousands of guests.

Termite mound and the Valmiki legend

Ever wondered why soil from the termite mound is believed to be auspicious? Stories related to termite mounds can date back to as early as the times of Rishi Valmiki who was



Fig. 4.: Idol of Sage Valmiki at Dwaraka Tirumala, Andhra Pradesh (Photo obtained from www.wikipedia.com)

rescued from his sins by the termites. Before becoming a sage, Valmiki was a notorious robber named “Ratnakar” with his ancestry tracing back to the family of Bhrigu Rishi. As per Adhyatma Ramayana, he got lost in a forest when he was a child and was separated from his parents. Later a childless robber couple adopted him and introduced him to the world of crime and robbery. Ratnakar married a shudra woman and also had children with her. One day in a forest, he came across a gathering of seven sages or “munis” (Saptarshi). When he tried to rob them of their clothes, the munis warned him about his sins. Initially he was not ready to acknowledge their saying and kept justifying that he was doing such crime to support his family. However, the hermits explained to him that his justification

In some folklores, Goddess Renuka has been named “Bhoomija” and “Valmiki devi”, meaning born out of earth. Many temples in South India like Karumariamman of Chennai, Vettuvanam Ellaiamman, Padaivtri amman, etc. had evolved from termite mounds.

cannot nullify his sins. They challenged him to go to his family and find whether any of his family members were willing to share his sins and report to them about the feedback. Once Ratnakar went to his family, he was shocked to find that none of his family members whom he was supporting were willing to share the burden of his sins. It was an eye-opener moment for him and he finally realized that the words of the munis held value. He fell at the feet of the munis pleading their forgiveness and to suggest ways to wash out his sins. The munis then told Ratnakar about the “Ram mantra”. However, Ratnakar could pronounce it as “Mara” thereby changing the order of the letters. While meditating for so long, the termites nested on his body and had built a huge mound on it. When the munis found about it, they came and rescued him. He was blessed by the munis and given the name “Valmiki” originating from the Sanskrit word “Valmika” meaning “anthill”. He was finally washed out of his sins. This incident turned him to a great sage and poet- “Rishi Valmiki”. Later he wrote the entire Ramayana which became the sacred religious script of Hinduism.

In some folklores, Goddess Renuka has been named “Bhoomija” and “Valmiki devi”, meaning ‘born out of earth’. Many temples in South India like Karumariamman of Chennai, Vettuvanam Ellaiamman, Padaivtri amman, etc. had evolved from termite mounds. Termite mounds are considered as a symbol of fertility. In some places, it is even treated as the womb of Mother Earth and a gateway to “Nagaloka” or “Land of Snakes” as snakes often reside inside termite mounds. During Navaratri or any auspicious events, soil from termite mounds are collected and seedlings are sown for germination thereby symbolizing fertility and birth of progeny.

The lac insect and story of Lakshagriha

In the Mahabharata, the story of Lakshagriha is an interesting one! The Kauravas were trying to kill their cousins- the Pandavas in different ways to gain control of the kingdom of Hastinapur. Influenced by his son Duryadhana, King Dhritarashtra, suggested the Pandavas to visit Varanavart city where a palace has been made for their staying. On the other hand, Duryadhana had instructed the architect Purochana to build the palace out of lacquer- a resin extracted from the lac insect (Order



Fig. 5.: The Pandavas escape from the Lakshagriha (Painting by Mughal artist Razmanama, obtained from www.wikipedia.com)

Hemiptera) which is highly inflammable. His plan was to set the palace aflame to kill the Pandavas. However, Vidur had informed the Pandavas about Duryadhana’s plan and they escaped through an underground tunnel leading to the banks of the Ganga by taking help of a miner who had carved the way out. Later the palace was set aflame as planned by Duryadhana but the Pandavas had already escaped.

According to the principles of Hinduism, god resides in the souls of all living creatures of the world and unnecessary killing of insects as well as other animals have always been looked down upon and believed to have karmic consequences. Thus insects, like every other creature in mythology, have been a metaphor to convey the message of kindness towards all living creatures on earth.



The Silent Puppeteers: Inside the Hidden World of Microgastrinae Wasps

Jayita Sengupta

Imagine about a slow lazy sunny afternoon, in the quite corner of the garden, you can suddenly see a caterpillar is munching away at the green leaf quiet and unmoving. What you cannot see is that beyond this an invisible play is unfolding. An actress, unseen, inaudible, and almost impossible to detect, is at work! Here we are talking about a wasp! Just a few millimetres long but she is strong enough to make the caterpillar fear. Welcome to the realm of the Microgastrinae. A subfamily of parasitic wasps. Frustratingly small to notice, yet the potent wasps are so powerful, that their very presence determines an entire ecosystem. In usual sense, they are not just predators, they are something more meticulous, more disconcerting. They are the life and death puppeteers. Surprisingly the female Microgastrinae wasp doesn't chase its prey. Instead, she

finds it! During the time, when any plants are getting attacked by a caterpillar because of their voracious feeding habit, they used to release a chemical in the surrounding atmosphere. This released chemicals are potentially being used by the tiny hunters. This chemical is being used by this tiny wasps. This tiny intelligent creature used them as their personal GPS to reach the specific location where the

caterpillar lives. Within a micro second, she has completed her task. By her aids and swiftness, she cautiously deposits eggs into the body of the caterpillar. Subsequently, she leaves the site silently leaving behind the next generation to grow inside the infected caterpillar. Surprisingly there is no blood, no struggle, and no fight from caterpillar's end for self-defence—rather it is just a simple flinch to an

Welcome to the realm of the Microgastrinae. A subfamily of parasitic wasps. Frustratingly small to notice, yet the potent wasps are so powerful, that their very presence determines an entire ecosystem. In usual sense, they are not just predators, they are something more meticulous, more disconcerting.

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ignored invasion. Within the body of the caterpillar, the real saga unfolds. The new wasps emerged from the laid eggs and start eating—but carefully and silently.

The young ones are also very careful like their mother. They use their practical skills to obtain resources only up to their requirement and not disturbing the central nervous system or other essential body parts of the infected caterpillar. By doing so they successfully keep their host alive until host body is needed for their own survival. On the other hand, poor caterpillar continues eating, growing routinely—unaware to the fact that its body has turned into a nursery for someone else's baby. Though, once this

Microgastrinae are virtually impossible for the human eye to see. But if you observe more closely and with more attention, you'll come to know about an empire where this precise, sly tiny wasps rule. Surprisingly neither they do rumble, nor do they sting.

wasps are ready to emerge, the calm nature of them suddenly evaporates. They break through the host body, coming out into the fresh air. All around the dying body, they create beautiful little cocoons—little white cocoons that attach themselves

Life inside Life: In the caterpillar's body, the real tale unfolds. The wasp larvae emerge and start eating; yet they do so cautiously. They are calculating. They feast selectively on what they require without attacking any vital parts and keeping the host alive. The caterpillar goes about eating, growing, and functioning as usual without realizing that its own body is now a breeding ground. It is no longer simply a caterpillar. It is a living crèche!!!

to the body as silent spectators of the process that took place just a moment ago. In one last incredible act, the caterpillar will even live on as the protector of the cocoons it has turned itself into. Despite their bizarre life cycle, Microgastrinae are one of nature's most useful creations. There are many pests whose populations they help control, specifically, caterpillars that would otherwise destroy namely the rice fields, different type of vegetable crop fields and also the forest flora. Because of their existence farmers should rely least on chemical pesticides and can grow the crops naturally and efficiently. Unfortunately due to lack of awareness, this tiny group's effort went unnoticed most of the time by the farmers. Interestingly this tiny wasps do not merely kill

but specialize. Each one is specialized for a specific host. And each one forms an intricate part of the larger ecological web of communication involving chemical signalling between plants, insects, and parasitoids. In bio-diverse zones such as India, particularly the forest and agro-ecological zones, there are numerous species of Microgastrinae that still wait to be discovered. Microgastrinae are virtually impossible for the human eye to see. But if you observe more closely and with more attention, you'll come to know about an empire where this precise, sly tiny wasps rule. Surprisingly neither they do rumble, nor do they sting. This tiny insects do not claim attention in any way. However, they shows us perhaps one of the most spectacular of survival stories. Far away from human's knowledge, this little Microgastrinae are working perhaps in every corner of this natural vegetation, For every

leaf, for every meadow, for every little niche in the natural world, crafting stability, regulating ecosystem, and altering the fate of their hosts. This tiny creatures teach us a very important lesson of life, an ultimate truth: Nature is always more powerful than we human can imagine and the stoutest forces of nature are those which are unnoticed. In this unknown auditorium of life, Microgastrinae are both the scriptwriters and the fine actor—quiet, precise and remarkable.



Microplitis manilae Ashmead, 1904 (Hymenoptera: Braconidae)



Tiny Pollinators: Diversity of Bees in Pollination

Dipanwita Das

Bees are the most significant crop pollinators among all the insect species That are associated with pollination. They help transfer pollen from the anther to the stigma of the flower, resulting in fertilization and fruit production. Their bodies are covered with hairs and meta-thoracic pair of legs having pollen basket to carry pollen. Young bees are nurtured and fed with the mixture of pollen and honey by the adults, whereas adults are completely dependent upon flowering plants for their food and help in pollination. Honey bees pollinate a wide variety of crops, horticultural plants, forest trees, shrubs, and weeds, thereby contributing significantly to the conservation of plant biodiversity. Nearly 75% of cultivated flowering plants depend on cross-pollination, and even self-pollinated crops benefit from it. Bee pollination enhances crop yield and quality,

contributing substantially to agricultural productivity and national income. In many countries, the economic value of pollination services is estimated to be 20–25 times greater than that of honey and beeswax production.

Diversity of Pollinating Bees

Bees belong to the order Hymenoptera, which has more

than 20,000 described species worldwide. Apidae is the most diverse and widespread group of bees. It consists of carpenter bees, bumblebees, and honeybees, and is the largest and most extensively distributed family of bees. Megachilidae (leafcutter bees), Halictidae (sweat bees), Colletidae, and Andrenidae are other well-known families of pollinating bees.

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Pollination by Major Bee Groups

Honey Bees (*Apis* sp.):

***Apis mellifera*:** *Apis mellifera*, also known as the western honey bee, is one of the most significant and common in crop pollination. *Apis mellifera* is a generalist pollinator and pollinates a range of crops like oilseeds, fruits, vegetables, and nuts. *Apis mellifera* is an essential pollinator for crops like sunflower, mustard, apple, almond, and cucurbits, leading to better fruit setting and seed formation.

***Apis cerana*:** *Apis cerana* is commonly referred to as the Indian honey bee or Asian honey bee. *Apis cerana* supports both natural ecosystems and traditional agricultural systems. It is an important pollinator of many crops, such as mustard, sunflower, citrus, litchi, apple, and different varieties of

vegetable crops. *A. cerana* is usually managed in wooden hives or log hives for honey production and pollination services.

***Apis florea*:** *Apis florea*, also called the Dwarf honey bee. Worker bees of *A. florea* actively forage for nectar and pollen while visiting flowers. *Apis florea* is reported to visit a variety of crops such as mustard, sesame, cucurbits, and various fruit plants, thereby increasing the fruit and seed set. This bee is also very significant in pollinating many important wild plant species, which promotes biodiversity and the stability of ecosystems. The ability of *Apis florea* to adapt to semi-arid and arid environments makes it very useful for such environments.

***Apis dorsata*:** *Apis dorsata*, commonly known as the Rock Bee or Giant Honey Bee, is one of the most important

wild pollinators that plays an important role in the pollination of forests as well as agricultural systems. *A. dorsata* is characterized by its high colony size, consisting of thousands of worker bees at one point in time. Therefore, there is extensive pollination, especially during the flowering season. It has been seen visiting different plants, including mustard, sunflower, coconut, mango, litchi, and forest trees.

***Apis laboriosa*:** *Apis laboriosa* (Himalayan giant honeybee) is mostly found in the high-altitude areas of the Himalayas. This species plays a crucial role in pollination within mountain ecosystems, where environmental conditions are often extreme, and pollinator diversity is relatively low. Worker bees of *A. laboriosa* forage on different varieties of flowers from alpine and subalpine vegetation. *Apis laboriosa* is reported to visit a variety of flowering plants such as rhododendrons, buckwheat, wild fruit trees, and other alpine vegetation.

Stingless Bees: Stingless bees, which belong to the tribe Meliponini, are highly efficient and social pollinators found in tropical and subtropical areas. They are generalist foragers and visit many types of flowering plants, including

fruits, vegetables, oilseeds, and ornamental crops. Crops like mango, guava, coconut, coffee, cardamom, and various cucurbits benefit from their pollination, leading to better fruit set, seed quality, and yield.

Bumble Bees: Bumble bees belong to the tribe Bombini, also called buzz pollinators. They are effective pollinators of strawberries, tomatoes, brinjal, and cucurbits. Bumble bees (*Bombus* sp.) are some of the most efficient and specialized pollinators, especially in temperate and high-altitude areas. They can perform buzz pollination, which makes them highly effective for crops like tomatoes, brinjal (eggplant), capsicum, and certain berries.

Leafcutter Bees: Leaf cutter bees are solitary bees that belong to the family Megachilidae. They serve as important pollinators and play a significant role in both natural ecosystems and agricultural production. These bees are known for their high pollination efficiency, which is enhanced by their foraging behaviour and physical characteristics that facilitate greater interaction with the reproductive parts of flowers. They are very important in the pollination of legumes like alfalfa, as well as wide range of fruits and vegetables.

Sweat Bees: Sweat bees are solitary bees that belong to the family Halictidae. They found in various regions, including tropical, subtropical and temperate areas. These bees are generalist foragers, visiting a wide range of flowering plants. They play a significant role in pollinating crops such as mustard, sunflower, carrot, onion, and several types of cucurbits. Although they carry smaller amounts of pollen compared to other bees, their frequent and quick visits to flowers make them effective pollinators at the population level.

Carpenter Bees: Carpenter bees belong to the subfamily Xylocopinae, a diverse bee group that actively forages on a variety of crop plants, including many temperate fruits and oilseed crops such as niger, safflower, mustard, linseed, apple, raspberry, cranberry, cosmos, sunflower, red gram, tomato, winged bean, mustard, and alfalfa. These bees are capable of buzz pollination, which makes them especially effective pollinators of crops like tomato, brinjal, and other solanaceous plants. Carpenter bees are generalist foragers, visiting a wide range of crops and

Pollinating bees play a crucial role in many ecosystems as keystone species. They help plants to reproduce to keep genetic variety and ensure the stability of the ecosystem. Forest regeneration, crop productivity, and the survival of many plant and animal species depend on these bees. In traditional environments like sacred groves and community forests, bees can flourish due to the availability of diverse flowering plants and less human interference. These habitats serve as safe places that support not only bee populations but also overall biodiversity.

wild plants, including passion fruit, sunflower, cucurbits, and legumes.

Digger Bees: Digger bees are solitary bees that belong to the tribe Anthophorini, that play an important role in pollinating both wild plants and agricultural crops. They are mainly distributed in temperate and semi-arid regions. Digger bees are important pollinators of early-flowering plants, including apple, pear, and plum, as well as oilseed crops like mustard. Their regular visits to flowers and efficient ability to carry pollen help increase the number of fruits, seeds and overall crop production.

Ecological Importance

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to the availability of diverse flowering plants and less human interference. These habitats serve as safe places that support not only bee populations but also overall biodiversity.

In conclusion, although bees are tiny, their role in pollination is extremely significant. Various types of bees, including honey bees such as *Apis mellifera* and solitary bees like *Megachile* and *Xylocopa*, pollinate a wide range of plant species by transferring pollen between flowers. This variety in pollinators enhances the effectiveness of pollination and helps numerous crops and plant species. Bees play a crucial role in the production of many fruits, vegetables, and seeds,

and they also help sustain the natural balance of ecosystems. Despite their importance, bee populations are declining due to habitat destruction, pesticide application, climate change, and diseases. This decline poses a significant threat to both agricultural productivity and biodiversity. Therefore, it is essential to take measures to protect bees and their habitats. Simple actions, such as reducing pesticide usage, planting a variety of flowering plants, and preserving natural habitats, can support bee populations. Protecting bees means protecting our food sources and the overall environment.

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The World Within the Web: Unveiling the Interactions of Baeini (Scelionidae: Hymenoptera) and Spider Egg Sacs

Sushama V.

Most of us have had that instinctive reaction—“Awww!” quickly turning into alarm—the moment a spider unexpectedly falls on our hand or crawls across our body. Are they truly the ones to fear, or do they themselves live in fear? Spiders are one among the top-level insect predators found in the natural ecosystems. Their common enemies include wasps, lizards, birds and so on. These are the enemies that spiders can see and escape from. But, there are some enemies exists which are hidden from sight and regulate the spider population. They primarily include spider egg parasitoids and egg sac predators or pseudoparasitoids. The former ones are the tiny group of insects that evade the silken spider egg sacs and lay their eggs inside the spider eggs, and their developing larvae feed on the egg contents as a source of nourishment thus killing the

developing spider embryo and emerges out as adult insects. While the later ones require multiple spider eggs in the egg sac for their development. These intrinsic interactions are common phenomenon in the world of parasitosis, yet they remain largely unnoticed by us.

Spiders spin multilayered silken egg sacs to protect their

eggs and offspring. These egg sacs provide a favourable microenvironment for both the eggs and the developing spiderlings, while also protecting them from mechanical damage, even when dislodged from treetops. In addition, maternal guarding behaviour offers further protection to the juveniles against attacks from natural enemies. The

Members of Baeini are very small in body size, typically ranging from 1–2 mm in length, with some species reported to be as small as 0.5 mm. Due to their minute size, the guarding female spider is often unable to effectively defend against these parasitoids, allowing them to successfully evade the silken nest.

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major insect families which are reported to attack the spider egg sacs includes Scelionidae, Encyrtidae, Eulophidae, Eupelmidae, Eurytomidae, Ichneumonidae, Pteromalidae, Pompilidae (Hymenoptera), Chloropidae, Phoridae, Drosophilidae, Ephydriidae, Sarcophagidae (Diptera), Cosmopterigidae, Stathmopodidae (Lepidoptera), Chrysopidae, Hemerobiidae, Mantispidae (Neuroptera). Among Scelionidae, the tribe *Baeini* (Scelionidae: Hymenoptera) plays a significant role. They are the only scelionids that use spider eggs as an exclusive food source for their developing young ones, except in a single case in which *Idris elba* Talamas (Scelionidae: Hymenoptera) emerged from the eggs of a bug *Bagrada hilaris* (Hemiptera: Pentatomidae). There are 11 valid genera of Baeini reported globally including *Baeus* Haliday, 1833, *Idris* Förster, 1856, *Ceratobaeus* Ashmead, 1893, *Odontacolus* Kieffer, 1910, *Aneurobaeus* Kieffer, 1912, *Mirobaeoides* Dodd, 1914, *Mirobaeus* Dodd, 1914, *Apobaes* Masner, 1964, *Hickmanella* Austin, 1981, *Neobaes* Austin, 1988 and *Neoceratobaeus* Rajmohana, 2014. Among these, the five genera, *Idris*, *Baeus*, *Ceratobaeus*, *Odontacolus* and

Neoceratobaeus are reported from India. Among these *Neoceratobaeus* is the only genus reported exclusively from India with two species *N. gibbus* Rajmohana, 2014 and *N. dwitius* Sunita & Rajmohana, 2019. There are approximately 500 species of Baeini reported globally, while only one fifth of these are found in India.

Members of Baeini are very small in body size, typically ranging from 1–2 mm in length, with some species reported to be as small as 0.5 mm. Due to their minute size, the guarding female spider is often unable to effectively defend against these parasitoids, allowing them to successfully evade the silken nest. The key identification characters of Baeini include a female antenna comprised of four compact clavomeres that are usually completely fused to each other; the antennal scape not reaching above the level

of the anterior ocellus; and tridentate mandibles with a convex outer surface. Along with these morphological features, oviposition behaviour also helps them attack spider egg sacs.

All the Baeini parasitoids are egg parasitoids in which they attack and continue their growth inside the egg stage of their host. Their mode of development includes both solitary and gregarious life strategies. Solitary parasitoid in which only one offspring develops on or within a single host while gregariousness occurs when more than one offspring completes their development on or within a host without siblicide. Among Baeini wasps, *Idris* shows both solitary and gregarious mode of development, in which up to ten individuals have been observed emerging from a single host egg. The common host of these parasitoid include a wide range of spider families, including

Among Baeini wasps, *Idris* shows both solitary and gregarious mode of development, in which up to ten individuals have been observed emerging from a single host egg.

jumping spiders, orb-weavers, wolf spiders, crab spiders etc. This shows how widespread and adaptable they are in different ecosystems.

The knowledge of these interactions can help in unwinding the hidden layer of ecological complexity—where even skilled predators like spiders are part of a larger web of interactions. It reminds us that even the smallest organisms can have a profound impact—showing that size alone does not define importance in nature. As E. O. Wilson aptly said, these are “the little things that run the world.”

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Fig. 1: Parasitoid *Odontacolus* sp. sitting above the host spider *Neoscona* sp.

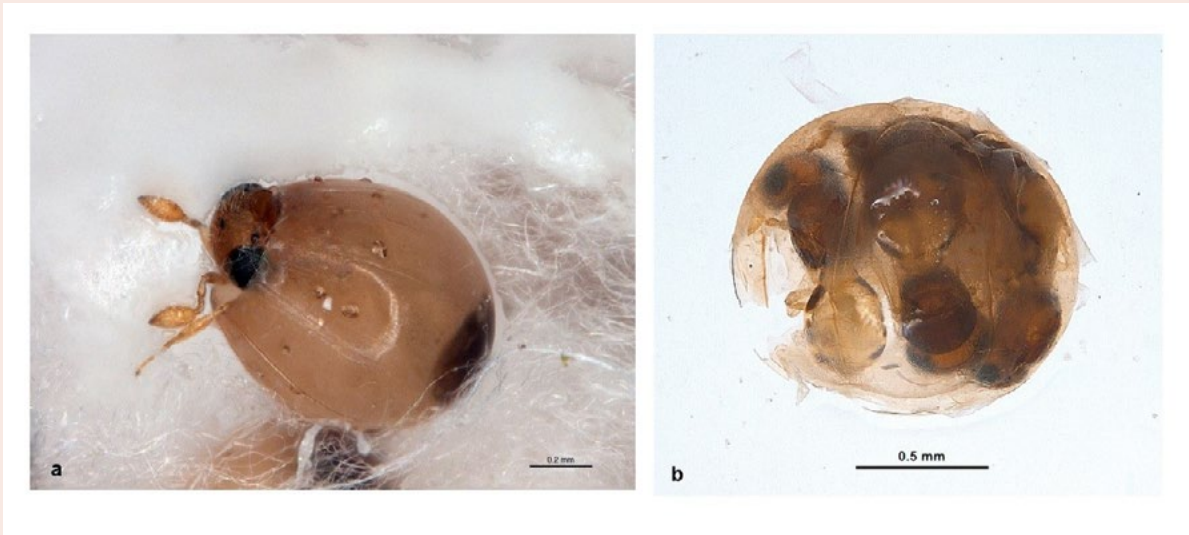


Fig. 2: Mode of development in *Idris* a. solitary mode of development b. gregarious mode of development



Fig. 3: Different genera of Baeini parasitoids a. *Idris* Förster b. *Odontacolus* Kieffer c. *Ceratobaeus* Ashmead d. *Neoceratobaeus* Rajmohana e. *Baeus* Haliday



Crores at Stake, Wasps at Work: Eco-Friendly Control of Cigarette Beetle

Sunita Patra

The Tiny Heroin behind a Giant Industry

Tobacco, with an industry valuation running into tens of thousands of crores of rupees in India, powers a remarkable chain of economic activity, stretching from green fields where the crop is raised to warehouses stacked with cured leaf, from humming factory lines to consignments bound for international markets. Few commodities create such a wide circle of livelihoods at once supporting farmers, labourers, transporters, warehouse workers, manufacturers, traders, and exporters. Every stage adds value, generates employment, and keeps commerce moving, making tobacco not just a crop, but a dynamic engine of trade, industry and revenue.

However, behind this impressive commercial journey story sits a threat that often overlooked. Hidden inside warehouses, tobacco bundles, cartons, and

storage godowns lives one of the most destructive enemies of stored tobacco, the **cigarette beetle**, *Lasioderma serricorne* (Fabricius) (Coleoptera: Ptinidae). The tiny insect can bore into cured leaves, feed on stored tobacco and contaminate stocks with powdery excreta and remains of the insects to cause crores of rupees in losses by boring holes through cigarettes and packing material to degrade product quality and reduce market value.

At the heart of this story stands a tiny female wasp, a natural warrior combating one of the most destructive storage pests threatening stored tobacco. This remarkable defender is a *Anisopteromalus calandrae* (Howard) (Hymenoptera: Pteromalidae) proposing a clean, clever and economic alternative to preserving high-valued tobacco reserves. If the cigarette beetle is the villain

hiding in warehouse shadows, then this wasp is truly the heroine of biological control

The Global Tobacco Industry Under Tiny Attack

Tobacco is cultivated and traded across Asia, Africa, Europe, and the Americas, making it one of the world's widely distributed commercial crops. It supports farmers, processors, packaging industries, transport systems, exporters, and retail markets. Because tobacco products are high-value commodities, even small storage losses can create serious economic consequences. Among storage pests worldwide, the cigarette beetle is one of the most notorious, it attacks cured tobacco leaves, cigarettes, cigars, bidi tobacco, chewing tobacco, tobacco dust, and even packaging materials. Whether in a warehouse in Europe or a storage unit in India, infestation

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can reduce quality, damage brand reputation, and increase management costs. This makes the cigarette beetle a pest of global concern.

Meet the Villain: Cigarette Beetle

The cigarette beetle may be only 2-3 millimetres long, but it is a specialist destroyer. Adults are reddish-brown, oval-shaped insects that thrive in warm storage environments. Females lay eggs directly on tobacco products or in cracks nearby. The larvae hatch and start feeding inside the material being kept. It is in the larval stage where it is most damaging, turns tobacco into powdery waste, contaminates stock with frass and insect remains, and damages aroma, texture, and market quality. In cigarettes and cigars, emerging adults create neat round holes that instantly reduce sale value. Since infestation often begins internally, damage may remain unnoticed until it becomes severe. A small insect might seem my inoffensive, but in a warehouse full of tobacco it can conspire to be a silent fiscal catastrophe.

Crores at Stake: Why It Matters

The real danger of cigarette beetle lies in scale. A small

proportion of damage in valuable stored tobacco can quickly translate into losses worth lakhs or crores. Once cleaning expenses, fumigation charges, labour costs, repacking, delayed shipments, downgraded goods, and rejected consignments are considered, the burden rises sharply. For traders, profits decline. For exporters, reputation suffers. For workers, opportunities may shrink. For industry, productivity falls. So the cigarette beetle does not merely feed on tobacco- it feeds on economic value.

Bihar to Bharat: Why Protecting Tobacco Matters

It is true that Bihar may not rank among the largest tobacco-producing states in India, but trade, transport, warehousing and other activities over and above production associated with tobacco still contribute to regional economic activity. The work of moving and handling tobacco products is a livelihood for many traders, warehouse operators, transporters as well as labourers. Moreover, Bihar's location in the eastern and northern India trade corridor fortifies its position as a distribution point of commodities. The ramifications of damage to tobacco warehouses in Bihar

would go beyond the premises. It creates value destruction for traders, raising costs for storage owners, reducing demand for labour and disrupting local business networks. From a national perspective, tobacco contributes through agricultural income, industrial processing, logistics, exports, and revenue generation. Protecting stored tobacco therefore supports both regional economic activity in Bihar and National Productivity and Prosperity (NPP) by reducing avoidable losses and preserving value.

The Wasp in Action: When the Heroine Makes Her Entrance

One of the most successful natural enemies against storage beetles is the parasitoid wasp *Anisopteromalus calandrae*, (Hymenoptera: Pteromalidae). This tiny, nearly invisible insect is a biological marvel of warfare. It is the female wasp who is the true heroine, specialists at rooting out hidden beetle larvae with scent and vibration, it searches only patiently. When she finds a host, she stings and paralyzes it with her natural venom and then eggs on or near the pest. She lays her eggs among a host of beetle larvae that are developing and uses them to stop the emergence of another destructive beetle.

In place of a pest, a protector is born with no noise, no machines, no chemicals just precision, instinct, and nature's engineering.

Bihar also Confirms the Heroine's Power

Earlier reports from different parts of the country had already indicated the promising role of *A. calandrae* as a natural enemy of storage beetles. Adding to this growing body of evidence, observations at the Gangetic Plains Regional Centre (GPRC), Zoological Survey of India, Patna, Bihar, also recorded successful parasitism of the cigarette beetle by this pteromalid wasp. During the study, the parasitoid was observed attacking and developing successfully on the beetle host, further supporting its value as an eco-friendly biological control agent under local conditions. This finding is significant because it shows that the effectiveness of this beneficial wasp is not limited to earlier reports alone. Bihar too has now contributed evidence that sustainable pest management through natural enemies can be practical, reliable, and relevant to storage environments and commercial systems across India. However, further investigations are

needed to fully understand its biocontrol potential, parasitism capacity, host-searching efficiency, reproductive performance, mass-rearing feasibility, adaptability under different storage conditions, and long-term effectiveness as a component of integrated pest management programmes.

Why Biological Control Is the Future

Parasitoid wasps provide a few benefits in comparison to repeated application of insecticides. They can reach pests lurking in places that sprays commonly miss. They do not leave toxic residue on tobacco products, allowing it to be one of the factors for product quality and acceptance in exports. These practices decrease long-term management costs and aid in delaying pesticide resistance development. Above all it offers a sustainable alternative for industries that are now searching more actively for cleaner, undoubtedly safer storage systems. Additional beneficials such as *Lariophagus distinguendus* (Förster) (Hymenoptera: Pteromalidae), *Theocolax elegans* (Westwood) (Hymenoptera: Pteromalidae) and *Habrobracon hebetor* (Say) (Hymenoptera: Braconidae)

might augment integrated pest management programmes.

Winning the Battle in Warehouses

The best defence against cigarette beetle combines sanitation, monitoring, proper storage practices, and biological control. Clean warehouses, removal of tobacco dust, good ventilation, stock rotation, and early detection traps can greatly reduce infestation risk. When combined with parasitoid releases, these methods create a powerful and environmentally friendly shield for stored tobacco.

The Last Sting

Definitely, cigarette beetle is a minuscule pest with huge repercussions. It quietly burns tobacco, denting profits and putting crores of rupees in peril tucked away inside warehouses. The repercussions of infestation can reach far beyond the boundaries of storage, from trade circuits in Bihar to the Indian economy at large. This little wasp, guided by science and inspired by nature, may help protect a behemoth industry for generations to come.



(Adult female of *Anisopteromalus calandrae* (Hymenoptera: Pteromalidae) parasitising the grub of cigarette beetle, under laboratory conditions)



Adult Cigarette beetle



Chalcididae: A wonderful creature and a proficient bio control agent

Nabasri Basak

Nowadays we all are familiar with the term “**Organic farming**”- it is a method of agricultural practice that depends on natural processes and biological substances without utilizing harmful synthetic chemicals (Pesticides). As we all are aware about the harmful effects of pesticides on ecosystem, climate and human health we are gradually opting for the organic products. When we think about organic farming the first thing which come into our mind are the large animals and some common insects which are easily visible in the agricultural field. But have we ever thought that without using pesticides how to control the pest species naturally in agricultural field? When we look deep inside the crop field we can find that there are some micro insect groups which are emerging from the larvae, pupae of other insects which make the most

powerful allies in agricultural field to sustain organic farming practice. They are mostly tiny in size but possess great impact on ecosystem. **Chalcididae** is one of such fascinating groups of small, robust parasitic wasps under the superfamily Chalcidoidea that play an important role in biological pest control

mechanism and Integrated Pest Management (IPM). Chalcididae are distinguished by their enlarged hind femur rowed with several small teeth, compact body structure with distinct sculpture and simple venation on fore wing without closed cell structures. They use their hind femur for holding the hosts tightly and to break the hard

“ But have we ever thought that without using pesticides how to control the pest species naturally in agricultural field? When we look deep inside the crop field we can find that there are some micro insect groups which are emerging from the larvae, pupae of other insects which make the most powerful allies in agricultural field to sustain organic farming practice. ”

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Chalcidids are different from other parasite as they kill the host organism after taking all possible benefits from it hence Chalcidids are known as Parasitoids. They are potential parasitoids of larvae and pupae of Butterflies and Moths (Lepidoptera), various types of Beetles (Coleoptera), Flies (Diptera) and Lacewing (Neuroptera) which causes severe harm to crops in agro ecosystems.

layer of pupal case. Unlike the other members of Chalcidoidea, Chalcididae wasps are mostly black in color with yellow, red or white spots particularly in the hind femur. Their body length measure from 1.5mm to 8 mm but some species can reach upto 15mm. In spite of being small in size they are highly proficient hunters. Chalcidids are different from other parasite as they kill the host organism after taking all possible benefits from it hence Chalcidids are known as **Parasitoids**. They are potential parasitoids of larvae and pupae of Butterflies and Moths (Lepidoptera), various types of Beetles (Coleoptera), Flies (Diptera) and Lacewing (Neuroptera) which causes severe harm to crops in agro ecosystems.

Where we can find Chalcididae wasps?

Chalcididae can be found in grassy fields, agricultural fields and also in forests area. They are more prevalent in tropical region. As the larva and pupae of Butterflies are their primary hosts of the chalcidid wasps so they can be found more around the flowering plants where more butterflies are observed.

Why Chalcididae are so important in Bio Control Mechanism?

As the Chalcididae are Parasitoids they show a highly **host specific interaction**. Parasitoids are the organism which live as a parasite inside the host body, absorbing the nutrient from host and eventually kills them.

To minimize the number of pest in agricultural field the chalcidid wasps particularly the female lay egg inside their host body (larvae/pupae) and developing chalcidid wasp larva consumes the pest from the inside effectively killing the host before it can reach the adult life stage. This specific biological interaction between both the host and parasitoids is the basis of biocontrol mechanism and key principle of organic farming.

Chalcididae wasps have a diverse range of host organisms. They primarily attack on the **major pests** which are found in the vegetable fields to cash crop fields. They are efficient natural enemies of pests of Rice, Tea, Coconuts and other vegetables. Some Chalcididae species also helps to reduce the number of particular beetle which feed exclusively on the wood (Xylophagous) and causing severe damage to the tree trunk.

Pesticides are the chemicals which not only kill the targeted organisms but also kill the beneficial organisms in agricultural field. Pesticides mix with soil, water and air which in turn pollute the environment. Using natural enemies like Chalcidid wasps instead of harmful pesticides also protect our Mother Nature

and balance the ecosystems properly. Significant challenge of excessive use of the similar kind of pesticides often results in **Pesticide Resistance** in pests. Pesticide resistance reduces the effectiveness of pesticides which causes significant consequences in ecosystems requiring more frequent and high doses of pesticides application in agro-fields. But the use of Chalcididae wasps as natural control agent does not possess any threat to ecosystems as it is environmental friendly procedure and it does not even create situation like **Pesticide Resistance**.

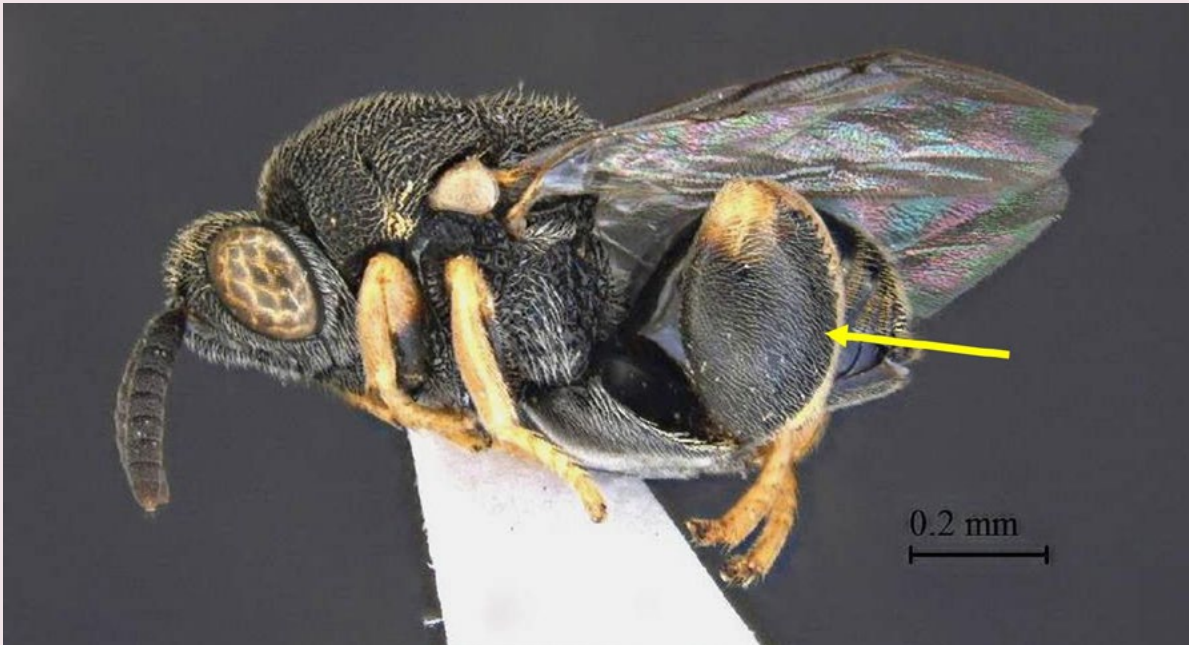
How to promote the use of Chalcididae as Natural Enemies?

As the Chalcididae are small sized insects they often get unnoticed and only a few people are aware about the important role played by these

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tiny creatures to maintain the health of the agro ecosystems. We need to explore more about their potential and encourage our farmers to utilize these fascinating wasps to mitigate the use of harmful pesticides in crop fields as it is an eco-friendly and cost effective procedure of pests management. We should aim to create a suitable habitat

so the Chalcididae as well as other natural enemies can survive properly. Crop rotation is one of such methods which help to reduce the number of pests as different crop supports different types of pest groups. Proper habitat would encourage the growth of these parasitoids which also facilitate to conserve the diversity of the ecosystems.



Brachymeria scutellocarinata Joseph, Narendran & Joy, 1972 with hind femur marked



Dirhinus anthracia Walker, 1846



Psilochalcis carinigena (Cameron, 1907)



Collecting the parasitoids in Yellow Pan Trap



Fig.5 Habitat of Chalcididae sample collection



Nocturnal and Neglected: The Moth Story

Ankhi Sarkar

June 7th. Meghalaya. Clouds playing hide and seek with the Moon in the dark night. Among the calmness and stillness of the night with the weather playing the perfect settings, a bright light was all that could be seen from afar. And then she comes at the back drop of bright light, draped in the most breathtaking colour as if God has himself painted with utmost patience and perfection. To make it up to the night, another Luna has appeared in all its glory, this time as- The Moon Moth. Seeing it alive on the light trap sheet made me realize how beautiful the moths are, with its extravagant colors. These vibrant insects can give a tough competition to its sister suborder, the crowned insect beauty pageant winner- The Butterflies.

Moths and butterflies both come under the order Lepidoptera. In

India there are 1,403 species of butterflies and 13,124 species of moths. Although, there are quite some morphological differences between both but to distinguish, we can rely on the character of antenna. The moths have a variety of antennae such as pectinate or comblike, bipectinate, plumose or feather like, etc., whereas butterflies have a single kind which is a long, slender

antenna that terminates into a club shaped tip. Even though butterflies attract more people because of its bright colour and unparalleled beauty moths are often neglected owing to its dull color and nocturnal behaviour. But the nature is a great artist and has its blessing for everyone. It painted the moths in such vivid colours and details that shook the idea of moths to be the dull creatures of night. But

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the real story of moths unfolds after dark in the mist covered forests and salubrious climes of Meghalaya.

Not All Gold Glitters

There are few moths which sets them apart in the natural color spectrum and can give the butterflies a run for the money. *Attacus atlas* Linnaeus, 1758 is known to be the largest Moth in the world. Its wingspan ranges from 250 mm to 300 mm. *Actias selene* Hübner, 1807 or the Indian moon moth as the common name goes by, is in a shade of green with markings bearing the crescent shape of the moon. Its long tail adds to its charm. *Dysphania militaris* Linnaeus, 1758 or false tiger moth is a day flying one, its bright colours often gives it off as a butterfly. The metallic sheen of zygaenid moths makes it shine and draws attention. These day flying moths are often mistaken as butterfly due to their remarkable colour contrast. *Tasta* sp., a geometrid moth, is often mistaken as a butterfly because of its shiny scales. Likewise, *Milionia* sp. another geometer possesses striking bright coloration and unless told otherwise no one would believe it to be a moth. *Lyssa zampa* Butler, 1869, which is also known as the tropical swallowtail moth or the

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Moths are considered as a pest species but only few know the pollinating role these tiny insects play. Settling Moths are key component in ecosystems for their role in pollination. They land on flowers and settle to feed on nectar.

”

Laos brown butterfly can easily be mistaken for a giant butterfly.

But for moths behind the canvas of beauty, lies the million years of survival strategy created by the master editor- Evolution. The wing tips of the Atlas moth bear markings that resembles the head of a snake, signals a warning to the predator to abort the attack. Moths like Brahmin moths (*Brahmaea* sp.) and *Anisoneura* sp. adapts a different survival strategy, its brown- blackish scales creates a mosaic which makes it a perfect camouflage to merge with the bark of a tree. In case of *Dysphania* sp. the bold yellow and blue colour announces toxicity to the predators. The enchanting tail of moon moths does not only add to its beauty; study suggests that it also helps in predator evasion. It interferes with bat echolocation causing the bats to misjudge

their strikes. These examples confirm strongly that for moths' beauty was never just about decoration it supplemented survival strategy all along.

Working the Night Shift

Moths are considered as a pest species but only few know the pollinating role these tiny insects play. Settling Moths are key component in ecosystems for their role in pollination. They land on flowers and settle to feed on nectar. Sphingids Moths hover over flowers for nectar and in that process, they carry pollen on their proboscides and help in pollination. Recent studies show that moths of families Erebiidae (*Nyctemera* sp.), Geometridae (*Chiasmia* Sp.), Noctuidae (*Pyrrhia* sp.) play vital role in pollinating fruits like apple, kiwi, etc. Sphingid Moths like *Acosmeryx sericeus* Walker, 1856 and *Rhagastis confusa*

Rothschild & Jordan, 1903 carry a higher pollen load, making them efficient pollinators. Ipso facto, moths play a vital ecological role as nocturnal pollinators, promoting plant reproduction and maintaining ecological balance.

Silk moths, belonging to family Bombycidae, have long been reared for commercial purposes. They have become back bone of livelihood for silk industry workers. This tiny insect sets the foundation for sericulture thereby sustaining an entire economy. Assamese silk is GI tagged which is exclusively extracted from the caterpillar of *Antheraea assamensis* Hefler, 1837, a silk moth. Another recent study showed silk fibroin, a natural biopolymer, which is known for its biocompatibility and mechanical strength is extracted from *Kunugia latipennis* Walker, 1855, a lasiocampidae moth. It has

gained attention for wound healing applications. Thus, paving way for an unexplored avenue in biomedical field.

In the Abode of Clouds, Wings Await

Meghalaya falls under Indo-Burma biodiversity hotspot. Its mist laden cloudy landscape offers an ideal condition for lepidoptera diversity. Varying elevations, abundance of host plants supports a vast range of species from massive saturniids to delicate geometrids. As a result, the landscape turns into a high yielding zone and perfect surroundings for species diversity. Meghalaya termed as the abode of clouds, but its species richness, ecological diversity surely qualifies it to be called as an 'Abode of the Moths'. In Meghalaya, every field night holds the possibility of a new discovery. I found an opportunity in the same darkness and serenity of jungles

“

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to unveil a new species of a Bombycid moth. The species, at first impression looked familiar, but as I delved deeper and reviewed the available literature the details of wing patterns differed. I got surprised to discover a new gem. With only two species known globally at that time, *Gnathocinara* Dierl, 1978 was first recorded from India. And a new species, *Gnathocinara zolotuhini* Sarkar *et al.*, 2025 was described as new to science. This is what makes the documentation of fauna here so urgent and exciting.

As Robert Frost said “The woods are lovely dark and deep”, for moths the darkness is all that matters. Expanding roads and glittering towns across north east India are diminishing the quite darkness of remote areas. Light pollution creates disorientation in moths hampering their ability to navigate & locate mates. Thereby interfering with their role as night pollinators. Climate change, loss of native forests are other major challenges threatening moth populations. A moth that can't reproduce, can't exist as per the law of nature. A forest without moths is a forest going handicap and silent. Slowly. Irreversibly. The need of the hour remains in putting up great efforts to

document the rich fauna the landscape offers.

I have witnessed many such nights in Meghalaya’s forests and every experience is enthralling than before. Every time a wing landed in the light sheet, every closer look reminds me why this work matters. That night in Meghalaya, as the Indian moon moth rested against the white sheet, it asked for nothing- no admiration, no credits. It had simply appeared, done what the evolution has programmed it to do. And will be gone before dawn. We have spent centuries

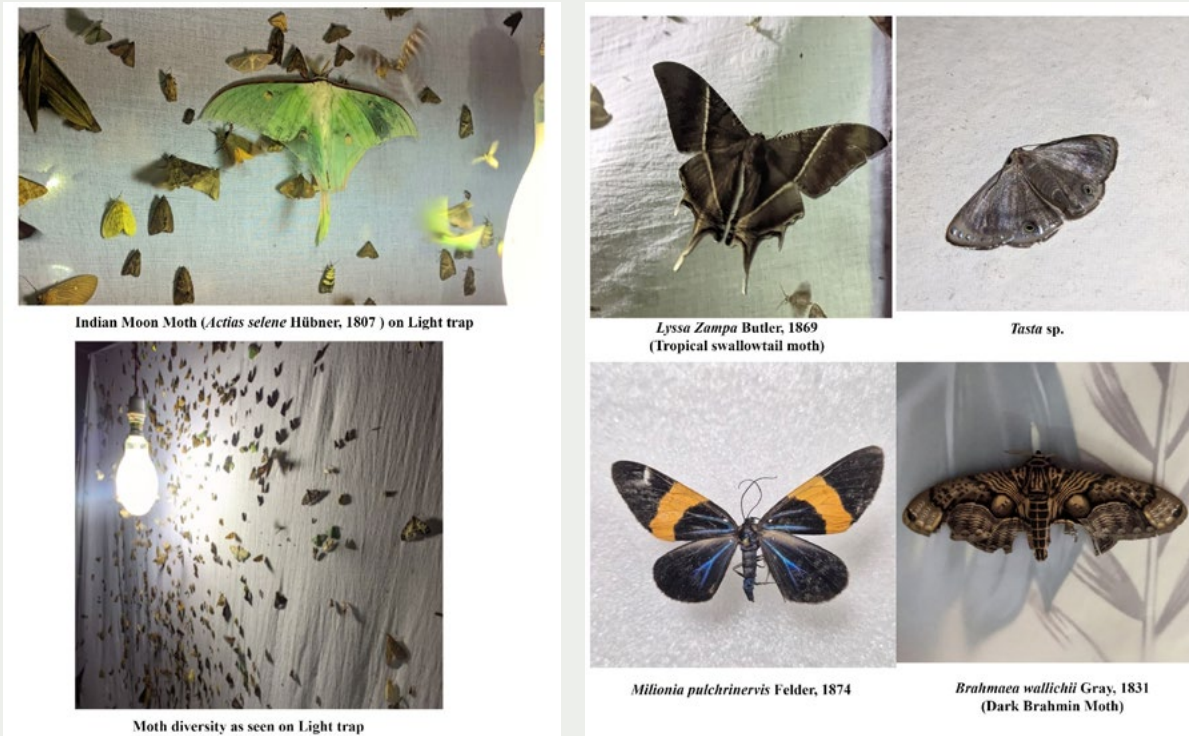
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celebrating butterflies, painting them, following them into forests with net, camera and notebook but never thought about the better sights of moths circumventing us. Meanwhile

moths have worked the night-pollinating, surviving, all while remaining largely uncelebrated. Perhaps it is time to stay up a little late and meet the other half.



Different Landscapes of Meghalaya





Tiny Titans of Freshwater: The Story of the genus *Amphiops*

Deepa Jaiswal

At the edge of a peaceful pond, where sunlight filters through floating vegetation, life flourishes in tiny, often invisible ways. Beneath these calm serene lives, a remarkable group of water beetles of the genus *Amphiops*. Though they are small and easily overlooked, species are vital players in freshwater ecosystems and provide fascinating insights into their diversity, adaptation, and environmental change.

The genus *Amphiops* belongs to family Hydrophilidae, commonly known as water scavenger beetles. Found almost in all freshwater habitats such as temporary pools, rice fields, roadside ditches, marshlands, ponds, and slow-moving streams. These beetles are well adapted to aquatic life, with specified modifications in their body shape, size and swimming mechanisms. Unlike

the more commonly recognized predatory diving beetles, many Hydrophilids, including *Amphiops*, are scavengers or detritivores, feeding on decaying organic matter and contributing to nutrient recycling. Apart from this, aquatic beetles are considered as biological indicators of ecosystems.

Species of *Amphiops* are small, oval-shaped, convex, semiglobular, antennae eight segmented, scutellum elongated, visible, pronotum punctuated, elytra with punctation, and darkly colored. Living in water brings unique challenges, and *Amphiops* have evolved clear solutions. Like other aquatic beetles, they

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Deepa Jaiswal

hold a thin layer of air with them when they dive, trapping it beneath their bodies. This air supply acts as a secondary oxygen resource, allowing them to remain submerged while foraging.

The genus *Amphiops* reported a total of 24 species including four subspecies globally, of which 3 species *A. mater* Sharp, 1873, *A. mirabilis* Sharp, 1890 and *A. simplex* Sharp, 1890 have been reported from India. The species *A. gibbus* is originally described from India but later Jia 2014 consider it as a synonym of *A. mater*, rest species are reported by different researchers. The species *A. mater* is a widespread species in India, known from many Indian states and originally described from Japan, known from Cambodia, China, Indonesia, Japan, Nepal, South Korea, Sri Lanka, Taiwan and Vietnam indicating its wide distribution globally. The species *A. mirabilis* and *A. simplex* are described from Sri Lanka and later reported from India. The species *A. mirabilis* has a narrow area of distribution, only known from Assam, Uttar Pradesh and Manipur, whereas *A. simplex* is known from Himachal Pradesh, Manipur, Odisha, Puducherry, Uttar Pradesh and West Bengal.

During our taxonomic field explorations in India, found

Tiny Titans of Freshwater: The Story of the genus *Amphiops*

The genus *Amphiops* reported a total of 24 species including four subspecies globally, of which 3 species *A. mater* Sharp, 1873, *A. mirabilis* Sharp, 1890 and *A. simplex* Sharp, 1890 have been reported from India.

multiple population of *Amphiops* were observed. Subsequent integrated taxonomic analysis suggested the occurrence of potentially undescribed taxa in the genus. These trends show that the genus underestimated in terms of species diversity within the genus.

Molecular systematics has become important tools to understand the species boundaries. Molecular analysis revealed that within collected populations, shows three different lineages. These findings not only refine classification but also deepen our understanding of evolutionary relationships within the genus. Genetic distances between the species ranged from 7–18%. *Amphiops* sp1 exhibits 7–10% genetic divergence with *Amphiops* sp3, 16–17% with *Amphiops* sp2. Further *Amphiops* sp1. shows 14–15% genetic difference with *A. globus* and 13–15% with *A. mater*. *Amphiops*

sp3. having 14–16% genetic divergence with *Amphiops* sp2. and raw genetic divergence of 14–16% with *A. globus*. The genetic divergence between *Amphiops* sp3. and *A. mater* shows 12–15%. *Amphiops* sp2. exhibits high degree of genetic differences with *A. globus* with 18%. The genetic divergent between *Amphiops* sp2. and *A. mater* is estimated from 8–9%. The study also analysed the genetic distance between *A. globus* and *A. mater* which is from 15–16%. In other hand *Amphiops* species shows intraspecific genetic distances; the study observed that within the *Amphiops* sp1. 1–3% genetic divergence, same way 1–2% of divergence in *Amphiops* sp3. and *A. mater*. Within genus of *Amphiops*, *Amphiops* sp3 and *Amphiops* sp1 forms a strongly supported sister-group relationship, indicating that these two species share a more recent

common ancestor with each other. Further molecular studies will be necessary to evaluate phylogenetic relationships and to clarify whether the Indian species constitute a monophyletic assemblage or represent multiple colonization events from southeastern Asia.

The micro habitats are dynamic and sometimes unpredictable, requiring creatures like *Amphiops* to be highly adaptable. Their presence in these ecosystems highlights their resilience, but also their vulnerability. Even slight disturbances caused by pollution, habitat drainage, climate change can greatly impact their diversity and abundance.

Aquatic beetles are closely associated with freshwater ecosystems, they serve as bioindicators. Changes in their diversity, abundance, and distribution may show underlying ecological changes. A decline in their diversity and abundance could signal degrading water quality or habitat loss. For researchers and conservation biologists, understanding the genus *Amphiops* provides an insightful window into the health of freshwater ecosystems, that are globally threatened.

A large amount of research focused on large and threatened



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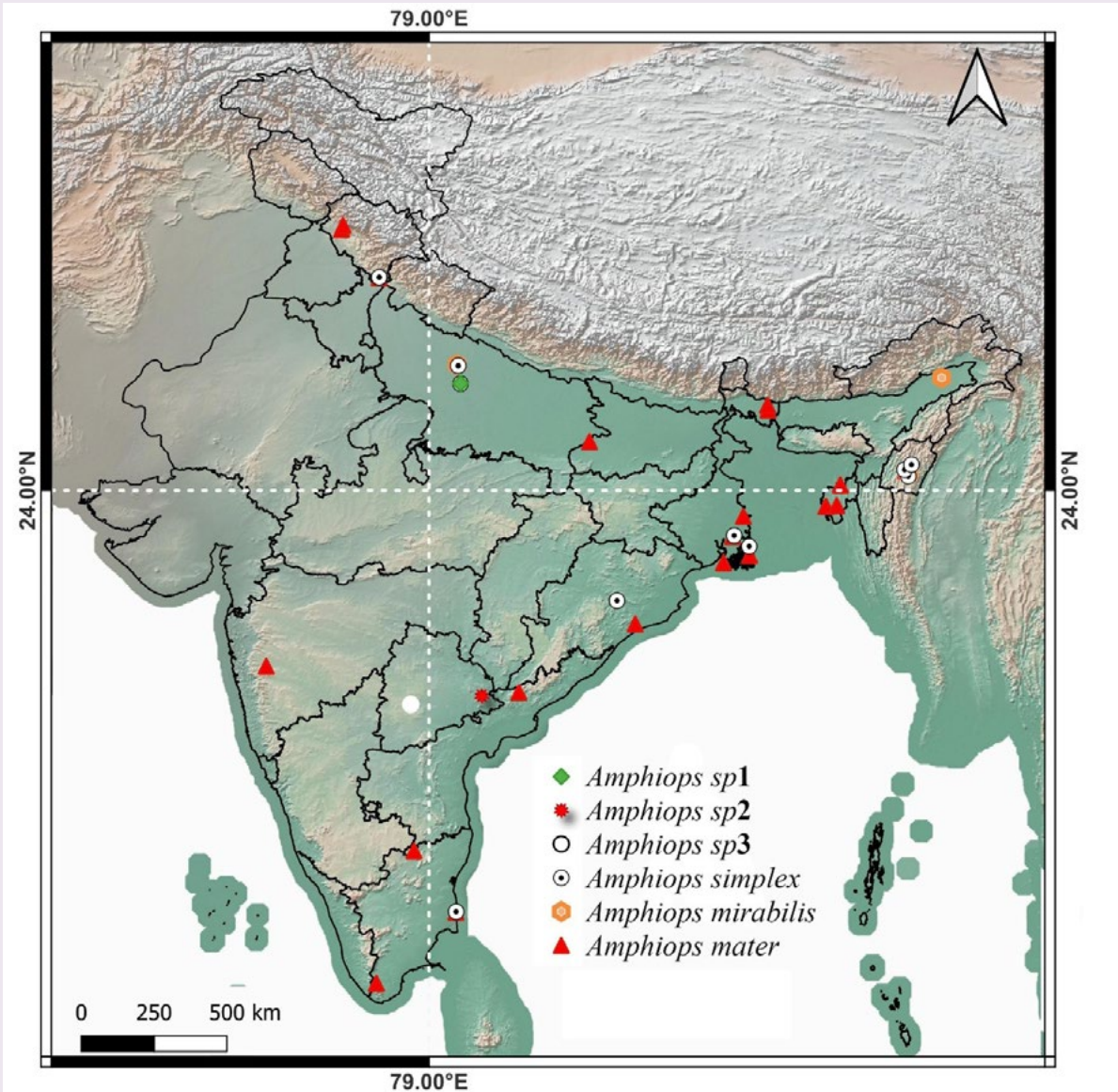
species; it is easy to overlook small creatures like aquatic beetles. Yet genera such as *Amphiops* play significant role in maintaining ecological balance, helps in breakdown of organic matter, support

food webs, and contribute to the overall functioning of the freshwater ecosystem. Moreover, the studies on aquatic beetles covering taxonomy, molecular biology, and ecology can demonstrate how even these

smallest organisms can inform big scientific questions. The insightful findings of the genus *Amphiops* demonstrate

that discovery often lies in the overlooked. Beneath still waters, these tiny unassuming beetles carry stories of diversity, and survival. By bringing them

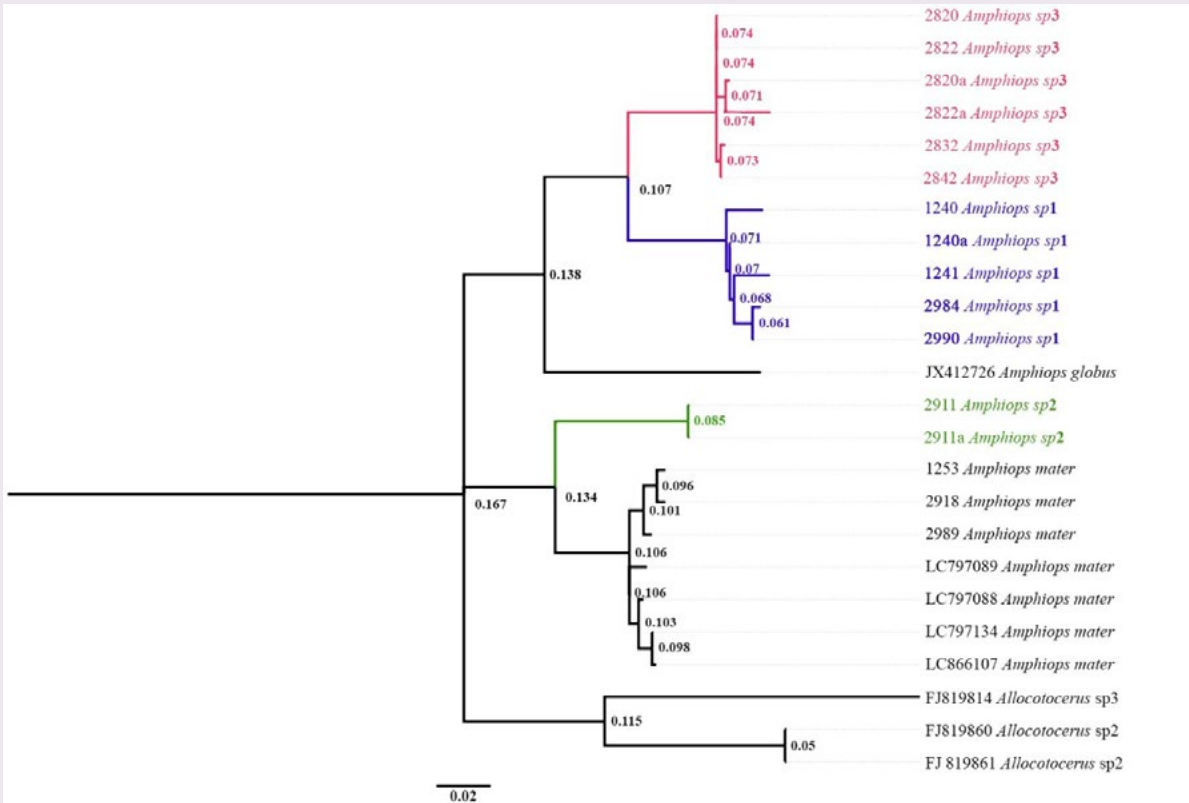
into focus, we not only expand our scientific understanding but also strengthen our appreciation for the delicate ecosystems they inhabit.



Distribution of *Amphiops* in India



Different populations of *Amphiops*



Maximum likelihood phylogenetic tree for *Amphiops* generated using cytochrome c oxidase gene.



The Hidden Billion-Dollar Beetle Beneath Your Feet

Aparna Sureshchandra Kalawate

On a warm evening in early summer, farmers across parts of India sometimes notice a quiet invasion. Small, brown beetles begin to gather around lights, tapping against windows, clustering under bulbs. Most people don't think twice about them. They aren't colorful, no dramatic horns, just soft-bodied, dusty-looking insects. But beneath the soil, their real story is unfolding, and it's costing agriculture millions. These are sericine chafer beetles, and their underground young are among the most underestimated agricultural threats.

Their feeding habits includes that the Adults feed on leaves of angiosperm plants and larvae feed on roots. Many Sericini are nocturnal and are inconspicuously colored, generally being various shades of brown, which adds to the difficulty of species determinations. They belong

to the scarab beetle family and are found widely across warm regions.

A Life Lived in the Dark

After mating, female beetles lay eggs in the soil. When the larvae hatch, they begin feeding on plant roots. This stage lasts much longer than the adult phase, which means most of the beetle's life is spent hidden underground. Their mouth parts whether larval or adult, belong

to the biting and chewing type and thus they have a pair of well-developed and sclerotized mandibles.

Because they feed on roots, the damage they cause isn't immediately visible. Crops may look healthy at first, but over time they begin to weaken. Plants can turn yellow, grow poorly, or even die. In some cases, they can be pulled out easily because the roots have

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Sericine chafer larvae are also known to damage lawns, golf courses, and pastures. Their feeding weakens grass roots, leading to brown patches.

already been eaten away. Adult Beetles feed on the leaves of the plants.

Why They Matter Economically

1. Agricultural Pests

Sericine chafer beetles are considered agricultural pests in many regions. Their larvae damage a variety of crops, including: groundnut (peanut); sugarcane; maize and wheat; grasses used for grazing. Adult beetles, in some species, also feed on foliage, further contributing to crop damage though this is usually less severe than larval feeding.

This root damage reduces crop yield and can lead to significant financial losses, especially when infestations are widespread. One of the biggest challenges is that farmers often notice the problem only after the damage is already done. They also affect lawns and turf. In places like golf courses or managed grasslands,

grub activity may create dry, patchy areas. Animals such as birds may dig into the soil to feed on the larvae, making the damage even more visible.

2. Impact on Turf and Landscaping

Sericine chafer larvae are also known to damage lawns, golf courses, and pastures. Their feeding weakens grass roots, leading to brown patches. Additionally, animals such as birds or wild mammals may dig up turf to feed on the grubs, compounding the damage.

3. Role in Soil Ecology (The Positive Side)

Not all effects are negative. In moderate numbers, sericine chafer larvae contribute to soil turnover and organic matter breakdown. By feeding on roots and decaying plant material, they help aerate the soil and recycle nutrients processes that are essential for long-term soil fertility.

4. Indicators of Environmental Change

Because their populations respond to soil conditions, climate, and land use, sericine chafers can serve as biological indicators. Sudden population surges may signal imbalances such as monoculture farming or reduced natural predators.

Not Entirely Harmful

Despite their reputation as pests, sericine chafer larvae do have some positive effects. As they move through the soil, they help loosen it, improving aeration. Their feeding also contributes to the breakdown of organic matter, which supports nutrient cycling.

So, in smaller numbers (below Economic Threshold Level), they are actually part of a healthy soil system. The problem arises when their population grows too large.

Managing the Problem

Controlling sericine chafer populations requires a careful approach. Heavy pesticide use can harm beneficial insects and disrupt ecosystems. Integrated pest management (IPM) strategies such as crop rotation, biological control agents (like entomopathogenic fungi or nematodes), and monitoring adult populations

are increasingly favored for sustainable control

A Quiet but Important Insect

Sericine chafer beetles are a good reminder that not all the important insects are obvious. Even small, plain-looking species can have a real impact on agriculture and the environment.

Their role is a mixed one, they can damage crops, but they also contribute to soil processes. Understanding that balance is key to managing them effectively.

Conclusion

The story of sericine chafer beetles is a reminder that economic importance in nature is rarely one-dimensional. These insects can be both destructive pests and quiet contributors to soil health. Understanding their biology and ecological role helps farmers and scientists manage them more effectively, reducing harm while preserving the benefits they bring to ecosystems.

Living mostly out of sight, their larvae can quietly damage crops and affect farmers' livelihoods, making them economically important in many agricultural regions. At the same time, they also play a role in maintaining

soil health when present in balanced numbers.

This dual role highlights an important idea in ecology: not every pest is entirely harmful, and not every beneficial organism is harmless in all situations. Managing sericine

chafer beetles is less about eliminating them and more about keeping their populations under control. Understanding their life cycle and behavior helps strike that balance, protecting crops while maintaining healthy soil systems.

This dual role highlights an important idea in ecology: not every pest is entirely harmful, and not every beneficial organism is harmless in all situations. Managing sericine chafer beetles is less about eliminating them and more about keeping their populations under control. Understanding their life cycle and behavior helps strike that balance, protecting crops while maintaining healthy soil systems.



A sericine chafer Beetle on the light trap



Fascinating Ladybird Beetles (Coleoptera: Coccinellidae): Heroes of Biological Control

Ruquaeya Bano

Ladybird beetles or Ladybugs are most attractive insects belong to the family Coccinellidae of Order Coleoptera most effective and well-known beneficial insects used in biological control with over 6,000 species and 360 genera worldwide. Lady beetles are easily recognized by their shiny, convex, half-dome shaped body and short clubbed antennae. They are small about 0.8 -10 mm in size, generally bright in colour with some combination of red and black, orange, or yellow. Most of them have round and oval bodies shape which contain six legs, small antennae and designed elytral patterns. Ladybird beetles have different elytral patterns (spots or strips or plain with no markings) which makes them easily identifiable. Tremendously majority of lady beetles are voracious feeder predators generally feeds on many insect groups like, feeds

on aphids, mealybugs, psyllids, scales insects, whiteflies, mites, leaf beetle larvae, eggs of small Lepidoptera, and other small arthropods etc. They are carnivorous predators by nature those serve as “nature’s own pest controllers,” crucial for reducing dependence on chemical insecticides in both organic and conventional agriculture farming its role as bio control agents. Many workers are describing the diversity of

Ladybird beetle in India. Dr Poorani, eminent Entomologist has documented an illustrated guide to lady beetles (Coleoptera: Coccinellidae) of the Indian Subcontinent.

As a biocontrol agents, Ladybugs are highly effective, natural predators of aphids, with a single adult consuming up to 50 aphids per day and thousands in its lifetime. Larvae are even more voracious than adult

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beetles can consume hundreds of preys during its development. The young larvae usually pierce and suck the body liquid from their prey while older larvae and adults chew and consume whole prey.

Ladybird beetles live where their preys live, mostly on herbaceous plants and bushes, but sometimes on trees or even grass, branches and foliage of trees. Some species found in temperate climates make short migrations to warmer habitats, and many spend the winter by hiding under bark or in a crack or crevice. Ladybird beetles have the same life stages as other beetles, spend the winters as adults and lay their eggs in the following summer. The hatched larvae eat a lot and grow fast, and emerge as adults in the late summers. The entire life cycle takes 4 weeks to complete. To document the diversity, distribution, abundance and host plant association of Coccinellidae fauna (Ladybird beetle) of different cropping systems, adult and larvae can be collected when tree or bush branches to shake them well in a cloth tray or applying an aerial insect net on the foliage, or by an aspirator. Each specimen

labeled with data about host plants, locality, coordinates and date. Collected specimens preserve in 70% ethanol, while other specimens use to dry mounted and preserved in collection boxes and for good photograph.

To protect the natural biocontrol agents, the simple community action ideas:

- » Go for organic: To avoid uses of chemical fertilizers.

Harmful chemicals can kill ladybugs and other beneficial insects.

- » Pollen-rich plants: Encourage local populations by planting Pollen-rich plants.
- » Kid-Friendly bugs: Since lady beetles are attractive so they are the “gateway bugs” for little hearts. They are safe to handle and a great way to teach kids about the ecosystem.

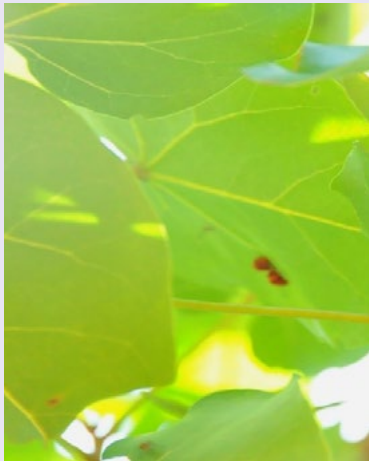
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Author collecting Ladybird Beetles from foliage by applying aerial insect Net



Ladybird beetles on ventral side of the leaf

Common Species of Ladybird beetles (Coccinellidae) of Rajasthan.



Cheilomenes sexmaculata (Fabricius, 1781)



Brumoides suturalis (Fabricius, 1798)



Coccinella transversalis Fabricius, 1781



Coccinella septempunctata Linnaeus, 1758



Tiny Beetles, Big Warnings: What Aquatic Beetles Reveal About the Health of the Indrayani River.

Rita Deb

Based on findings from the study conducted by the author and team on aquatic beetle diversity and water quality of the Indrayani River, early in the morning, along the banks of the Indrayani River near Pune, researchers gently sweep nets through shallow waters filled with aquatic plants. To many people, the river appears ordinary, flowing past towns, temples, and villages. But hidden within its waters are tiny creatures that quietly record the river's story. These creatures, aquatic beetles, are among nature's most reliable bio-indicators, revealing whether a river is healthy or under stress. The Indrayani River is not just another freshwater system. Originating in the Western Ghats near Lonavala, it flows eastward through culturally important towns such as Dehu and Alandi before joining the Bhima River at Tulapur. Over the years,

rapid urbanization, industrial expansion, and increasing population pressure have begun to affect the river's ecological balance. Monitoring its health has become essential, not only for biodiversity but also for the communities that depend on it.

The Hidden Life of Aquatic Beetles

Aquatic beetles belong to one of the most diverse insect groups in freshwater habitats. Globally, more than 13,000 species of aquatic beetles have been described, and

In the Indrayani River, researchers recorded 31 species of aquatic beetles belonging to 19 genera and four families during a year-long study. These families included Dytiscidae, Hydrophilidae, Gyrinidae, and Noteridae, with the family Dytiscidae being the most dominant, represented by 15 species. Hydrophilidae followed with 11 species, while Gyrinidae and Noteridae contributed three and two species respectively.

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about 776 species are known from India. These insects play an important role in aquatic ecosystems by participating in nutrient recycling and forming a crucial part of the food web. In the Indrayani River, researchers recorded 31 species of aquatic beetles belonging to 19 genera and four families during a year-long study. These families included Dytiscidae, Hydrophilidae, Gyrinidae, and Noteridae, with the family Dytiscidae being the most dominant, represented by 15 species. Hydrophilidae followed with 11 species, while Gyrinidae and Noteridae contributed three and two species respectively. This diversity highlights the ecological richness of freshwater habitats and underscores the importance of studying aquatic beetles as indicators of water quality.

Studying Beetles to Understand Water Quality

To understand how aquatic beetles reflect river health, scientists conducted monthly collections from eight locations along the Indrayani River: Valvan, Kamshet, Warangwadi, Begadewadi, Moshigaon, Alandi, Dhanore, and Tulapur. Using a pond net, researchers collected beetles systematically along 100-meter stretches of river habitat. Each collected

specimen was preserved and identified using microscopes and standard taxonomic literature. At the same time, water samples were collected from each location to measure important physicochemical parameters such as pH, temperature, dissolved oxygen, salinity, total dissolved solids (TDS), and electrical conductivity. This combination of biological and chemical monitoring allowed researchers to connect beetle diversity with water quality conditions across different parts of the river.

Upper Basin vs Lower Basin: A Clear Ecological Pattern

One of the most striking findings from the study was the difference between the upper and lower regions of the river. The upper basin sites, including Valvan, Kamshet, Warangwadi, and Begadewadi, supported a higher diversity of aquatic beetles. These areas experienced relatively less human disturbance and maintained better water quality conditions. In contrast, the lower basin sites, including Moshigaon, Alandi, Dhanore, and Tulapur, showed reduced beetle diversity. In fact, no aquatic beetles were recorded at Alandi and Tulapur, indicating ecological stress or

unsuitable habitat conditions. This difference strongly reflects the impact of anthropogenic activities such as industrial discharge, sewage inflow, and construction activities along the river banks.

The Role of Water Quality Parameters

Water quality parameters measured during the study showed noticeable variation among sites. For example, dissolved oxygen a critical factor for aquatic life was lowest at Moshigaon (3.69 mg/l) and highest at Tulapur (5.72 mg/l). Similarly, electrical conductivity and total dissolved solids showed high values in certain locations, suggesting increased pollution or mineral load. Water colour and odour also provided visible signs of pollution. Some downstream sites showed unpleasant odour and greenish-black water, along with excessive growth of aquatic plants such as water hyacinth and algal blooms. Suspended sediments were also observed in several locations, indicating habitat disturbance. These physical and chemical changes directly influence aquatic beetle communities, making them reliable biological indicators of environmental health.

Why Aquatic Beetles Are Powerful Bio-Indicators

Aquatic beetles are widely recognized as useful bio-indicators because they respond quickly to environmental changes. Their presence or absence reflects the overall ecological condition of freshwater habitats. Several characteristics make aquatic beetles ideal indicators:

- i) Sensitivity to Environmental Change: Many species require clean, oxygen-rich water. Pollution reduces their survival, leading to changes in species composition.
- ii) Wide Habitat Range: Aquatic beetles inhabit ponds, rivers, wetlands, and temporary pools, allowing researchers to monitor diverse habitats.
- iii) Ecological Importance: These insects help recycle nutrients and serve as prey for fish, amphibians, and birds, making them essential components of freshwater ecosystems.
- iv) Ease of Collection: Sampling beetles requires simple tools such as nets, making long-term monitoring practical and cost-effective.

Because of these advantages, aquatic beetles meet most of the criteria used in selecting indicator organisms for environmental studies.

Human Activities and Their Impact on River Health

The Indrayani River basin has experienced rapid industrialization and urban development over the past three decades. Expansion of residential areas, industrial zones, and infrastructure projects has placed increasing pressure on the river ecosystem. Industrial effluents, untreated sewage, and recreational activities contribute to water pollution. In addition, seasonal gatherings of large populations along the riverbanks add further stress due to insufficient sewage management facilities. Such disturbances alter habitat structure and water chemistry,

ultimately affecting aquatic organisms including beetles. If these pressures continue unchecked, they may lead to long-term loss of biodiversity.

Aquatic Beetles as Tools for Conservation

The findings from the Indrayani River study highlight the importance of using aquatic beetles in environmental monitoring and conservation programs. Because beetle diversity responds to pollution levels, regular surveys can help detect early signs of environmental degradation. This information can guide policymakers, conservationists, and local authorities in implementing effective river

“Aquatic beetles offer a practical and affordable method for monitoring freshwater habitats across the country. Their study supports biodiversity conservation, sustainable water use, and ecological restoration. Educational institutions can also use aquatic beetles as teaching tools, introducing students to the concept of bio-indicators and encouraging participation in citizen science programs.”

management strategies. Furthermore, the present dataset serves as baseline information for future research on aquatic beetles along the Indrayani River. Such baseline studies are essential for tracking ecological changes over time and assessing the effectiveness of conservation efforts.

The Broader Significance for India

India’s freshwater ecosystems face growing challenges from population growth, agricultural runoff, and industrial expansion. Rivers such as the Indrayani illustrate how biological monitoring can complement chemical testing to provide a more comprehensive

understanding of water quality. Aquatic beetles offer a practical and affordable method for monitoring freshwater habitats across the country. Their study supports biodiversity conservation, sustainable water use, and ecological restoration. Educational institutions can also use aquatic beetles as teaching tools, introducing students to the concept of bio-indicators and encouraging participation in citizen science programs.

Listening to Nature’s Smallest Signals

Aquatic beetles may be tiny, but their ecological significance is enormous. By studying these small organisms, scientists can detect pollution, understand

habitat changes, and protect valuable freshwater resources. The Indrayani River study demonstrates how biodiversity research can reveal hidden environmental patterns. It shows that the presence or absence of aquatic beetles is more than just a biological observation; it is a warning signal about the health of our rivers. Protecting freshwater ecosystems requires attention not only to visible signs of pollution but also to the subtle changes recorded by nature’s smallest inhabitants. In the quiet movement of aquatic beetles lies a powerful message one that reminds us that safeguarding rivers begins with understanding the life within them.



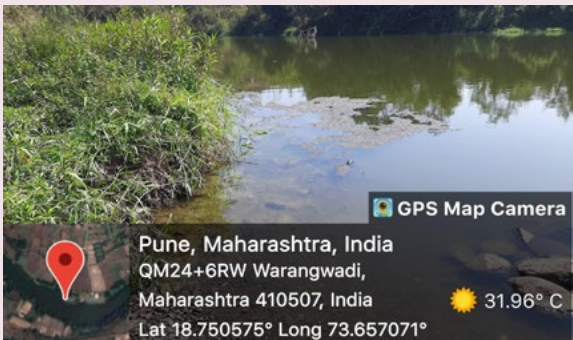
Collection site of Alandi, Pune, Maharashtra



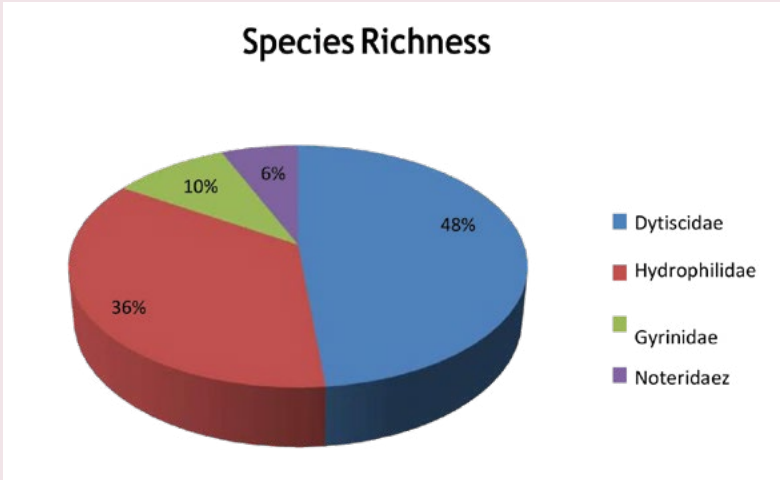
Collection site of Tulapur, Pune, Maharashtra



Collection site of Valvan, Lonavala, Maharashtra



Collection site of Warangwadi, Ahmednagar , Maharashtra



Graph showing species richness w.r.t families in Indrayani River.



Sand Artist of Thar Desert: Ground Beetles

Sonal Yadav

Imagine walking through sand dunes at night and you just step on something without realising and suddenly you feel strong vibration with sound under your foot and a smoke like spray scattering in the air. What was that? You just encountered with a bombardier beetle (*Pherosphus sobrinus*). Bombardier beetles (Tribe: Brachinini and Crepidogastrini) come under family Carabidae (Coleoptera: Caraboidea). Among the Carabids, the bombardier beetle illustrates a remarkable example of chemical defence. Sensing danger, it sprays a chemical shoot from the tip of the abdomen. Near its abdomen there are two large opening called “Pygidial glands” containing Hydrogen peroxide and hydroquinone. These chemicals are potential irritants causing burning sensation on skin and even fatal for small insects.

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Thar Desert also called “Great Indian Desert” is one of the largest arid regions in the world and overall 9th largest subtropical desert. Covering over 2,00,000 square kilometres it is spread across Punjab, Haryana, Rajasthan and Gujarat in India. The vegetation is thorny bushes, grasses, shrubs like *Acacia*, Khejri, Cactus, Karonda etc. The temperature is mostly high throughout the year in daylight

with high humidity. With annual rainfall less than 25 cm, surviving here comes with challenges and adaptations.

Carabidae belong to suborder Adephaga under the order Coleoptera which is the most diverse and omnipresent group on earth. Globally, almost 4,00,000 species of Coleoptera have been reported so far. Carabidae is derived from a greek word “*karabos*” which

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means “a beetle with horns”. Commonly, they are called ‘ground beetle’ or ‘carabids’ as they are an integral part of soil fauna. Globally, almost 40,000 species have been reported till date. In India, only over 1900 species have been reported so far. They are usually found on ground, leaf litters, under stone, forest’s edgy places, sandy trails, moist banks of water bodies, under barks of trees, grasslands. Their body shape and coloration changes according to the substrate demonstrating “Phenotypic adaptation”. Their body is flat, from small to moderate in size and nocturnal in nature. Most of them including larvae are predaceous in nature (Feeding on Aphids, caterpillars, mites, slugs, bugs etc.). In most cases, they are easily distinguishable from other beetles by the specific shape of clypeus (which is typically wider on ends and narrower on onset) and from the distance between insertion point of antennae. The head is trapezoidal shape, with powerful, sharp, wide mandibles which are designed to pierce and cut a prey. The eyes are convex moderately prominent, 11 segmented filliform antennae for sensing directions, quadrate prothorax, robust margined pronotum, three pair of long slender legs with five segmented tarsi adapted for running and

From Thar Desert, a total of 42 species belonging to 23 genera (*Omphra*, *Pseudognathaphanus*, *Brachinus*, *Harpaglossus*, *Scarites*, *Phersosophus*, *Forcipator*, *Dromius*, *Paussus*, *Harpalus*, *Microlestes*, *Calosoma*, *Lophyra*, *Pterostichus*, *Anthia*, *Chlaenius*, *Stenolophus*, *Apristus*, *Tetragonoderus*, *Amara*, *Platynus*, *Acupalpus*, *Bembidion*) under 12 subfamilies (Harpalinae, Paussinae, Platyninae, Trechinae, Brachininae, Cicindelidae, Anthiinae, Pterostichinae, Lebiinae, Scartitinae, Carabinae, Licininae) have been reported till date.

burrowing and presence of setae on different body parts also plays a high taxonomic value.

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Amara, *Platynus*, *Acupalpus*, *Bembidion*) under 12 subfamilies (Harpalinae, Paussinae, Platyninae, Trechinae, Brachininae, Cicindelidae, Anthiinae, Pterostichinae, Lebiinae, Scartitinae, Carabinae, Licininae) have been reported till date. Some species like *Anthia sexguttata* is a large size (up to 2 inches) six spotted ground beetle known for its unique aposematic coloration or warning coloration. *Lophyra catena* is known for luminous,

nacreous colour. pattern that resembles with “Leopard spots” and massive sickle-shaped mandibles. Some species from genus *Paussus* are have truly alien looking squashed, thickened or spoon-shaped antennae.

Adaptations of Ground Beetles in the Thar Desert

Thar is no hidden place for its vast faunal diversity. As for the extreme climatic situations every animals is adapted according the environment. Ground beetles also go under morphological and behavioural changes which allow them to survive in the harshest desert conditions.

1. Nocturnal Activity: Due to hot climatic conditions they prefer roaming in dark and avoid peak daytime temperature to minimize water loss and escape from extreme heat.

2. Robust Cuticular Exoskeletons: They have robust hardened elytra which protect them from heat loss during daytime and other predators.

3. Body Coloration and Pattern: Their body is usually black, brown or metallic green with yellow spots on elytra which are a suitable adaptation with the sand of Thar Desert. It gives them protection from other predators.

4. Food Inclusivity: They are a great example of opportunistic feeding behaviour as they are mostly carnivores (even larvae) but if situation demands they can live on consuming seeds or detritus.

Importance of Carabids in Environment

1. Keystone organism: They play crucial role in pest management as they are carnivorous and primary predatory by nature, feeding off other small crop insects they control the population of pests.

2. Soil Dynamics: They contribute in nutrient recycling as they feed detritus of other insects. Their specialised front legs and head adapted are for making deep burrows (for nesting and laying eggs). By doing so they protect their egg chambers from predators and prevent dehydration. In this process they also increase soil fertility.

3. Acting as alert indicators: Due to specific demand for shelter, food and reproduction they show sensitivity to habitat changes like desertification, soil erosion and vegetation loss which makes them an impeccable early warning signaller for any environmental change.

4. Ecosystem engineers: They play great role in shaping ecosystem process. By burrowing the soil they aerate the soil and improve its structure and nutrient recycling as well.

5. Reflect diversity and population size of non-carabid species: As predators to many other insects their population is crucial to determine the population of other insects. If we see carabid fauna flourishing which ultimately mean other significant faunal diversity doing well in that area. That is how they become a key source to count the taxa.

Threat to Ground Beetles

The ground beetle plays an important role in balancing the ecosystem. They serves as a bridge in the physical geography of the sand and biological vitality of the region. Even after making significant contribution to the desert ecosystem, the beetle is constantly moving towards danger. Several species of Desert beetle (Tenebrionidae) are already considered threatened. The population of this beetle is very sensitive to environmental changes, such as climate change and desertification resulting from perpetually happening due to urbanisation, agricultural expansion, over grazing of cattle. All these human led

interventions have only added insult to injury and causing greater harm to these creatures. This must be a wakeup call for all the naturalists. We must come together and protect these beautiful creatures, so they can live in their natural habitat peacefully.

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Phersophus sobrinus (Fabricius, 1775)



Paussus sp.



Brachinus pictus Hope, 1833



Anthia sexguttata (Fabricius, 1775)



Red Dots on White Fields: The Quiet Story of Cotton Stainer Bugs

Aakriti

Some field trips seem the usual, until the one, which leaves a mark and quietly change the way you look at the crops forever. During a field visit to the agricultural fields of Osian village, Jodhpur district of Rajasthan, the semi-arid yet agriculturally active terrain offered rich opportunity to observe the insect diversity associated with cultivated crops. The landscape was dry, sunlit and stretched under the semi-arid sky. The region is known for its seasonal farming practices and semi-arid climate.

In the month of December, during peak winters, majority of the cotton bolls on the plants were open making the field appear white, however, a small number were still closed, giving the insects the favourable conditions to grow. During collection and observation, one of the most

striking encounter was the presence of bright red and black coloured insects, cotton stainers (Genus *Dysdercus*)



Cotton stainers are “True Bugs” of the family Pyrrhocoridae belonging to the order Hemiptera. The family Pyrrhocoridae consists of 450 species reported globally. Among these, 49 species under 13 genera (*Abulfeda*, *Antilochus*, *Dermatinus*, *Dindymus*, *Dysdercus*, *Ectatops*, *Euscopus*, *Indra*, *Melamphaus*, *Probergrothius*, *Pyrrhocoris*, *Pyrrhopeplus*, *Scantius*) are reported from India. From Rajasthan, three species have been reported, viz., *Dysdercus koenigii*, *Antilochus coquebertii* and *Euscopus indecorus*. The “Cotton Stainers” or “Red Cotton Bugs” belongs primarily to a single genus, *Dysdercus*, distinguished from other genera by the sharp white markings at the head and thorax junction and abdomen.



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concentrated in a bunch on cotton plants (*Gossypium* spp.). Their appearance in clusters on developing bolls immediately drew attention, not only because of their bright colour but also because of their strong association with single crop. Their absence from the nearby vegetation highlight a strong host association under local field settings. This observation eventually led to a deeper curiosity about their morphology, feeding behaviour, ecological role and habitual preference.

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the head and thorax junction and abdomen.

Members of *Dysdercus* genus are well known insects in agricultural entomology due to their parasitic association with cotton crop vegetation. During the visit, the bugs observed were mostly active nymphs and adults, often found dwelling and feeding directly on developing seeds inside the cotton bolls. The most noticeable thing was their striking morphology. Adult cotton stainers are medium-sized bugs with an elongated oval body, ranging from reddish-orange to deep red coloration with contrasting black markings on the wings and the thorax. Their body surface is relatively smooth and flattened, that allows them to move easily among cotton bolls and plant surface. The head is small and triangular that bears a distinct sucking-piercing beak (rostrum) that is tucked and folded under the body when not in use, but when feeding begins, it extends forward with precision. The beak is their primary feeding part, which is strong to penetrate the soft tissues of the developing seeds. True bugs in general, are “Liquid feeders”, that drink their food rather chew.

The antennae are slender, long and segmented which aids in sensory detection of the

surroundings. During rest, their wings are divided in hardened basal portion and a membranous tip (a characteristic feature of True Bugs: Hemiptera). When at rest, the wings lie flat over the abdomen, forming a neat “X” pattern on the elytra that is prominently visible to the naked eyes. The legs are longer, strong and well adapted for walking and gripping on the plant surface, especially the rough textured cotton stem and bolls. Unlike adult cotton stainers, nymphs lack the fully developed wings and appear more uniformly reddish with darker red patches, making them look small and wingless version of the adults.

Their bright warning coloration in combination of red, black and orange shows their aposematic behaviour. This signals the predators that they are non-palatable, because of either taste, chemical defence or learned avoidance. The bright colour of the bugs stood out sharply against the white cotton fibres, making them easy to detect from a distance. In the fields, the bugs were not randomly distributed. Instead, they were found in loose groups, occupying specific plants that had mature or open bolls. This typical grouping behaviour of Pyrrhocoridae helps in increased mating opportunities, protection

from predators and efficient feeding. In contrast, these bugs did not infest the surrounding crops and plantation, reinforcing the idea that cotton served as their primary host in this agricultural habitat.

India being the world's second largest cotton producer, consumer, and one of the largest cotton exporter, these bugs are considered as a threat to the cotton industry. As sap suckers, their continuous feeding activity and excrement lead to discoloration, quality and quantity reduction of cotton lint, which can cause around 40% yield loss, upto 88% reduced seed viability and upto 15% seed damage. Their preference for cotton over other nearby present vegetation indicates strong host selection behaviour and the favourable micro-climatic conditions within cotton fields that support their growth.

These bugs are also reported to attack Okra (*Abelmoschus*), *Hibiscus*, *Sorghum*, Maize, Wheat, Silk cotton tree (*Bombax ceiba*), etc. Despite being considered as pests, these bugs also plays a role in maintaining the ecosystem balance. They serve as both consumers of the

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plant resources and prey for birds and other predatory big insects, thus contributing to the food web within the agricultural landscape.

The cotton field landscape of Osian village offered more than just a glimpse of an agricultural landscape, a small world where cotton stainers play a visibly important role. Their distinct morphology, feeding behaviour,

social existence, ecological interaction and strong host association all come together to tell a story of adaptation, survival and scientific significance. Such field visit experiences deepen our understanding of insect life but also remind us that every agricultural field is a living ecosystem where complex interactions quietly unfolds.



Cotton Stainer Nymphs on Cotton Boll



Adult Cotton Stainer (*Dysdercus* spp.)



Stink Bugs: A Friend or A Foe?

Archana Sagar

Insects are the most diversified and dominating group on Earth which constitutes nearly 90 percent of the recorded diversity of the kingdom Animalia (Uniyal *et al.*, 1998). There are total 1,070,781 species of insects that have been described globally (Zhang, 2013). The class Insecta comprises of 2 subclasses i.e. Pterygota and Apterygota on basis of presence and absence of wings. The members of Apterygota are wingless, with no metamorphosis and it comprises 4 orders. The members of the subclass Pterygota are winged and are further divided into Endopterygota and Exopterygota on basis of location of development of wings. The members of the group Endopterygota shows complete metamorphosis and it comprises 10 orders. The insects of the group Exopterygota shows

incomplete metamorphosis and it comprises 16 orders.

Hemiptera is the fifth largest order of class Insecta after Coleoptera, Diptera, Hymenoptera and Lepidoptera (Forero, 2008). Hemiptera is widely distributed and highly diverse order of subclass Pterygota (Exopterygota) with most of the species are phytophagous or predators, and

is recognized as a monophyletic group (Henning 1969; Carver *et al.* 1991). Order Hemiptera can be identified by the particular structure of the mouth parts: the mandibles and maxillary laciniae are modified into concentric stylets, the mandibular enclosing the maxillary ones, both forming the food and salivary channels: the multisegmented sheet

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like labium is covering the mandibular and maxillary and labial palpi are always absent (Weber 1930; Henning 1969, 1981; Cobben 1978; Kristensen 1991).

Presently, the order Hemiptera is divided into two sub orders Homoptera and Heteroptera on the basis of location of origin of rostrum and wing modification. homopterans have uniform fore and hind wings with rostrum originating from base of front leg or from back of the head while Heteropterans have partially hardened fore wings and membranous hind wings with rostrum attached to apex of the head and hidden underside of abdomen. Heteroptera is further divided into eight infraorders: Gerromorpha, Nepomorpha, Enicocephalomorpha, Cimicomorpha, Dipsocoromorpha, Leptopodomorpha, Pentatomomorpha and Aradomorpha (Schaefer, 2013). Heteropterans can be terrestrial or aquatic. Aquatic heteropterans can be distinguished by reduced or concealed antennae, silvery velvety coating on their body, oval streamlined head structure and modifications in legs. Aquatic heteropterans come under infra orders Gerromorpha, Leptopodomorpha and Nepomorpha. Remaining infra orders of Heteroptera are terrestrial. According to Carl

“

Stink bugs are considered serious pests to agricultural crops. They suck out the plant juices from plant parts like fruits, nuts, seeds, stems etc. using their needle like mouth parts called rostrum

”

W. Schaefer, (2013) the infra orders of terrestrial Heteroptera are Enicocephalomorpha containing 400 species, Cimicomorpha includes more than 26,400 species (being largest heteropteran infraorder), Dipsocoromorpha has 320 species, Aradomorpha consists of about 1940 species and Pentatomomorpha comprises of at least 16,200 species.

These true bugs, occupy a varied range of habitats across the globe, thriving in nearly every environment except the extreme polar regions. Most species are terrestrial, congregating in areas with abundant vegetation where they inhabit plant foliage, stems, bark, or even the root systems deep underground. Beyond land, they also inhabit various aquatic niches; some on the surfaces of freshwater ponds and streams, others are fully submerged predators or scavengers in stagnant pools.

This remarkable adaptability allows them to flourish in environments ranging from tropical rainforests and arid deserts to human dwellings and salt marshes. The terrestrial bugs of family Pentatomidae which inhabit wide range of vegetation are very smelly.

People are often disgusted by swarming presence of pungent smelling insects called stink bugs. These shield-shaped insects frequently infiltrate homes and graze on crops, giving the impression that they are obvious pests due to the strong stench they emit when disturbed. Beneath their foul-smelling defense and poor image, however, is a more nuanced ecological tale that blurs the distinction between ally and enemy.

Stink bugs belong to the family Pentatomidae, a large group of insects with more than 4000 species worldwide. They can

be easily identified by their distinctive shield-like bodies and the foul odor they emit when handled or crushed — a defense mechanism meant to ward off predators such as birds and lizards. The pungent defensive spray composed of aldehydes and alkanes although the exact composition is species specific, is emitted through spiracles present on the metasternum of bugs.

Stink bugs are considered serious pests to agricultural crops. They suck out the plant juices from plant parts like fruits, nuts, seeds, stems etc. using their needle like mouth parts called rostrum. The most common plant feeding species of stink bugs which can be seen in agricultural fields are *Eurydema pulchra* (Westwood, 1837), *Bagrada hilaris* (Burmeister, 1835), *Carpocoris purpureipennis* (De Geer, 1773), *Nezara viridula* (Linnaeus, 1758), *Halyomorpha hylas* Stal, 1855, *Cyclopelta siccifolia* (Westwood, 1837), etc. They cause deformation, internal rot and leave behind blemishes while sucking out plant juice. The green stink bugs [*Nezara viridula* (Linnaeus, 1758)] affect the wheat and paddy crops by sucking the plant juice from the soft stems of the crops and seeds of the crops.

Despite so many problems caused by them, all stink bugs are not villains. Some species of stink bugs are predators that feed on pests like caterpillars, beetle larvae, and even other plant eating stink bugs.

The brown marmorted stink bugs (*Halyomorpha hylas* Stal, 1855) destroy fruit orchards and reduce its yield. A painted stink bug [*Bagrada hilaris* (Burmeister, 1835)] causes great damage to cauliflower and cabbage yield. The red coloured stink bug [*Eurydema pulchra* (Westwood, 1837)] destroy the seeds of wheat crops decreasing the profit of growers. Some of these act as disease vectors carrying diseases and tissue rot from one plant to other.

These stink bugs are seasonal menace as they seek warmth in human settlements, cluster in large numbers on walls and ceilings and window frames. Luckily, they don't bite but breed indoors and cause structural damage and not welcomed by home owners due to clustering habit and unpleasant odor secreted by them when disturbed.

Despite so many problems caused by them, all stink bugs are not villains. Some species of stink bugs are predators that feed on pests like caterpillars, beetle larvae, and even other plant-eating stink bugs. These predatory species play a beneficial role by acting as biological pest control agents which maintains ecological balance in nature. For instance, shiny blue shield bug (*Zicrona caerulea* Linnaeus, 1758) feeds on larvae of Chrysomelidae beetles that harm the strawberry plants. *Eocanthecona furcellata* (Wolff, 1811) act as biological control against Lepidoptera and coleopteran pests. Spiny soldier bugs, [*Podisus maculiventris* (Say, 1832)] feed on caterpillars and beetles harming the agricultural crops.

According to a research by Entomological Society of America, some plant feeding stink bugs contribute indirectly

to ecosystems. While feeding they create wounds on the trees through which trees ooze out sap, which is valuable food for hymenopterans like wasps and ants.

Some stink bugs like *Encosternum delegorguei* Spinola, 1850 are gathered and consumed in Limpopo Province of South Africa as they are rich in antioxidants, amino acids, fatty acids. These contribute to local food security and income of the Venda tribe. Despite their pungent odor, stink bugs contribute to biodiversity by acting as food for various African tribes.

Effectively controlling stink bug populations in residential and agricultural areas by understanding their role in the ecosystem helps maintain environmental equilibrium. These can be done by sealing entry points in homes and removing attractants like light in gardens and crops field. Crop cultivators can use integrated pest management (IPM) approaches for differentiating

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between pest and predatory species before spraying pesticides in their fields.

Therefore we can say that stink bugs serve as both ally and enemies. Some species wreak havoc on crops while others silently contribute to keep ecosystem healthy by reducing the population of crop pests.

Rather than considering them smelly intruders, we should remember that these pungent little insects plays role in maintaining ecological balance in nature. Lastly, stink bugs remind us that ecology is not story of saviors and evildoers but of relationships and even the smelliest creature serve a purpose.

Images of Some Sting Bugs



Carpocoris purpureipennis (De Geer, 1773) (Pest Bug)



Nezara viridula (Linnaeus, 1758) (Pest Bug)



Zicrona caerulea Linnaeus, 1758 (Predatory Bug)



Marine Water Strider: The Insects That Conquered the Marine Ecosystem

Swetapadma Dash

The marine ecosystem is traditionally dominated by organisms such as fish, corals, and whales, while insects, so abundant on land, are notably scarce in the open ocean. Most of the aquatic insects are restricted to freshwater environments like ponds, lakes, and streams, as they treat the salty, turbulent ocean like a death trap, but one insect genus decided to break the mold. Meet *Halobates*, the marine water strider. These are the only insects to have successfully colonized the open ocean, turning the vast, unforgiving blue into their personal playground.

Evolutionary Constraints and Ecological Barriers

Most of the insects are adapted to freshwater and almost entirely absent from the marine ecosystem due to the following reasons:

Most insects would shrivel up from osmotic water loss due to salt. There are no plants to lay eggs on or hide under in deep water. A single splash of wave could drown a creature that breathes through tiny holes in its sides (spiracles). But, against all odds, ten species of *Halobates* from India have successfully adapted to life in the marine ecosystem. They

don't just survive; they thrive in a world of predators and storms. **The survival mechanisms of *Halobates* in marine ecosystems** Survival in marine ecosystems is a matter of both the physics and fashion. The exoskeleton of marine water striders is covered in a specialized layer of superhydrophobic microtrichia. These microscopic hairs facilitate the formation of a

Meet *Halobates*, the marine water strider. These are the only insects to have successfully colonized the open ocean, turning the vast, unforgiving blue into their personal playground.

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But, against all odds, ten species of Halobates from India have successfully adapted to life in the marine ecosystem. They don't just survive; they thrive in a world of predators and storms.

plastron, a thin atmospheric boundary layer that prevents wetting and aids in **buoyancy** and **gas exchange**.

Life in the Marine Ecosystem

Locating food or a mate in the marine ecosystem might be challenging for insects, but *Halobates* are efficient predators. They live at the interface of air and water, with a portion of their body projecting into the air, which allow them to use wind for propulsion.

Diet

They are opportunistic predators and scavengers. Their diet consists of:

Zooplankton trapped at the surface level.

Fish spawn and hatchlings.

The remains of jellyfish, or "By-the-Wind Sailors" (*Velella velella*).

The Challenge of Oviposition

Perhaps the most significant challenge for a marine insect is to find a suitable egg-laying site. In the absence of aquatic vegetation found in freshwater habitats, *Halobates* must utilize alternate substrates. They lay their eggs on floating debris. Historically, this meant pieces of wood, pumice, or bird feathers. In the modern era, however, they have adapted to anthropogenic changes by utilizing the Great

The exoskeleton of marine water striders is covered in a specialized layer of superhydrophobic microtrichia.

Pacific Garbage Patch, laying thousands of eggs on floating plastic scraps.

Importance in Marine Ecosystem

Marine water striders may be small, but their ecological role is significant:

They are part of a specialized neuston (surface) ecosystem that scientists are still exploring.

They help to regulate populations of tiny marine organisms by acting as a key predator.

In a strange twist of ecology, their population growth signals a decline in environmental quality, as they capitalize on the very debris that characterizes a polluted ocean.

A Tiny Marine Colonist

The evolutionary history of the marine water strider represents a significant ecological triumph.

They lay their eggs on floating debris. Historically, this meant pieces of wood, pumice, or bird feathers.

Unlike most of the aquatic insects, which are restricted to fresh water, the marine water striders have crossed an ecological boundary. *Halobates* has not only entered this marine environment but also adapted to it, distinguishing itself as a

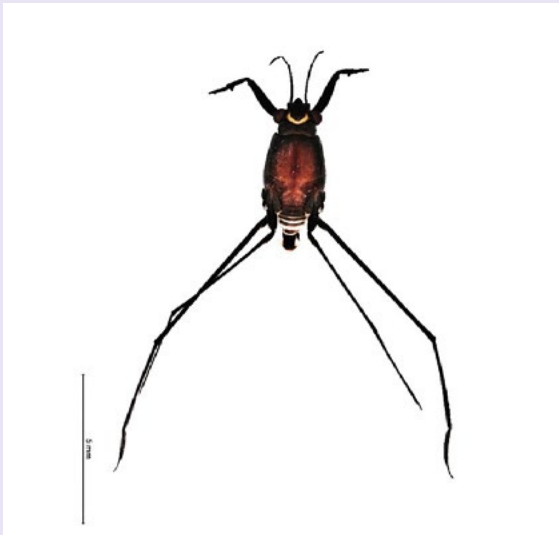
Interesting Fact

Despite living in the ocean, *Halobates* cannot survive on brine. They get their hydration from the bodily fluids of their prey or by drinking raindrops before they mix with the salty brine.

rare and resilient pioneer of the ocean's surface.

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Halobates elephanta Andersen & Foster, 1992.



Collection from Backwater



Under the Wax: Exploring the Hidden World of Mealybugs

Rakhi Das

Mealybugs often appear as small white cotton-like spots on the leaves, stems, or fruits of indoor and outdoor ornamental plants, or agricultural crops, or forest species. Though, they seem harmless, but are among the most destructive sap-sucking insects, belonging to the family Pseudococcidae under the order Hemiptera. Though they are very small in size and do not grab much attention, but causes significant damage to different plant species. Understanding their hidden world beneath the waxy covering is essential for developing effective management strategies and minimizing their impact on agriculture and ecosystems.

Mealy bugs are generally soft bodied, oval-shaped insect that are covered with powdery or filamentous wax that appears to be a white cottony layer, consists of Fatty acids,

ester, ketones, alcohol and cuticular hydrocarbons. This layer protects them not only from natural enemies but also from environmental stress and insecticides that are used for pest management. The wax layer is a crucial protective adaptation for the soft-bodied bugs as it helps to reduce water loss from the body in hot and dry weather and preventing the organism from overheating and drying out. The hydrophobic

nature of the wax prevents the insect from drowning and also protects them from rain and water spray. It also prevents insecticides to reach to the insect body and also act as a protective barrier against the parasitoides and predators.

The life cycle of mealybugs is very interesting and exhibits exceptional diversity. In suitable conditions, they can grow rapidly and can destroy the host

The wax layer is a crucial protective adaptation for the soft-bodied bugs as it helps to reduce water loss from the body in hot and dry weather and preventing the organism from overheating and drying out.

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Though many species reproduce sexually but many of them can also reproduce parthenogenetically, which helps in rapid population growth, without the help of any male individual.

plant very easily. Though many species reproduce sexually but many of them can also reproduce parthenogenetically, which helps in rapid population growth, without the help of any male individual. Depending on the species, females can either lay eggs or can give birth to live young individuals. The immature mealybugs are highly mobile in nature that is capable of infesting other unaffected branches of the host plant or other nearby host plants. The dispersal of mealybug to new host plants is also possible through wind as the first and second instar is very small in size and also through ant associations. Once they reach to the new host plant, they insert their stylets into the plant tissue to suck the sap from the plant for nutrition and generally become stationary to that place.

One of the most interesting facts about mealybugs is their

mutualistic association with ants. Mealybug produces a sugary substance called 'honeydew', which they produce as a by-product of plant sap feeding. This honeydew is a major source of food and nutrition for the ants. In return, the ants protect these tiny

One of the most interesting facts about mealybugs is their mutualistic association with ants. Mealybug produces a sugary substance called 'honeydew', which they produce as a by-product of plant sap feeding. This honeydew is a major source of food and nutrition for the ants. In return, the ants protect these tiny insects from the predators and parasites that allows the mealybug colonies to thrive.

insects from the predators and parasites that allows the mealybug colonies to thrive. The ants also help to keep the mealybug colonies clean by removing the dead individuals. They can also transport the mealybugs to the new feeding sites of the host plant or also to some other new host plants nearby.

Pest status and associated economic losses: Worldwide, mealybug is considered one of the most important agricultural pests. As these individuals sucks the plant sap and drain the nutrients of the plant, it leads to disruptive physiological processes that weaken the plant and the plant shows symptoms like leaf yellowing, stunted

growth, premature leaf or fruit drop and in some severe cases the plant may also die. They mostly affect plants like citrus, papaya, grapes, cotton and different horticultural plants. They also act as a vector of many viruses borne diseases.

How to get rid of this tiny menace? It is very difficult to control mealybug infestation with insecticides as it has a protective wax layer around its body that limits its effectiveness. Regular monitoring and removal of the infested plants or part of the plants is very necessary. Its natural enemies like ladybird beetles, parasitoid wasps and lace wings also helps to regulate its population naturally. The best way to control it is Integrated Pest Management, that is combining different strategies together.

“ Its natural enemies like ladybird beetles, parasitoid wasps and lace wings also helps to regulate its population naturally. ”



Mealybug (*Ferresia sp.*) after slide mounting



Croton plant with dry and dead leaves due to mealybug infestation

Croton (ornamental plant) infested with mealybug Croton plant, almost died due to mealybug infestation



Guava plant with mealybug infestation

Plumeria pudica with mealybug infestation



“DNA Barcoding”- a Double-Edged Sword in Taxonomy: Insights from Indian Cockroach Diversity

A. Shabnam

DNA barcodes was formally introduced by Paul Hebert and team in 2003, which involves using a standardized genetic marker, most commonly a ~650 base pair region of the mitochondrial cytochrome c oxidase I (COI) gene for species identification across the animal kingdom. Although not supported across the entire animal kingdom with limitation and constraints attributing to gene evolution rate and utility in delimiting species, but the gene is widely used and accepted within arthropods for molecular studies. This technique operates on the principle that closely related species have more similar DNA, while distantly related ones show greater divergence.

DNA barcoding has advanced taxonomic research by efficient species-specific identities

even in challenging scenarios like damaged specimens, specimens from diverse life stages of an organism, morphologically cryptic species complexes which has limitation in classical methods. It has accelerated the pace of species discovery and resolved taxonomic ambiguities across arthropod groups. However, the technique is efficient only when a well curated, authentic,

voucher-specimen affiliated DNA barcode reference library already exists for any group. Without a reference library, DNA barcode aren't of much help by themselves, as any inference can only be derived when the data is compared with existing data. Apart from data pre-requisite, another constraint with DNA barcode-based identification is the authenticity of the data. If a mislabelled

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Apart from data pre-requisite, another constraint with DNA barcode-based identification is the authenticity of the data. If a mislabelled sequence exists in the database, and it matches with the query sequences in NCBI BLAST by a non-taxonomic expert, eventually it keeps multiplying the erroneously labelled data in the database and other end users, acting as a double-edged sword if the tool is not used correctly.

sequence exists in the database, and it matches with the query sequences in NCBI BLAST by a non-taxonomic expert, eventually it keeps multiplying the erroneously labelled data in the database and other end users, acting as a double-edged sword if the tool is not used correctly.

Across insect groups, two recurring issues emerges. First, discrepancies frequently arise between morphology-based identifications by taxonomic

experts and sequence-based identifications obtained through DNA barcoding and BLAST searches. Such incongruence highlights the high degree of crypticity in many insect taxa and underscores the limitations of relying solely on traditional morphological approaches for species identification.

One such example of DNA barcoding misleading the species identities due to unavailability of data is as follows. This study commenced a few years

ago with the collection an intriguing cockroach specimen from the forests of Tamil Nadu. To ascertain its identity, the specimen was barcoded. BLAST searches revealed no perfect match with existing sequences in the database; however, it exhibited partial similarity to the genus *Cryptocercus*. Assuming it belonged to this genus, we conducted phylogenetic analyses. Contrary to our hypothesis, it was not *Cryptocercus*. This unexpected result led us to further investigate. A thorough review of the literature on wingless cockroaches from India indicated that it is an endemic species, *Salganea rehni*, as reported by Kalwate et al. (2022). Therefore, DNA barcode-based identification is often inadequate for unique or poorly represented taxa, particularly where reference sequences are scarce or absent. In such cases, barcode matches cannot provide reliable species-level assignments, where species inventories remain incomplete and barcode data are largely unavailable. Consequently, exclusive reliance on DNA barcoding in such contexts may be both, a wonderful tool when

reference data present , and also problematic and insufficient in absence of authentic data and expertise.



Neolobopetara peninsularis-first cockroach species described based on DNA barcodes from India

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The Twisted Tale of Termite Mandibles

Sharmistha Das

Termites (Order: Blattodea; Infraorder: Isoptera) are eusocial insects that play a crucial role in decomposition and nutrient cycling in terrestrial ecosystems. Their caste system—workers, soldiers, and reproductives—shows distinct morphological specialization. Among these, mandibles are essential structures used for feeding, construction, and defense. Worker mandibles are adapted for processing wood, soil, and organic matter, with well-developed cutting and grinding regions. In contrast, soldier mandibles are highly specialized for defence, exhibiting diverse forms such as crushing, piercing, sabre-shaped, and snapping types. Mandible morphology is therefore important for understanding termite ecology, taxonomy, and evolution. The mouth parts of termite consists of a pair of mandible, a pair of

maxillae and a median ,fused labium. The two mandible which are of the biting-chewing type, are massive, squarish, hard dark coloured structured lying on either side of the mouth. The soldier mandibles show

an enormous and rather inexplicable degree of variability in size and shape. The may be long, massive and multidentate, long and sword like; long; twisted and asymmetrical ; in most Nasutitermitinae they are minute and vestigial.

“ Worker mandibles are adapted for processing wood, soil, and organic matter, with well-developed cutting and grinding regions. The soldier mandibles show an enormous and rather inexplicable degree of variability in size and shape. ”

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Different type of mandible structure in soldier caste of termite.

The asymmetric mandibles of termites are hypothetically more efficient, rapid, and powerful than the symmetric mandibles of snap-jaw ants or termites. Early work by Hare demonstrated that soldier mandible morphology provides significant insights into termite phylogeny, with increasing specialization reflecting evolutionary advancement among termite lineages.

Functions of Termite Mandibles

Termite mandibles are highly specialized mouthparts that perform multiple essential roles, varying across castes.

1. Feeding

The mandible of the workers serve the main purpose of cutting, grinding and crushing various types of food, including soil, wood, leaf litter, paper and fungal material.

2. Construction of Nest

» Mandibles are used to exhume soil, mould the

galleries, and construct nests (Carton nest in *Microcerotermes* sp.) or mounds.

» Workers manoeuvre soil and wood particles to maintain colony structure.

3. Brood care

» Workers use mandibles to carry, groom, and protect eggs and larvae, ensuring proper growth.

4. Defence

» Soldier mandibles are specialized for colony defence. They are used to Bite and attack predators by secreting fluid (e.g., ants) .Block the tunnels, Crush or pierce intruders by strong grip of mandible.

» In inquilines, defensive needs may prevail over building and foraging, it

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seems adaptive for inquiline termite workers to have mandibles modified for defence. These adaptations play relevant roles in the defence/attack dynamics of guests and hosts. In termite workers, the size and position of the apical tooth relative to the marginal teeth may arm termite hosts and termite inquilines with an effective defensive weapon.

5. Special defence mechanism

» Some termites possess snapping mandibles that deliver rapid, high-force strikes producing a spark like sound.

» Others have sabre-shaped or asymmetrical mandibles adapted for specific defensive strategies.

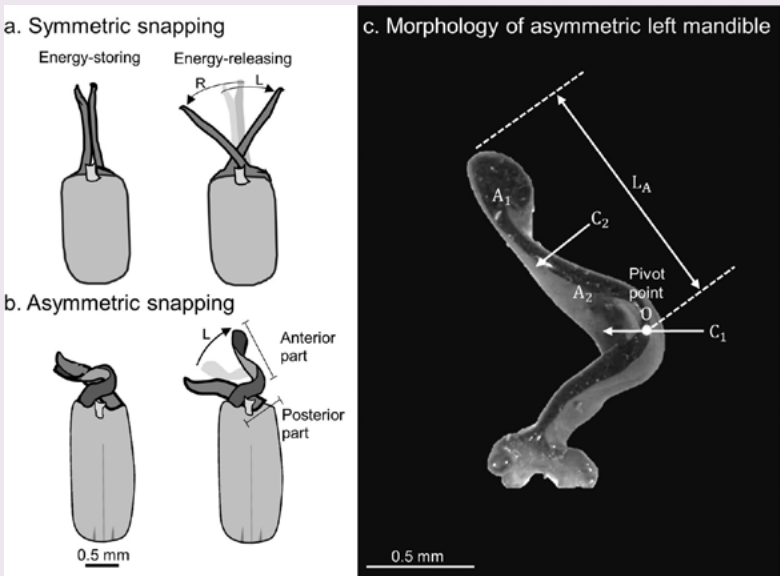
6. Transport of material.

» Mandibles help in transporting food, building materials, and waste within the colony.

The asymmetric mandibles of termites are hypothetically more efficient, rapid, and powerful than the symmetric mandibles of snap-jaw ants or termites.

7.Communication

Some termite use their mandibles to create vibrations or sound to relay signals, especially in alarm situation.



The robustness of Termite mandibles are often enriched with Zinc (Zn) and Manganese (Mn). These metals increase hardness, wear resistance and cutting efficiency.

The robustness of Termite mandibles are often enriched with **Zinc (Zn) and Manganese (Mn)**. These metals increase hardness, wear resistance and cutting efficiency. The study of termite mandibles provides insights into the evolution of insect feeding mechanism and the development of sclerotized structures. The Complex interplay between genetic factors, development processes, and environmental pressures has resulted in the remarkable diversity of mandibles morphology observed in termites.



Odonates of the Sundarbans: Survival in a Saline World

Suranjana Banejee

The Sundarbans located in south West Bengal is famous for harbouring the largest active delta on Earth and the world's largest mangrove ecosystem. It is recognised as a UNESCO World Heritage site for its immense biodiversity and globally renowned for its tidal forests, labyrinthine creeks, unique flora adapted to saline environment and the magnificent Royal Bengal Tiger. It plays a crucial role as a major carbon sink in coastal protection against cyclones. Yet, hidden beyond this dynamic unique landscape lies a lesser-known, fascinating group of ancient insects which are the colourful Odonates, comprising of the swift dragonflies and slender damselflies. These colourful yet resilient insects thrive in a harsh landscape where land and water constantly negotiate space, and where salinity poses a formidable survival challenge.

A Challenging Habitat

Unlike typical freshwater habitats that support abundant Odonate diversity, the Sundarbans delta present an unstable, harsh environment that poses daily survival challenges for Odonates whose life cycle is intimately tied to water. The aquatic life of Odonates is made continuously unstable by tidal inundations, fluctuating water salinity and a mosaic of brackish water creeks, large mudflats, and tidal mangrove creeks. In

order to overcome an adverse environment Odonates demand remarkable adaptability in their life cycle. "For odonates, the saline waters of Sundarban islands are not just a habitat—it is a survival story of tolerance." Most Odonate females lay eggs in freshwater or slightly brackish water habitats, where their aquatic larvae (nymphs) hatch before emerging as adults. High salinity can disrupt osmoregulatory balance in larvae, posing threats to

It is recognised as a UNESCO World Heritage site for its immense biodiversity and globally renowned for its tidal forests, labyrinthine creeks, unique flora adapted to saline environment and the magnificent Royal Bengal Tiger

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Unlike typical freshwater habitats that support abundant Odonate diversity, the Sundarbans delta present an unstable, harsh environment that poses daily survival challenges for Odonates whose life cycle is intimately tied to water.

survival. As a result, the Odonate assemblage in the Sundarbans is shaped not just by availability of varied habitats in the islands like saline and freshwater ponds in villages, agricultural fields, brackish marsh, roadside canals, scrublands, beachside vegetated creeks, mudflats, mangrove forests and estuaries but by the ability to tolerate or avoid saline stress. Mangrove habitats support only a select group of adaptable dragonfly and damselfly species compared to freshwater habitats. This is because salinity limits larval development and breeding is often restricted to freshwater pools, rain fed ponds and rice fields scattered across the mangrove matrix. Therefore, adults which are observed perching on tidal mudflats or pneumatophores are often using the area only for resting or feeding rather than breeding or laying eggs.

Odonate Diversity in the Mangrove Landscape

The Sundarban mangrove islands despite the presence of adverse environmental conditions supports a modest but important assemblage of Odonates. The species encountered in these islands are significantly those with broader

As a result, the Odonate assemblage in the Sundarbans is shaped not just by availability of varied habitats in the islands like saline and freshwater ponds in villages, agricultural fields, brackish marsh, roadside canals, scrublands, beachside vegetated creeks, mudflats, mangrove forests and estuaries but by the ability to tolerate or avoid saline stress.

ecological tolerance, often recognised as euryhaline species or associated with freshwater pockets within the domain of a wide mangrove matrix. Mangrove habitats usually support fewer odonate species in comparison to freshwater dwelling Odonates because fluctuating salinity levels constraints larval development. During a rapid Odonate diversity and habitat association documentation survey in March 2026 in coastal Sundarbans (Amrabati, Lakshimpur, Bijaybati, Debnibas in Fraserganj, Henry's island, Susni Island and Fedric Island near Bakkhali) several odonate species that are regularly recorded from the Sundarbans mangrove and coastal belt of West Bengal were encountered

The species encountered in these islands are significantly those with broader ecological tolerance, often recognised as euryhaline species or associated with freshwater pockets within the domain of a wide mangrove matrix.

during surveys in different habitats like mangrove creeks, coastal scrubs, mangrove forests, brackish marshes, mudflats, aquaculture ponds, village ponds, paddy margins and irrigation canals of localities like Bakkhali, Fraserganj, Henry's Island, and nearby tidal creeks of Susni Island. *Brachythemis contaminata*, *Orthetrum sabina*, *Diplacodes trivialis* and *Pantala flavescens* were the four common Libellulid dragonfly species that were frequently sighted. These dragonfly species are well-known for their ecological plasticity and ability to exploit polluted or disturbed habitats. *Brachythemis contaminata* or the common ditch jewel is a highly tolerant species found in disturbed and slightly brackish wetlands and seen around tidal creeks and mangrove mudflats that serves as a microhabitat for this species. They were

frequently observed to be resting on pneumatophores that served as a perching substrate. These dragonflies rest at ground level and this common behaviour was observed at the study site. During the field study *Orthetrum sabina*, *Diplacodes trivialis*, *Pantala flavescens*, *Crocothemis servilia* and *Rhyothemis variegata* were some of the dragonfly species collected from the open coastal mangrove habitats that are remarkable for tolerating

The heavy showers of the monsoon season often actively aid in reducing salinity levels in the coastal waters creating favourable conditions for reproduction, egg laying and larval development.

fluctuating salinity levels and survive in disturbed wetlands. *Neurothemis tullia* and *Acisoma panorpoides* were the two dragonfly species collected near freshwater ponds and rice fields near the surrounding villages. As because true mangrove water is often saline, breeding sites for Odonates are usually the freshwater ponds and rice fields in the nearby rural areas. It was observed that female Odonates laid eggs and bred mainly in rain-fed ponds, freshwater pools, and rice fields near mangroves. The surrounding mangrove forests and tidal mudflats were preferred microhabitats for these dragonfly species for resting or catching preys rather than breeding. Among damselflies, family Coenagrionidae dominated the landscape. *Ceriagrion coromandelianum* was found to be tolerant to saline waters and widely recorded from less saline ponds or temporary fresh water

bodies such as village ponds, rain-fed pools and irrigation canals. *Ischnura senegalensis* and *Agriocnemis pygmaea* were found near village freshwater ponds and rice fields and thrived in habitats with lower salinity levels. *Ischnura senegalensis* the coenagrionid damselfly, is known to be moderately tolerant to brackish water but generally prefers freshwater or low-salinity habitats in the Sundarbans delta. Species diversity in Sundarban Odonates is often closely linked to seasonality. The heavy showers of the monsoon season often actively aid in reducing salinity levels in the coastal waters creating favourable conditions for reproduction, egg laying and larval development. Several temporary freshwater habitats emerge in mangrove pockets allowing a vibrant Odonate population to expand. In contrast, the dry summer season brings increased salinity and habitat contraction, with disappearance of several species and reduced species distribution.

Strategies for Survival

The persistence of Odonates in the Sundarbans is a testament to their unique ecological versatility. Several strategies enable them to survive in this saline world. Habitat Selection is a key survival strategy for many

In turn, both larval and adult Odonates serve as prey for many coastal birds, spiders, and larger insects, forming an integral part of the food web. Their presence also highlights the availability of a mosaic of aquatic habitats, making them useful bioindicators of diverse ecological conditions, even in such a complex environment ranging from open water to dense mangrove cover.

dragonfly species. *Brachythemis contaminata* regularly tolerates brackish or slightly saline environments, which is why it is frequently seen on mangrove mudflats and tidal creeks. While, some dragonflies are widely tolerant others such as *Diplacodes trivialis*, *Orthetrum sabina* and *Crocothemis servilia* choose open dry ground near freshwater habitats or perch on bare soil, sand, or stones during feeding or resting near microhabitats like sea beaches. Thus, habitat selection often helps certain species to avoid saline stress and instead select microhabitats with lower salinity, such as freshwater pockets of rainwater pools, fish farms and temporary man-made water bodies such as roadside

village canals. Adapting a rapid life cycle is another strategy adopted by damselflies like *Agriocnemis pygmaea* and *Ischnura senegalensis*. These damselflies often take advantage of short windows of favourable conditions during monsoons to complete their life cycle rapidly, thus ensuring their continuity in this mangrove ecosystem. This strategy is particularly helpful in temporary freshwater habitats that may not persist throughout the year. The survival strategy of long dispersal is seen in *Pantala flavescens* which is a powerful flier and strong migrant species. It allows this species to colonize newly formed island habitats rapidly and escape detrimental environmental conditions. Another, useful survival strategy

Sundarbans is under increasing pressure from escalating climate change; sea-level rise related to global warming and anthropogenic activities. Rising salinity due to reduced rainfall and increased tidal ingress are significant threats to freshwater-dependent organisms, like Odonates. The indiscriminate cutting of mangrove forests for constructing fishery ponds in Henry's Islands is causing serious habitat loss, pollution, and the conversion of mangrove forest lands for agriculture or aquaculture further reduce suitable breeding sites for these insects.

is often moderate physiological tolerance to saline stress borne by these common Odonates of the Sundarbans giving them an edge in brackish environments as true halophily (salt-loving adaptation) is rarely observed in Odonates.

Ecological Role of Odonates in the Sundarbans

During this study tour, even though Odonate species diversity was found to be less in several parts of these islands of Sundarbans, every species found here play important ecological roles by predated upon larval and adult insect populations of several Orders like Diptera, Hymenoptera and

Lepidoptera. This makes them valuable natural biocontrol agents of harmful insect populations. In turn, both larval and adult Odonates serve as prey for many coastal birds, spiders, and larger insects, forming an integral part of the food web. Their presence also highlights the availability of a mosaic of aquatic habitats, making them useful bioindicators of diverse ecological conditions, even in such a complex environment ranging from open water to dense mangrove cover. Moreover, as bioindicators, Odonates act as useful tools to monitor slightest changes in habitat quality, particularly in response to salinity shifts during

tidal changes and hydrological alterations. They serve as barometers of climate change and ecological imbalance.

Threats and Conservation Concerns

The present study revealed high levels of plastic pollution in many pockets near the beaches of Bakkhali, Henry's island and Fedric island, most importantly due to continuous tourist inflow. Sundarbans is under increasing pressure from escalating climate change; sea-level rise related to global warming and anthropogenic activities. Rising salinity due to reduced rainfall and increased tidal ingress are significant threats to freshwater-dependent organisms, like Odonates. The indiscriminate cutting of mangrove forests for constructing fishery ponds in Henry's Islands is causing serious habitat loss, pollution, and the conversion of mangrove forest lands for agriculture or aquaculture further reduce suitable breeding sites for these insects. The smallest of freshwater habitats which are crucial for sustaining odonate assemblages in this saline ecosystem deserve greater attention in conservation planning and should not be overlooked.

These insects demonstrate their capability to adapt to environmental extremes and revealing their unique power of resilience.

Significance of Sundarban Odonates

The Sundarban Odonates move between natural agricultural landscapes and human-modified habitats like aquaculture ponds of Henry's Island to the mangrove forests in the fringe areas of the Sundarbans seas linking ecological processes across physiogeographic zones. The present study was not merely about documenting species diversity but offered valuable insights into ecological flexibility and survival strategies. These insects demonstrate their capability to adapt to environmental extremes and revealing their unique power of resilience. In a protected

Biosphere Reserve dominated by the charismatic elusive tigers, Odonates may seem insignificant. The magnificent golden colours of the beautiful *Rhyothemis variegata* hovering amidst the Sundari trees near mangrove creeks or the brilliant yellow flashes of

Their inspiring story is not one of abundance, but of adaptation and of survival in a challenging environment, and even thriving in a saline dominated landscape where few freshwater species dare to flourish.

Ceriagrion coromandelianum darting across sunlit rice fields and the sudden shimmers of golden yellow wings of a resting *Brachythemis contaminata* perching on mangrove roots conveys joyous reminders that even in the most challenging environments, life continues to persist. The Odonates of the Sundarbans exemplify quiet resilience. Their inspiring story is not one of abundance, but of adaptation and of survival in a challenging environment, and even thriving in a saline dominated landscape where few freshwater species dare to flourish.



Common Habitats and Odonates of Henry's Island in Sundarbans



Garden Sentinels: Life cycle and Diversity of Praying Mantids in India.

Pallabi Priyadarsini

Previously placed in a single Order Dictyoptera, along with its sister group Blattodea (cockroaches and termites) , Praying mantis were elevated to a separate order Mantodea in the class Insecta by German Zoologist Burmeister in 1838. The etymology of “Mantids” or “Praying mantids” is derived from the Greek word “*mantis*” which means “Prophet”, based on its prayer like posture of forelegs (Wikipedia:Mantis).

The Fossil history of Mantids revealed an ancient insect ancestry, with its existence since early Jurassic period and modern age mantids, believed to be originated on Gondwana in cretaceous strata (Svenson and whiting, 2009).

Diversity: Mantid often neglected in taxonomic studies in Indian subcontinent plays an crucial role in maintaining the ecological stability as an active predator. Globally the

order Mantodea is distributed worldwide in mostly tropical and temperate regions and has 2500 named species belonging to 436 genera and 31 families (Anderson, 2022). According to the published article on renowned journal Zootaxa, India supports a remarkably rich mantid fauna, comprising 171 described species distributed among 70 genera and 13 families and these taxa span a diverse array of habitats, with many maintained in tropical and subtropical ecological matrices.

Despite India being a mega biodiversity country, taxonomic study of these important group is largely neglected with some scattered available data. According to the Faunal Checklist published by Zoological survey of India (2024). The diversity of praying mantids in India are well documented in Western ghats (Maharatra, Kerela , Tamil Nadu), follwed by Uttar Pradesh and West Bengal whereas other parts of the country like deserts, semi arid

“ The Fossil history of Mantids revealed an ancient insect ancestry, with its existence since early Jurassic period and modern age mantids, believed to be originated on Gondwana in cretaceous strata. ”

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areas, islands, northeast India, Gangetic plains, Central India and Parts of Deccan Plateau remained neglected.

Biology: Mantids shows hemimetabolous metamorphosis or incomplete metamorphosis with three developmental

stages: egg (within the ootheca), nymph, and adult.



Bark Mantis of Family Liturgusidae exemplifies the cryptic colouration that helps in camouflage.

The average lifespan of praying mantids is about one year, although it varies among species (approximately 3 months to 1 year). females lay 12-400 eggs in a frothy liquid mass on twig or underside of leaves the leaf of a plant which hardens as soon as it comes in contact with air is called ootheca. The size and shape of ootheca vary from species to species. Ootheca formation is a long process which may takes many hours while the incubation period is 16 days after which nymphs emerge out of the ootheca (Mukherjee *et al.*, 1995).

“The average lifespan of praying mantids is about one year, although it varies among species (approximately 3 months to 1 year). Females lay 12-400 eggs in a frothy liquid mass on the twig or underside of the leaf, which hardens as soon as it comes in contact with air is called ootheca.”



Ootheca of Hierodula species after the nymph emerged.

Nymphs are wingless replica of adults or sometimes completely different from the adult (mimic ants). They are also the active predators feed on small and soft bodied insects, cannibalism is sometime observed between the siblings. Nymphs undergo 7 instars with total development time about 80-90 days. While the nymph emergence time varies in different climatic zones in India.

“Nymphs are wingless replica of adults or sometimes completely different from the adult (mimic ants).”



Fig.4. Nymph of Hierodula species.



Nymph of *schizocephala bicornis* (Linne, 1758) in its natural habitat where it mimicking dry Grass

Adult mantids characterized by fully developed or reduced wings. Mantids show sexual dimorphism where females are usually larger than males. The size of an adult mantid ranges from 1-17 cm. (Sureshan and Kamila, 2023).

Morphology: Mantids are characterized by a triangular head which can rotate 180 degree, mantids exhibits unique morphological features which significantly differentiate it from its other closely resembled orders like Phasmida and Orthopteras. It posses two big bulbous compound eyes supported by a flexible neck. One of the striking morphological characters of mantid is their raptorial forelegs adapted for grasping prey.



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Adult *Heirodula tenuidentata* saussure, 1869

Ecology and Behaviour: As the name suggests mantids usually exhibits posture either upright of hanging up to downwards with forelegs folded in praying position. It represents a group of predatory insects, recognized for their exceptional morphology

, cryptic variation and complex behaviour such as “Sex Cannibalism” where usually gravid female cannibalizes the mate during the copulation and usually male complete the process without a head. mantids are one of the most

precise groomed insects who love to preen themselves by cleaning their antennae, wipe their eyes and head using their raptorial legs, cleaning forelegs most of the time. (Sureshan and Kamila, 2023).



Grooming behaviour of *Heirodula tenuidentata* saussure, 1869

Diet: Praying mantids are the active predators that destroys both noxious and beneficial insects shows an opportunistic predation, their camouflage and mimicry help them help it to catch its Prey. Mantids are exclusively carnivores, feed primarily on other arthropods as well as small vertebrates, which in turn make it one of the crucial part to maintain herbivore diversity and important part of the food chain. It also regulates



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insect pest population including agricultural pests. Thus in this article they are recognized as the “**Sentinels of the Gardens**”.

A study of mantids behavioral study was conducted on *Ambivia undata* (Fabricius, 1793) in a plastic enclosure, mimicking its natural habitat with twigs and leaves. Various insects from different orders were introduced to assess food preference. The key findings were like mantid prefer more active insects like Orthoptera (grasshoppers, crickets), Coleoptera (beetles) more than Lepidoptera (moth and its larvae) and Hymenoptera (wasp and bees) with Millipedes were consistently rejected. The hunting and Grooming behaviour were also studied where the mantis maintained downward praying posture waiting for ambush style of predation and thoroughly grooms its raptorial forelegs after each meal and at regular intervals. This systematic food preference and meticulous grooming habit highlights specialised predatory adaptations in mantis *Ambivia undata* (Fabricius, 1793) highlighting its pest control efficiency for justifying the name “**Sentinels of the Gardens**”.



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Mantis *Ambivia undata* (Fabricius, 1793) in artificial enclosure, feeding on Moth Larvae.



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Where to look for Mantids:

Ecologically, mantids occupy a wide range of habitats ranging from Grasslands to Gardens, Forests to agro-ecosystem, where they ambush prey through excellent camouflage and are generally active in sunny days.

Threats: Mantids are one of the ecologically important yet poorly explored Insect groups. The life history traits, ecological roles, predatory as well as its complex behaviour make it one of the vital part of terrestrial ecosystem. However various factors like habitat destruction, use of insecticides, urbanization and habitat fragmentation specially lack of scientific attention pose challenges to their conservation. Despite their ecological importance mantids still remain as one of the lesser studied group in the Indian subcontinent. Accessing species distribution status at a regional level is highly beneficial for effective conservation planning. Further, taxonomic research on this ecologically important group is the need of the hour in order to evaluate exact Mantodea diversity.



Despite their ecological importance mantids still remain as one of the lesser studied group in the Indian subcontinent. Accessing species distribution status at a regional level is highly beneficial for effective conservation planning.



Heirotula tenuidentata Saussure, 1869 in its natural habitat mimicry as a leaf.



Centipedes: Nature's Fast, Fierce... and Misunderstood Neighbours

Thapasya K.

If you have ever lifted up a stone after rain or switched the lights on bathroom at night, chances are there that you have had a surprise encounter with a centipede. With their many legs, lightning-fast movement, and slightly intimidating appearance, centipedes often trigger fear. But behind that fear lies a fascinating and important creature that quietly helps keep our environment balanced.

Centipedes (Chilopoda) are one of the four important lineages of Myriapoda. They are poisonous, solitary, carnivorous, nocturnal, and cryptic; prefer wet and moist places as habitats; and are known from all countries except Antarctica. Their bodies are long, flattened, and divided into segments, each bearing a single pair of legs. Unlike their slow-moving cousins, the millipedes, centipedes are active predators. They have a

pair of modified front legs called forcipules, which inject venom into their prey. It is medically important due to the presence of powerful neurotoxic venom.

The centipedes are grouped in five orders:

- » **Order Scutigermorpha** – House centipedes (*Scutigera*) are long-legged and fast and have 15 pairs of elongated legs.
- » **Order Scolopendromorpha** – The order

scolopendromorpha are the most aggressive and most voracious predators among the centipedes. Large tropical centipedes like *Scolopendra* are present.

- » **Order Geophilomorpha** – Soil-dwelling, it is a worm-like-bodied centipede with 29-191 pairs of short legs.
- » **Order Lithobiomorpha** – Smaller, ground-dwelling species under stones and leaf litter. it also has 15 pairs of legs.

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Centipede uses its forcipule to kill or capture prey like insects but they were also capable to capture small vertebrates, like lizards, amphibians, rodents, snakes and even birds and bats.

- » **Order Craterostigmomorpha** – Soil centipede, with only one or two species described from this order from Tasmania and New Zealand. It also has 15 pairs of legs.

The order Scolopendromorpha is studied in India as compared to other orders. Scolopendromorpha divided into 5 families: Scolopendridae, Cryptopidae, Mimopidae, Scolocryptopidae, Plutonimidae.

Masters of Hunting

Centipedes are strictly carnivorous. They hunt at night, using their antennae to sense vibrations and locate prey. Once they detect movement, they strike quickly, injecting venom to immobilize their victim. Centipede uses its forcipule to kill or capture prey like insects but they were also capable to capture small vertebrates, like

lizards, amphibians, rodents, snakes and even birds and bats. They are predators of many species of pests of crops such as millipedes, groups of harmful beetles, and moths. This makes them important natural pest regulators, especially in agricultural and household environments.

Habitat

Centipedes are found in wet forests and woodlands, but many species also exist in dry forests, grasslands and deserts. In the littoral zone, several Geophilomorpha seek seaweed

clusters. Other species have a penchant for caves, and few are cave-specific. Even for a single species, centipedes can endure elevations ranging from sea level to high mountain summits. While some have very specific microhabitat, most centipedes thrive well in diverse microhabitats such as rotting logs, agricultural fields, bathroom corners and basements during monsoons. Centipedes become abundant in the rainy season due to high humidity and abundant food sources.

Importance in Ecosystems

Centipedes fulfil many important functions in the ecosystem through their ability to reduce numbers of harmful insects without using chemical pesticides and being natural pest controllers. Being soil and leaf litter dwelling animals, they play a role in decomposition and aeration of soil. They are preys to various animals like

Even for a single species, centipedes can endure elevations ranging from sea level to high mountain summits

Centipedes fulfil many important functions in the ecosystem through their ability to reduce numbers of harmful insects without using chemical pesticides and being natural pest controllers.

birds, reptiles, frogs, and small mammals thus playing an integral part in the ecosystem through functioning as the link in the food chain and food web. Centipedes can be taken as indicators of the health of the habitat with respect to its moisture and organic material. In other words, finding a centipede in your garden means that the centipede is doing free pest control work for you. Centipedes are not dangerous animals.

Centipedes and Humans: Should You Be Concerned?

Centipedes are not harmful as people tend to think about them. Centipedes that belong to the *Scolopendra* can give you a painful bite causing swelling and redness on the skin. The venom produced by these animals serves more for hunting than for harming people; hence

severe conditions rarely develop and are connected with allergic reactions. Centipedes prefer to keep away from humans and attack only if they are touched or provoked.

Venom: From Fear to Medicine

The most intriguing thing about these animals is their venom that has evolved from something terrifying to something beneficial for people. Centipedes called “Wu Gong” are dried and used

in Chinese traditional medicine for different purposes. They are believed to have properties such as anti-inflammatory effects, pain relief (analgesic properties), anticonvulsant uses (for conditions like seizures and spasms), treatment of stroke-related symptoms (in traditional formulations), skin conditions and infections. Centipede extracts are often used in carefully prepared herbal formulations, not as raw venom. China uses centipede *Scolopendra mutilans* Koch, 1878 for treating many disorders such as stroke induced hemiplegia, epilepsy, apoplexy, whooping cough, tetanus, burns, tuberculosis, and myocutaneous disease. Countries like Korea, China, and other east Asian countries described centipedes for the treatment of cardiovascular diseases. The venom of centipedes targeted for biologically active molecules

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that shows anti-tumor properties and show their activity against the human breast cancer tumor.

Conservation and Scientific Importance

Despite their ecological value, centipedes are poorly studied in India. Habitat destruction, pesticide use, and human fear are major threats. Studying centipedes is helpful in studying biodiversity, monitoring ecosystems’ health, finding new species of these animals, and examining the venom of centipedes in biomedicine research.

Centipedes may never be considered “cute,” but definitely play an essential role in nature. They are great predators, ecologists, and even contribute to the development of science and medicine. When you meet a centipede next time, do not get afraid since it probably kills pests for you.

Fascinating and Funny Facts

Not all centipedes have 100 legs; the number varies widely, and interestingly, it’s always an odd number of pairs.

Leg regeneration: Some species can regrow lost legs after moulting.

Centipedes may never be considered “cute,” but definitely play an essential role in nature. They are great predators, ecologists, and even contribute to the development of science and medicine.

Night hunters: They are mostly nocturnal and prefer darkness.

Speed champions: Their movement is so fast it’s hard for the human eye to track.

Parental care: Some female centipedes curl around their eggs and protect them until they hatch.

They enter ears or brains: No scientific evidence supports this claim.

Venom research: Scientists are studying centipede venom for potential use in medicine, including painkillers.



Parental care in Centipede



Habitat of Centipede



Invasive Non-Marine Molluscs of India: Silent Threats to Biodiversity and Livelihoods

Sk Rehanuma Sulthana

India harbors a rich diversity of non-marine molluscs in freshwater and terrestrial habitats, with more than 214 freshwater species and 1,138 land snails, many of which are endemic to biodiversity hotspots such as the Western Ghats and Northeast India. Gastropods (e.g., *Pila*, *Filopaludina*) and bivalves (e.g., *Lamellidens*, *Corbicula*) play vital roles as bioindicators, grazers, and filter feeders. However, invasive species such as *Lissachatina fulica* and *Pomacea diffusa* pose serious threats through agricultural damage, biodiversity loss, and public health risks, particularly as vectors of parasitic diseases. Effective monitoring by national agencies and integrated management strategies are essential to mitigate ecological and economic impacts while conserving native molluscan diversity.

A single giant African snail can consume 500 grams of vegetation in a week. Multiply that by thousands, and a vegetable farm becomes a wasteland within days. Yet this is only one of several invasive molluscs quietly reshaping India's landscapes while the country's remarkable native snail and clam diversity remains largely hidden from public view.

India harbours approximately 214 species of freshwater molluscs and 1,138 land snails, many of which are endemic to biodiversity hotspots such as the Western Ghats and Northeast India. Spread across the Western Ghats, Ganga & Brahmaputra basin, and Northeast Indian hill ranges, these organisms inhabit diverse freshwater and terrestrial habitats shaped by

“A single giant African snail can consume 500 grams of vegetation in a week. Multiply that by thousands, and a vegetable farm becomes a wasteland within days. Yet this is only one of several invasive molluscs quietly reshaping India's landscapes while the country's remarkable native snail and clam diversity remains largely hidden from public view.”

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varied climate, topography, and hydrological regimes. Globalized trade, aquaculture expansion, and horticultural imports have paved pathways for invasive alien species that outcompete communities. The giant African snail (*Lissachatina fulica*) has widespread populations

through out India and causes severe agricultural damage and posing public health risks as a vector of parasitic diseases. In freshwater habitats, the non-native apple snail *Pomacea diffusa* competes with native gastropods and may disrupt aquatic food webs. This article

brings overview of Invasive Non-Marine Molluscan species and impacts of these invasive non-marine molluscs, highlighting the urgent need for integrated monitoring, management strategies, and public awareness to safeguard India's native molluscan heritage.

Table:1 Non-Marine Invasive/Exotic Molluscs of India

Taxonomic Group	Species	Common Name	Native Range	Status in India	Key Impacts	Key References
Terrestrial Gastropod	<i>Lissachatina fulica</i> (Férussac, 1821)	Giant African Snail	East Africa	Widely established across India	Severe crop damage (>500 host plants); vector of <i>Angiostrongylus cantonensis</i>	Benson, W.H. (1858). Sarma et al. (2015); Raut & Barker (2002)
Terrestrial Gastropod	<i>Laevicaulis alte</i>	Tropical Leatherleaf Slug	Africa	Widely distributed; invasive	Agricultural pest; competes with native molluscs	Sajan et al., 2021
Freshwater Gastropod	<i>Pomacea diffusa</i>	Apple Snail	South America	Emerging	Potential agricultural and ecological threat	(Mukhopadhyay et al., 2017)
Freshwater Gastropod	<i>Physella acuta</i> (Draparnaud, 1805)	Acute Bladder Snail	North America	Widely reported from Indian freshwater bodies	Rapid colonizer; competes with native snails; tolerant to pollution	Gurumayum, S.D. (2023)
Freshwater Gastropod	<i>Planorbella scalaris</i>	Marsh Ramshorn Snail	North America	reported from Godavari River.	Potential invasive competitor;	(Mukhopadhyay et al., 2017)
Freshwater Gastropod	<i>Planorbella duryi</i>	Seminole Ramshorn	North America	occasional aquarium records	Potential invasive species; competes with native planorbids	(Mukhopadhyay et al., 2017)

Agricultural Impact

Infestations of invasive species such as *Lissachatina fulica* are most severe during the monsoon and post-monsoon seasons, when high moisture levels enhance activity, feeding, and dispersal. The species is voracious feeder, feeding on over

500 plant species, including economically important crops such as cabbage, cauliflower, tomato, banana, and papaya. Field-based evidence from India demonstrates that its impact can be substantial: in East Sikkim, invasion by *L. fulica* resulted in a 56.8% decline in farm income.

Observations from Karnataka further indicate crop damage ranging from 20% in cucumber to 40–50% in groundnut, and up to complete loss in mulberry under heavy infestation. Damage is particularly acute during the seedling and nursery stages, where tender plant tissues are

Damage is particularly acute during the seedling and nursery stages, where tender plant tissues are rapidly consumed. Feeding typically occurs at night, and infestations are often identified by characteristic defoliation patterns and mucus residue on damaged plant surfaces.

rapidly consumed. Feeding typically occurs at night, and infestations are often identified by characteristic defoliation patterns and mucus residue on damaged plant surfaces. In densely infested fields, the cumulative feeding pressure can reduce entire plots to bare stems within a short period. Farmers frequently report repeated crop losses across seasons due to persistent populations in soil and surrounding vegetation. These characteristics collectively make *L. fulica* one of the most economically damaging terrestrial molluscan pests in India. Other land snail pests reported are *Macrochlamys indica*, *Allopeas gracile*, *Ariophantasolata*, *Cryptozona semirugata*, *Cryptozona bistrialis* and *Bensonia monticola*.

Reproductive Biology

Achatina fulica is a simultaneous hermaphrodite that is primarily cross-fertilizing, although self-fertilization can occur when mates are scarce. This preference for outcrossing enhances genetic diversity and increases offspring viability, contributing to invasion success. The species lays 100–500 eggs per clutch, with multiple clutches produced annually, often resulting in more

Achatina fulica is a simultaneous hermaphrodite that is primarily cross-fertilizing, although self-fertilization can occur when mates are scarce.

than 1,000 eggs per individual per year under favorable conditions. Eggs are deposited in moist soil, leaf litter, or crevices, where environmental conditions favor high survival rates. Juveniles grow rapidly and reach reproductive maturity within months, allowing populations to expand quickly following favorable rainfall events. The relatively long lifespan of up to five years further increases reproductive potential over time. In the absence of effective natural predators or control measures, populations can build up to extremely high densities. Such reproductive efficiency enables the species to re-establish even after partial control efforts, making eradication difficult. The snail's ecological success, however, carries consequences that extend beyond agriculture.

Public Health Implications in the Indian Context

The ecological success of *Lissachatina fulica* carries a hidden medical cost, as the species serves as an intermediate host of the rat lungworm *Angiostrongylus cantonensis*, the causative agent of eosinophilic meningoencephalitis in humans in southern part of India. Transmission occurs when infective larvae are accidentally ingested through contaminated vegetables or improperly handled snails. In India, angiostrongyliasis is increasingly recognized as an emerging parasitic infection, although confirmed cases remain sporadic and likely underreported due to limited diagnostic awareness. Reports from southern India, particularly Kerala, have indicated isolated cases associated with exposure to infected molluscs and contaminated food sources. The risk is amplified in regions where dense human populations overlap with high snail abundance and poor sanitation practices. Children and individuals involved in agriculture are particularly vulnerable due to frequent contact with soil and vegetation. The presence of *A. fulica* in peri-urban and garden environments increases the likelihood of

“ Reports from southern India, particularly Kerala, have indicated isolated cases associated with exposure to infected molluscs and contaminated food sources. The risk is amplified in regions where dense human populations overlap with high snail abundance and poor sanitation practices ”

human exposure. Public health surveillance for mollusc-borne parasitic infections in India remains limited, highlighting a gap in disease monitoring. Preventive measures such as proper washing of vegetables, public awareness, and control of snail populations are therefore essential. The dual role of *A. fulica* as both an agricultural pest and a disease vector underscores the need

for integrated management strategies.

Implications for Native Biodiversity and Western Ghats Endemics

The continued spread of *Lissachatina fulica* has serious implications for native biodiversity, particularly in ecologically sensitive regions such as the Western Ghats. This biodiversity hotspot harbors

“ The expansion of *A. fulica* into these habitats raises concerns about competitive exclusion, resource overlap, and habitat alteration. ”

a high degree of endemism among land snails, many of which are restricted to specific forest microhabitats. Endemic genera such as *Indrella* and *Ariophanta* are associated with moist evergreen forests and exhibit narrow ecological tolerances. The expansion of *A. fulica* into these habitats raises concerns about competitive exclusion, resource overlap, and habitat alteration. Invasive populations can alter leaf litter composition and nutrient cycling, indirectly affecting native molluscan communities. Additionally, the potential for parasite transmission between invasive and native species remains poorly understood but represents an emerging risk. Habitat fragmentation and anthropogenic disturbance further exacerbate these pressures, making endemic species more vulnerable to invasion. Given their restricted distribution, even localized invasions can have disproportionate impacts on native diversity. Conservation of these evolutionary lineages requires not only habitat protection but also active management of invasive species. Without intervention, the spread of *A. fulica* may lead to irreversible changes in the composition and functioning

of terrestrial molluscan communities in India.

Management Strategies and the Way Forward

The concurrent threats posed by these invasive molluscs across terrestrial and aquatic ecosystems demand coordinated management responses. Managing invasive molluscs such as *Achatina fulica* and *Pomacea canaliculata* requires an integrated approach combining mechanical, biological, chemical, and policy-level interventions. Mechanical control remains one of the most practical and immediate strategies. Handpicking of adult snails and systematic destruction of egg masses—particularly the

conspicuous pink clutches of *P. canaliculata*—can significantly reduce population densities when implemented consistently at early stages of infestation.

Biological control offers sustainable alternatives when applied cautiously. In rice agro-ecosystems, integrated practices such as duck rearing have proven effective, as ducks actively consume both snails and their eggs, reducing pest populations while providing additional livelihood benefits. However, classical biological control using introduced predators must be carefully evaluated to avoid unintended ecological consequences, as seen in other regions.

“ Chemical control using molluscicides such as metaldehyde and niclosamide can provide rapid suppression of snail populations but must be used judiciously. ”

Therefore, chemical methods should be integrated with ecological approaches and guided by agricultural extension frameworks (IPBES, 2023).

Chemical control using molluscicides such as metaldehyde and niclosamide can provide rapid suppression of snail populations but must be used judiciously. Indiscriminate application can harm non-target organisms, contaminate water bodies, and disrupt aquatic ecosystems. Therefore, chemical methods should be integrated with ecological approaches and guided by agricultural extension frameworks (IPBES, 2023).

Institutional support is critical for long-term management. The Zoological Survey of India plays a central role in documenting species diversity, conducting faunal surveys, and maintaining National Zoological Collections that support taxonomic verification and invasion monitoring (Zoological Survey of India, 2024–25). Such efforts provide essential baseline data for biodiversity assessment and policy formulation.

At the policy level, strengthened biosecurity measures are urgently needed. Regulation of the aquarium trade, monitoring at ports of entry, and restrictions on the movement of contaminated agricultural materials can help prevent further introductions. Farmer awareness programs and community-based monitoring systems are equally important for early detection and rapid response.

In conclusion, invasive non-marine molluscs pose a growing threat to India's agriculture, biodiversity, and public health. Addressing this challenge requires coordinated action that integrates scientific research, sustainable management practices, and proactive policy interventions. Without such integrated efforts, the continued spread of these species will intensify ecological disruption and economic loss across vulnerable ecosystems.

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Economic Significance of Mollusca: An Extensive Analysis

Abhijna Ghosh

One of the most varied groups of invertebrates, the phylum Mollusca, makes a substantial contribution to both the human economy and ecological equilibrium. This text examines the economic significance of mollusca, emphasizing both their detrimental effects on infrastructure, agriculture and human health as well as their advantageous functions in food industry, medicine and environmental monitoring.

The second largest group of invertebrates is the phylum Mollusca which includes creatures like octopuses, clams, snails, slugs and oysters. These creatures live in freshwater, marine and terrestrial habitats. Mollusca play important roles in both natural ecosystems and human economy because of their extensive range and diversity.

Beneficial Economic Importance:
Food Source - A significant portion of the world’s seafood resources are found in Mollusca. Bivalves (oysters, mussels and clams), cephalopods (squids, octopus) and gastropods (snails) are examples that are commonly consumed because of their high nutritional value. They are a great source of high-quality protein as they contain vital amino acids which are easier to digest than red meat and crucial for tissue repair and growth

in human body. Molluscs are high in essential minerals like iron, zinc, calcium and iodine, vitamins like B12, A and D and heart-healthy omega-3 fatty acids. They are typically low in saturated fats hence aid in the prevention of cardiovascular illness.
Economic Importance in the Food Industry- Mollusca plays an important role in Global Sea Food industry including shellfish aquaculture and fisheries. Mollusca farming often known as “Mari culture,”

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are nowadays very common activity. Compared to other aquacultures, oyster and mussel farming is less expensive and more environmental friendly.

Cultural and Culinary Importance - Molluscs are essential to many cuisines. They are utilized in soups, curries and grilled foods and they are particularly well-liked in coastal areas and upscale dining establishments.

Industrial importance - Through the production of pearls by oysters (*Pinctada fucata* (Gould), *Pinctada margaritifera* (Linnaeus) etc.) and the use of various shells (*Lambis* sp., *Strombus* sp., *Trochus* sp. etc.) in the shell craft industries, Molluscs are essential in world’s luxury goods and handicraft industries. Annual global production of cultured pearls is estimated around 40 tons per year. The market for pearl

production was estimated to be worth USD 12 billion in 2024 and is expected to increase by USD 22 billion in 2032. In nations like China, India and Japan pearl farming supports the aquaculture industries and creates jobs in coastal and rural areas. Calcium carbonate (shell powder) is also used in Paints, fertilizers, medications and cosmetics. Additionally shells

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are utilized to make lime and chicken feed.

Role in Agriculture and Soil Fertility - A variety of mollusks including land snails and slugs have beneficial roles in agricultural systems. Although some Mollusca are considered as pests, others play a vital role in nutrient cycling, soil health and sustainable farming methods. By breaking down organic matters into simpler forms for their consumption they increase soil fertility thus encouraging the growth of plants. In addition by improving soil pH and fertility, crushed mollusc shells are utilized as natural fertilizers that release calcium and minerals gradually. Thus they can be used as biofertilizers in Integrated Pest Management (IPM) encouraging environmentally sustainable farming methods.

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Scientific and Medicinal Importance - Mollusca play important roles in science and medicine. They are useful in the advancement of biological and medical sciences because of their physiology, organ systems and secretion of biochemical substances. Many Molluscs are frequently used in neural system research. For example *Aplysia* sp. (sea hare) is a traditional model for research on learning Synaptic transmission and neural circuits contributing in memory research. In terms of medicinal importance few neurotoxins and biologically

active peptides are secreted by marine molluscs for example Cone shells (*Conus* sp.). These substances are utilized in antimicrobial medications, pain relief and anticancer research. In early civilizations also molluscs have been used in traditional medicine where shell powder was used as calcium supplement.

Environmental and Toxicological Importance – Molluscs, particularly bivalves and certain gastropods, are regarded as effective bioindicator species because of their sensitivity

towards environmental changes which aids scientists in determining pollution levels and evaluating the health of an ecosystem. Many species of molluscs are filter feeders, especially bivalves like oysters and mussels. They unintentionally accumulate pollutants including heavy metals, pesticides and micro plastics as they constantly pump water through their bodies to get nourishment. Over time they retain harmful materials in their tissues without dying right away. This makes it possible for researchers to assess pollution levels of an ecosystem over an extended period of time rather than simply short-term monitoring. For instance, monitoring operations to look for heavy metal pollution in coastal waters frequently use mussels (*Mytilus* sp., *Margaritifera* sp. etc.). Their tissues offer important information about pollutants like cadmium, lead and mercury. Mollusca also have visible deformities to environmental stress on themselves. Population reduction, reproductive failure and changes in shell growth can also be the signs of ecological disturbances. For example, an abrupt decline in mollusca population could be an indication of habitat degradation, water pollution

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or climate change of that ecosystem.

Harmful Economic Importance:

Agricultural Pests - There are certain terrestrial gastropods, primarily slugs and snails, which are considered as significant agricultural pests causing widespread damage to crops and vegetables through their rasping feeding behavior. They thrive in moist conditions, feeding on leaves, stems, seedlings and fruits. It results lower crop yields and financial losses. Common genera include *Deroceras sp.*, *Tandonia sp.* etc. which feed on a wide range of broad leaf plants, seedlings and root crops. Species like *Lissachatina fulica* (Bowdich)(Giant African Snail), *Helix aspersa* O.F. Mueller and *Pomacea canaliculata* (Lamarck) (Golden Apple Snail) are highly destructive to fruits, vegetables and rice fields.

Disease Transmission - Some freshwater snails serve as intermediary hosts of parasites causing widespread human illnesses like Schistosomiasis (*Biomphalaria sp.*), **Angiostrongyliasis** (*Lissachatina sp.*) and **Liver Fluke infections** (*Lymanaea sp.*). Marine bivalves like oysters, mussels and clams filter large volume of water and can concentrate pathogens from contaminated water, leading to

Marine bivalves like oysters, mussels and clams filter large volume of water and can concentrate pathogens from contaminated water, leading to diseases like bacterial, viral and typhoid fever to human when consumed raw or undercooked.

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Destructive Effect on Infrastructure – There are few molluscs which have a significant impact on human infrastructure. Some species of bivalves and gastropods seriously damage freshwater and marine constructions built by humans. Marine mollusca such as boring clams and shipworms are particularly well-known for damaging wooden structures. Shipworms are wood-boring bivalves (*Teredo sp.*, *Bankia sp.* etc.) under Teredinidae family dig into wooden constructions that are submerged frequently causing damage to piers, docks and ships. They resemble worms, but they are actually Mollusca. Some clams pierce hard surfaces like concrete and rocks around the coast thus

weakening harbor installations and seawalls. Large numbers of certain species like mussels (*Mytilus sp.*) adhere to hard surfaces of ships and their pipes, increasing weight and decreasing fuel efficiency to drag the ship.

Role of Mollusca as an Invasive Species - Invasive Alien Species (IAS) are plants, animals, pathogens and other organisms from other countries or ecosystems, which have a tendency to dominate and threaten the communities of native species, thereby causing economic and environmental harm and adversely affecting human health. Some mollusca spread rapidly in non-native environments disrupting local ecosystems and biodiversity which also affect fisheries and water systems of that area, hence considered as Invasive Alien Species. As per the Global Invasive Species Database (2011), in India a total of 95 species (microorganisms, plants and animals) are declared as alien invasive of which one species of Mollusca *Lissachatina fulica* (Bowdich) is one of the most notorious agricultural snail pests. Originally a native of East Africa, it has been spread either actively or passively by man throughout the tropics. It has enormous potential to

They resemble worms, but they are actually Mollusca. Some clams pierce hard surfaces like concrete and rocks around the coast thus weakening harbor installations and seawalls. Large numbers of certain species like mussels (*Mytilus sp.*) adhere to hard surfaces of ships and their pipes, increasing weight and decreasing fuel efficiency to drag the ship.

reach sexual maturity within 6 months and reproduce rapidly. There are few other species of exotic mollusca posing threat to the Indian environment which needs to be prevented. These are namely *Pomacea diffusa* Blume, *Physella acuta* Draparnaud, *Planorbella scalaris* (Jay), *Planorbella duryi* (Wetherby) among freshwater species and *Laevicaulis heroldi* Dundee, *Meghimatium pictum* (Stoliczka) among terrestrial species.

Molluscs act as a sustainable substitution for traditional protein resource in today's world. They are essential to the shell and pearl industries which support millions of people's livelihoods and provide billions of dollars to the

world economy. The economic significance of Mollusca is anticipated to increase due to developments in sustainable practices and aquaculture. To guarantee these industries' long-term viability appropriate management and protection are crucial. Mollusca's destructive actions pose a serious threat to industrial operations and maritime engineering. Although conventional control techniques have proven successful, they frequently present environmental hazards. As a result, the need for environmentally friendly and sustainable management techniques are rising. Sustainable management of Mollusca should involve balancing aquaculture production, environmental protection and conservation

specifically through monitoring non-native species, reducing disease and utilizing their natural filtering roles for ecological health. Future studies should concentrate on ecologically viable ways to reduce detrimental effects while maintaining ecological equilibrium in Molluscan management techniques in the ecosystem.

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Fish Diversity and Coastal Fisheries in India: Recognising Women's Underappreciated Contributions

Honey U K Pillai

India's coastal fisheries are underpinned by extensive marine biodiversity and function as complex socio-economic systems that support livelihoods, contribute to food security, and drive regional economic development. The country's coastline, extending approximately 7,516 km across mainland and island territories, encompasses a wide range of ecological habitats, including estuaries, mangrove forests, coral reef systems, seagrass meadows, mudflats, and riverine interfaces. These ecosystems provide critical habitats for numerous marine and brackish water species, resulting in high ichthyofaunal diversity, with over 2,500 marine fish species documented from Indian waters. This ecological diversity forms the foundation of productive fisheries and plays a significant role in supporting employment, nutritional security, and

economic stability, particularly within small-scale and artisanal sectors. Within this integrated system, women represent a crucial yet insufficiently acknowledged component, contributing substantially to the handling, processing, and distribution of fish resources along the fisheries value chain.

Women constitute an essential, though frequently under-recognized, segment of the coastal fisheries workforce, with their involvement predominantly concentrated in post-harvest operations. These activities include sorting, processing, marketing, net repair, and household financial management, all of which

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are critical for sustaining fisheries-based livelihoods. Through their engagement, women facilitate the efficient movement of fish from landing centres to end consumers, ensuring appropriate handling and availability in marketable forms. Their contributions are integral to maintaining product quality, extending shelf life, and minimizing post-harvest losses, thereby enhancing resource-use efficiency. In this context, women indirectly contribute to the sustainability of fisheries by optimizing the utilization of harvested biological resources. Despite the scale and significance of their roles, much of their work remains inadequately represented in formal economic accounting systems and receives limited recognition within policy frameworks. Women are estimated to

account for approximately 40–50% of the fisheries workforce, with millions engaged across multiple sectors, particularly in small-scale fisheries (Food and Agriculture Organization, 2018; Government of India, 2020). The distribution of work within coastal fisheries reflects a clear gender-based pattern influenced by socio-cultural norms, historical practices, and

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unequal access to resources. Men are primarily engaged in fishing activities at sea, whereas women are mainly involved in land-based operations such as processing, handling, and local trade, along with preparatory tasks including net-mending and gear maintenance. These responsibilities require experience, practical knowledge, and careful timing to maintain product quality and market value. In addition, women contribute to local economies through small-scale fish marketing, operating within informal systems where they must manage uncertainties related to fluctuating prices, perishability, and competition. Income generated from these activities plays a vital role in supporting household needs and reducing financial vulnerability. It also contributes to improved educational and

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social opportunities for their children. However, the informal nature of such work limits access to institutional credit, insurance, and organized market structures, thereby constraining opportunities for economic growth.

Limited access to infrastructure and productive resources remains a major challenge affecting women's involvement in fisheries. Facilities such as cold storage, hygienic processing units, transport networks, and organized market spaces are often inadequate or difficult to access, resulting in continued dependence on traditional practices that are sensitive to environmental conditions and market variability (Food and Agriculture Organization, 2024). Financial constraints further restrict their activities, as many women rely on

informal lending arrangements that involve high interest rates (International Collective in Support of Fishworkers, 2015). In addition, the benefits of technological advancements in fisheries have not been evenly

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distributed, particularly in the post-harvest sector, limiting women's ability to enhance efficiency or participate in higher-value markets. Social factors such as restricted mobility, limited ownership of assets, and low representation in institutional bodies further reduce women's influence in decision-making processes related to fisheries governance.

Environmental pressures are increasingly affecting coastal fisheries and have direct implications for women's livelihoods. Changes such as declining fish availability, degradation of coastal habitats, and increasing climate variability influence both the quantity

and quality of fish available for processing and trade (Food and Agriculture Organization, 2018). Irregular weather conditions disrupt traditional preservation practices, raising the risk of spoilage and financial loss (International Collective in Support of Fishworkers, 2015). Extreme events, including cyclones and coastal erosion, further heighten vulnerability. At the same time, women are exposed to occupational health risks due to prolonged work in open environments, exposure to harsh climatic conditions, and limited access to sanitation and healthcare services. These challenges are intensified by their dual responsibilities of income generation and household care, which reduce opportunities for skill development or alternative livelihoods.

Improving the conditions of women in coastal fisheries requires a shift towards inclusive and equitable development approaches. Recognizing their contributions within formal economic and policy frameworks is essential for ensuring fair participation. Expanding access to infrastructure, financial services, and suitable technologies can significantly improve productivity and income. Training initiatives



Improving the conditions of women in coastal fisheries requires a shift towards inclusive and equitable development approaches. Recognizing their contributions within formal economic and policy frameworks is essential for ensuring fair participation. Expanding access to infrastructure, financial services, and suitable technologies can significantly improve productivity and income. Training initiatives focused on value addition, entrepreneurship, and market linkages can further strengthen women's economic roles (Food and Agriculture Organization, 2020). Increasing their participation in governance and decision-making processes is equally important, as it ensures that fisheries management reflects the perspectives of all stakeholders. Such inclusive strategies not only address gender disparities but also enhance the overall sustainability and resilience of fisheries systems.



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This article is inspired by field observations and interactions with women fish workers across different coastal regions of India during fish diversity-related survey programmes conducted for the Zoological Survey of India over the past four years, which provided valuable insights into their contributions and the challenges they face.



In conclusion, coastal fisheries in India depend not only on marine biodiversity and capture fishing but also on the important yet often overlooked contributions of women, especially in post-harvest and market-related activities. Their role in linking

fish diversity with livelihoods and economic systems is significant, but it is still not adequately recognized. Structural barriers, socio-cultural factors, and environmental challenges continue to limit their full participation. This article is

inspired by field observations and interactions with women fish workers across different coastal regions of India during fish diversity-related survey programmes conducted for the Zoological Survey of India over the past four years, which provided valuable insights into their contributions and the challenges they face. Addressing these issues through inclusive and gender-sensitive approaches can improve both fairness and efficiency in the fisheries sector. Recognizing women as key stakeholders is therefore essential for strengthening sustainable fisheries management and ensuring the long-term resilience of coastal communities in India.



Women engaged in diverse activities across coastal fisheries in India, including fish catching, sorting, and marketing, highlighting their vital contributions to livelihoods and local economies.



Beneath the Mud Lies a Mystery: The Hidden World of Eel Fishes

Veena Kumari

Rivers, ponds and marshes are full of life that are easy to see, though another part of life that is hidden from view, like the eel fish. Down in the mud, where plants are all tangled up. It is really hard for sunlight to get through and Eel fish are really good at hiding. They dig into the mud and avoid the busy areas where other fish like to hang out. Eel fish move quietly through the mud they hide among the roots. They squeeze themselves into quiet spots, along the water. You ever see them, and to be honest most people do not think about eel fish very much. Rivers, ponds and marshes still need eel fish. Eel fish are ecologically very important as they keep rivers, ponds and marshes healthy, that most of us do not notice.

The Unseen life of Freshwater Wetlands.

Eel fish does not look like a normal fish, the body of the eel is long and thin, resemble



Mastacembelus armatus (Lacepède, 1800)

to snake, has fins coated with slime on its body. This is why a lot of people do not think that eel is a fish which that lives in freshwater. The way the eel

looks is really interesting and a lot of people do not know much about the eel. There are hidden creatures in freshwater wetlands. The Indian Mottled Eel and the

The country’s coastline, extending approximately 7,516 km across mainland and island territories, encompasses a wide range of ecological habitats, including estuaries, mangrove forests, coral reef systems, seagrass meadows, mudflats, and riverine interfaces.

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The Indian Mottled Eel and the Freshwater Swamp Eel are important, for fisheries and the wetland food web. They are becoming rare as their habitats are disappearing fast.

Freshwater Swamp Eel are two eel- fish that stand out for their habits and survival skills. The Indian Mottled Eel is a predator that lives in freshwater and its body is built for moving through canals and muddy pools. It feed on worms and small fish. This helps it survive in ponds and marshes with low oxygen levels. The Indian Mottled Eel and the Freshwater Swamp Eel are important, for fisheries and the wetland food web. They are becoming rare as their habitats are disappearing fast.

To the people a shallow marsh or muddy pond may be the most uncomfortable place, but for eel fish these areas are heavens. The soft mud is easy to dug, plants protect them from predators, old roots and leaves make shelters. During monsoon season, wetlands charged with water, become a great place to find food. When the water level drops, these areas turn

into places where eel fish can survive. The changing habitat makes mud a protective thing, for eel fish and mud helps eel fish to stay safe. Eel fish often live in the less explored parts of freshwater ecosystems. They look for edges, narrow channels, and muddy banks. Although these places may not seem appealing, but they provide

Eel fish often live in the less explored parts of freshwater ecosystems. They look for edges, narrow channels, and muddy banks. Although these places may not seem appealing, but they provide safety to stay hidden from both predators and people. These often-overlooked corners of wetlands are not well understood because they get ignored.

safety to stay hidden from both predators and people. These often-overlooked corners of wetlands are not well understood because they get ignored.

The eel stays hidden in holes during the day, comes out at night to feed. When the wet areas start to dry up the eel does not swim away, they go deep into the mud, waits for the water to come back, to move.

The eel's body is long and strong, this helps them to move through tunnels and muddy areas easily. Its small fins and smooth skin, along with its tail help them to dig through the mud. The eel's body stays wet because of a layer of slime, which helps them slide through the mud. This special adaptation help them to hide in mud. The eel lives in muddy

Night Hunters of the Wetland Food Chain

During the night, eel fish begin to hunt for worms, molluscs and small fish. This helps to maintain the wetlands in ecological balance. The eel fish also become the food for birds and snakes, which's an important aspect of food chain in the wetland. The eel fish are very important for the wetland ecosystem, and also a source of food and jobs for people. People like to eat the eel fish because they are a good source of protein. Some types of eel fish can live in extreme conditions, which makes them good, for fish farming that does not require a lot of effort.

river edges and deep pools, hunts for worms and small fish. People like to eat the eel, that's why its number is going down in wetland areas. Eel fish are really not just sitting ideally and doing nothing, continuously changing the wetland floor when they make tunnels, by virtue of which, they loosen the mud, that makes paths for oxygen to enter.

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A hidden world in danger

There is a world that we do not see in trouble, though eel fish are very strong, but they are not safe, due to the changing environment, wetlands destruction and other anthropogenic activities. A lot of eel fish get caught by fishermen as by catch and some eel fish are hurt because people are scared of them.

To protect eel fishes, we have to understand that wetlands

are very important, as these wetlands are homes for species that live in dark and moist places with mud without any disturbance. We have to take care of their habitat and need to protect these places, so that eel fish and other species can survive. We must conserve these wetlands, be careful, with our fishing practices to save the eel fish and other mud dwellers.

Quiet Survivors beneath the mud

Eel fishes are very interesting and can survive in very harsh conditions, they are great at digging and they are like Eco-builders that can work hidden below the water. Their world is

“For those who wish to learn about eel fishes, one will have to study the mud under the water, as a lot of secrets are hidden there in the fresh water fishes.”

a secret one, where they have to be strong to survive. For those who wish to learn about eel fishes, one will have to study the mud under the water, as a lot of secrets are hidden there in the fresh water fishes. The Indian mottled eel and the freshwater

swamp eel are examples of eel fishes that can survive quietly beneath the mud. Eel fishes, like these, can do a lot of things that other fishes cannot do that's why eel fish are so interesting to learn about.

“Eels are nature’s hidden lifelines - conserve them before they vanish.”



GloFish! A beauty pageant in the Aquarium
Swamarpita Mukherjee

Science and Technology has not only made Human more beautiful by the breakthrough innovations in Cosmetic industry but has also made the cute creatures of the aquarium more attractive and colorful. GloFish are the bright colored fish exhibiting fluorescence under light and display an array of different neon toned colors of blue, red, orange, pink etc.

The First Transgenic Pet Animals!
As we are well known with the principle of transgenic animals where organisms whose genome has been modified or altered by incorporating foreign DNA (transgenes) thus expressing the desired traits. The GloFish is the first transgenic animal which has been commercially available in market for trade as a pet. The GloFish are created by incorporating the gene taken from jelly fishes and sea corals encoding for fluorescent

proteins in the genome of original fish species. Thus, the genetically modified GloFish differs from their wild variant in possessing fluorescence and glowing vividly under naturally and more strikingly under ultraviolet rays.

How it came into existence?
Well, the story goes like this: In the year of 1999. Dr. Zhiyan

Gong, Professor, National University of Singapore along with his research team developed transgenic fish. They introduced a gene which encodes the green fluorescent protein (GFP), that was taken from jelly fish and inserted in the genome of the tropical fresh water fish *Danio rerio* (Hamilton 1822) which is a common Cyprinidae

“The GloFish is the first transgenic animal which has been commercially available in market for trade as a pet. The GloFish are created by incorporating the gene taken from jelly fishes and sea corals encoding for fluorescent proteins in the genome of original fish species”

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These transgenic fish were developed to act as environment pollution detectors. In presence of pollutant or toxins they will selectively respond by fluorescing.

Known as Zebra fish distributed commonly in Ganga River basin in India, Bangladesh and Nepal. Fishes, thus developed glowed brightly under natural white light and ultraviolet light. These transgenic fish were developed to act as environment pollution detectors. In presence of pollutant or toxins they will selectively respond by fluorescing. Soon after that the team also developed a line of red and yellow fluorescent zebra fish by infusing the gene extracted from coral and many other variants subsequently. In line with this Professor Huai-Jen Tsai from Tawain also infused a fluorescent green color in Japanese Rice fish (*Oryzias latipes*), commonly known as medaka, often used as a model organism for biological studies.

Introduction in Market and Subsequent development: Two remarkable trade agreements were carried out in year of 2003

to make the GloFish available for trade and commerce apart from scientific research applications. Scientist from National University of Singapore and the Austin, Texas based company Yorktown technologies after extensive experiments, introduced Glofish in US market in the year of 2002. This was done after the U.S Food and Drug Administration carefully assessed and concluded that the transgenic fish will be only traded for aquarium purpose

In market the GloFish comes in mainly six vibrant colours registered as Starfire Red, Moonrise pink, Sunburst Orange, Electric Green Cosmic blue and Galactic purple.

hence they cannot penetrate the natural habitat and food chain and will not pose any threat to natural and indigenous population. These findings were also supported by State of California Department of Fish and Game and the State of Florida Transgenic Aquatic Task Force. The second deal was made between Taikong, the aquarium fish producer and researchers of Taiwan that authorized the sale of a pet animal that is genetically modified for the first time. They started the trade of medaka rice fish. Thereafter, Yorktown Technologies also developed green and orange yellow colored GloFish Danio and blue and purple colored GloFish Danio in the year of 2006 and 2011 respectively from the genes of sea coral. In 2012, this infusion with color genes was introduced to species of fish other than zebra fish, the Black tetra

(*Gymnocorymbus ternetzi*), fresh water fish native to Brazil and Argentina and followed by the Tiger barb (*Puntigrus tetrazona*), freshwater fish distributed in Indonesia, Singapore Sumatra. In market the GloFish comes

in mainly six vibrant colours registered as Starfire Red, Moonrise pink, Sunburst Orange, Electric Green Cosmic blue and Galactic purple. Some of the other key types of GloFish available across global market

are GloFish Rainbow Shark (*Epalzeorhynchus frenatum*), GloFish Corydoras (*Corydoras aeneus*), GloFish Angelfish (*Pterophyllum scalare*).



GloFish' with six attractive fluorescent colour combinations, including Starfire red, cosmic blue, electric green, galactic purple, sunburst orange and moonrise pink as ornamental transgenic fish (From Internet).

The Beauties of Aquarium: GloFish owing to its spectacular view and great aesthetic value are largely famous as ornamental fishes maintained in the aquarium. A simple description of keeping and maintaining some very common and popular GloFish in an aquarium which are widely traded across market is presented here.

GloFish Danio: The original fish of this variant known as *Danio rerio* (Zebrafish) can grow up to

The Beauties of Aquarium: GloFish owing to its spectacular view and great aesthetic value are largely famous as ornamental fishes maintained in the aquarium. A simple description of keeping and maintaining some very common and popular GloFish in an aquarium which are widely traded across market is presented here.

2 inches, is peaceful and fast, generally surface level floaters one requires a minimum tank size of 10-20 gallons, can be kept together in 6 numbers in a planted tank. They prefer to to remain in a group and has life span of 3-5 years. They can be best paired with bottom dwellers and peaceful mid water swimmers that includes Corydoras catfish, Gouramis (Honey or Dwarf), Rasboras.

GloFish Tetras: The original species of this variant is known as *Gynocorymbus ternetzi* (Black skirt Tetra), grows up to 2 inches is also a peaceful, active and generally are mid-level

“The original species of this variant is known as *Gynocorymbus ternetzi* (Black skirt Tetra), grows up to 2 inches is also a peaceful, active and generally are mid-level floaters requires a minimum tank size of 10-20 gallons, also kept together in school of 6+ in a planted tank.”



Wild *Danio rerio* (Zebra Fish) and its GloFish variant in Electric Green(From Internet source).

GloFish Barb: The original fish of this variant known as *Puntius tetrazona* (Tiger Barb) can grow up to 2.5 inches, semi aggressive requires a minimum tank size of 30 gallon. They tend to remain in a group and has life span of 2-4 years. They are schooling fish , at least a group of 5-6, ideal a minimum of 10-12, can

be kept in an open swimming space so that they can feel secure and neither stressed and timid nor too aggressive. They can be maintained in the aquarium with GloFish Danios and Tetras, but long fin flowing fish like Betta or Angel Fish is avoided.



Wild *Gynocorymbus ternetzi* (Black tetra) and its GloFish variant in Sunburst orange (From Internet source).

GloFish Betta: The original species of this variant is known as *Betta splendens*(Bettas), grows up to 2.5 to 3 inches is mainly a territorial solo fish , requires a minimum tank size of 5-10 gallons that can be kept in a gentle filter and soft lighting set up .Their life span is also about 2-4 years. Thy can

coexist with non- fin nipping and peaceful species in a well planted tank. Their compatible tank mates can be bottom dwellers like Corydoras Catfish, Kuhli Loaches and schooling fish like Ember tetras, Harlequin Rasboras, chili Rasboras. They should not be kept with fin

nipper and fast and aggressive fishlike barbs. **GloFish Shark :** The original species of this variant is known as *Epalzeorhynchus frenatum* (Rainbow Shark), grows up to 5-6 inches is an aggressive and bottom dweller

fish, requires a minimum tank size 55 gallons, can be kept in a gentle filter and soft lighting set up. Their life span is also about 2-4 years. They are ideally kept one per tank best paired with mid and top dwelling fish such as Tetras, Rasboras, Danios.



Wild *Puntius tetrazona* (Tiger Barb) and its GloFish variant in Starfire Red (From Internet)



Wild *Betta splendens* (Betta) and its GloFish variant in Galactic Purple (From Internet)



Wild *Betta splendens* (Rainbow Shark) and its GloFish variant in Moon Rise Pink From Internet).

Ideal Parameters in The Aquarium: The GloFish generally needs some prerequisites water parameters in an aquarium to sustain. An ideal temperature range of 22-28°C, a pH of 6.5-

7.5, water hardness of 5-15 dGH (Degrees of General Hardness) and a nitrate concentration of less than 20 ppm(parts per million). To make best out of the GloFish, blue LED or GloFish specific

lightning should be used for maximum fluorescence. Use of dark substrate and backgrounds enhances it. The aquarium can have live or silk plants for shelter.



Wild *Puntius tetrazona* (Tiger Barb) with GloFish Tetra (Long Fin) of different colours (Aquarium shop)



GloFish *Betta* (Galactic Purple) with different species of Rasbora (Aquarium shop)

Are GloFish Ethical? The initial motive of the developers of GloFish was to detect the presence of water pollutants with the help of GloFish Danio producing fluorescence in presence of pollutants. But

due its striking colour and aesthetic appeal these fishes got recognition for commercial purpose. Thereafter, this commercial potential was made into trade by the U.S based company, the Yorktown

Technologies, L.P. As discussed above it was first brought into the market in 2003, the GloFish is a patented and trademarked brand.



A school of GloFish Tetra (*Gynocorymbus ternetzi*) in different colours. (Aquarium shop)

From 2017 the rights to GloFish have been with Spectrum brands, Inc. which purchased GloFish from Yorktown Technologies. Only authorized traders can breed and sell them under legal rules and regulations. Therefore, intentionally breeding, marketing or selling of GloFish offspring is strictly regulated. The import and sell of GloFish was banned in California in 2003 as already due to existing regulations that strictly regulates trade of genetically modified organism due to concern about a growing biotech Salmon. Also in European Union, Australia the trade is not permitted. In India also the trading of GloFish is illegal under bio-safety law. But the Food and Drug Administration, USA

“The import and sell of GloFish was banned in California in 2003 as already due to existing regulations that strictly regulates trade of genetically modified organism due to concern about a growing biotech Salmon.”

and the Florida Department of Agriculture and Consumer Services removed these restrictions after findings that GloFish can never takeover their wild counterparts and cannot sustain and reproduce in nature effectively. Further

extensive studies can predict the environment risk associated with GloFish breeding and release in nature. Hence the GloFish is traded across the global market under strict regulations and patents.



Amphibians Beyond the Spotlight: Revealing the Secret Story of Caecilians

Sejuti Biswas

When we think about amphibians, usually, frogs or toads come to our mind; but beneath the soil, there lies a hidden world of serpentine vertebrates that very few of us have even heard about. Welcome to the underground realm of Caecilians, one of the most surprising and lesser-known group of amphibians.

Amphibians exist in three prominent forms: Frogs and Toads, lizard look-alike Salamanders and worm-like Caecilians, each belonging to the order Anura, order Caudata and order Gymnophiona respectively. The name “Caecilian” is derived from the Latin word “caecus” which means sightless or blind. The first scientifically described caecilian, *Caecilia tentaculata*, was authored by Carl Linnaeus in 1758, marking the first taxonomic recognition for this group. Since then, a total of

234 species of caecilians have been discovered worldwide, including 43 species in India.

Not Worms, Not Snakes - But Amphibians!

Let’s get into the fascinating form and features of caecilians. At first glance, they resemble snakes or earthworms as they

are limbless and having an elongated body with a smooth look. Hence, they are often known as ‘Apoda’ meaning ‘without leg’. Their skull is powerfully constructed with a pointed snout and a projecting mandible. Their tiny vestigial eyes, sometimes covered by bone or skin, make them mostly

The name “Caecilian” is derived from the Latin word “caecus” which means sightless or blind.

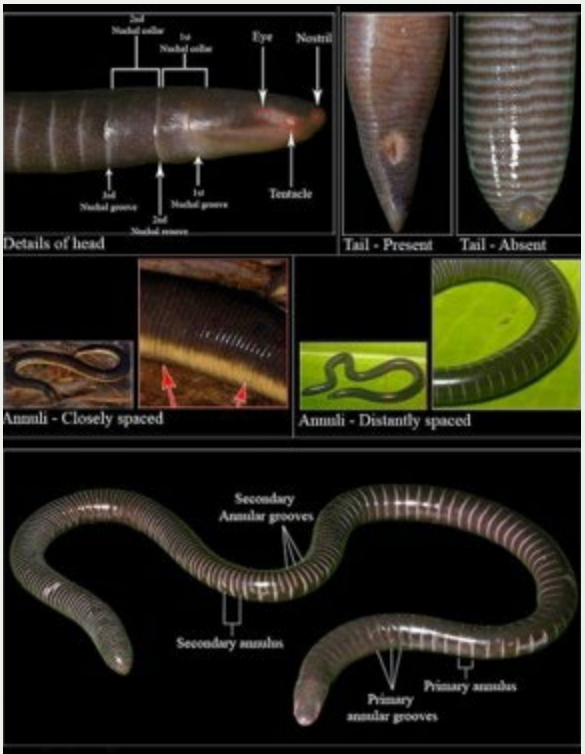
At first glance, they resemble snakes or earthworms as they are limbless and having an elongated body with a smooth look. Hence, they are often known as ‘Apoda’ meaning ‘without leg’

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sightless, instead, they rely on a specialized chemo-sensory organ, a pair of retractile tentacles, located between the eyes and nostrils, allowing them to detect environmental cues in the dark. The position of the tentacles varies among species making it a significant key character for species identification. Their bodies are marked by ring-like folds called Annuli, which give them a segmented look. Unlike the true segmentation found in earthworms (Annelids), these

rings are not internally divided or fused like a Clitellum, a reproductive structure seen in some worms. There are two types of rings across the body: the complete ones are Primary annuli, and the incomplete rings are Secondary annuli. The number and pattern of the annuli provide other important clues for distinguishing species. Within the body folds, there are numerous microscopic scales concealed under the skin indicating an unusual feature for amphibians. They are devoid

of ears or tympanum. In most caecilians, the tail is extremely short and barely distinguishable from the rest of the body, giving them a uniform and continuous look. The shape of the tail tip may be pointed, round or blunt-another distinctive character among caecilian families, serving as a useful tool for family level identification. The opening of the vent can be longitudinal or transverse depending on the family. Adults



Caecilian Morphology Fig 2: Earthworm vs. Blind snake vs. Caecilian



Earthworm vs. Blind snake vs. Caecilian Source: Giri, V.B. (2013). Caecilians of India (blog)

The Sixth Sense: The chemo-sensory tentacles detect the chemical signals and act as the navigating tool in absence of vision. It also helps in locating prey in complete darkness.

Subterranean Survivors

Caecilians are predominantly fossorial and possess a remarkable set of burrowing adaptations that allow them to live efficiently beneath the surface.

- » **Fossorial Flow:** The long, limbless body reduces resistance, allowing smooth and easy movement through narrow underground tunnels.
- » **Serpentine Motion:** Wave-like muscle contraction mechanism helps them to push against moist soil, producing the optimum momentum under the surface.
- » **Nature's Living Drill:** A powerful and pointed bony snout along with projecting lower jaw act like a natural digging tool for penetration into the soil while burrowing.
- » **The Sixth Sense:** The chemo-sensory tentacles

detect the chemical signals and act as the navigating tool in absence of vision. It also helps in locating prey in complete darkness.

- » **Ringed Morphology:** The ring-like annuli provide grip as well as flexibility and

In India, their distribution is primarily restricted to the Western Ghats and the Northeastern Region. Both the areas experience heavy rainfall, high humidity and dense forest cover. These climatic conditions support their way of life and make both the zones major hotspots for caecilian diversity.

support them to anchor while moving through soil.

Where to Find Caecilians: Habitat and Distribution

Caecilians thrive in moist and humid environment and that is why they prefer to be found in loose moist soil, leaf litters and underground burrows in dense and rain-rich evergreen forests.

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Worldwide Distribution of Caecilians
Source: Internet (original source unknown)



Live Specimen (*Ichthyophis* sp.)
Photograph by Dr. Kaushik Deuti

Top 10 Super Secrets of Caecilians

1. This hidden amphibian diversity peaks in India with extreme endemism- about 88%. In fact, among all animal groups of vertebrates as well as invertebrates in India, caecilians exhibit the highest percentage of endemism! 38 of 43 caecilian species are unique to the country, dominated by the Western Ghats with 29 species, followed by the Northeast region with 9 species.
2. Surprisingly, the most recently discovered family Chikilidae has been found to be more closely related to African caecilian family Herpelidae than to other Asian families of caecilians, supporting the idea of an Indo-African evolutionary connection!
3. Not all caecilians are soil-dwellers, all the species under Typhlonectes from South America are fully aquatic, living in rivers and streams! The members of this family also have a fleshy fin that enhances propulsion in water.
4. They are secretive predators, and in rare cases even show inter-species predation, as recorded in Uraeotyphlus
5. Their stretched body reshapes internal organs, like testes and lungs, sometimes with one lung reduced to fit the narrow space, just like in snakes!

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bombayensis and *Ichthyophis kodaguensis* (Family: *Ichthyophiidae*) preying on *Gegeneophis* species (Family: *Grandisoniidae*)!

- 6. The presence of tentacles among caecilians makes them exceptional, as they are the only vertebrate group to have this sensory organ, which is basically an invertebrate trait!
- 7. Some caecilians do not dig at all! They simply reuse tunnels made by earthworms or other animals.
- 8. Unlike most amphibians, caecilians exhibit internal fertilization, with the male ones using a specialized copulatory organ known as Phallodeum.
- 9. Caecilians display both oviparous (egg-laying) and viviparous (offspring-bearing) modes of reproduction, depending on the species.
- 10. Parental care in caecilians can be unusual, where sometimes juveniles are found to feed on the mother's skin, a behaviour called Dermatophagy. In some species, young ones absorb nutrient-rich secretions from the mother's reproductive tract. Often, the mother remains coiled around the egg clutch, guarding and protecting them from drying out.

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Parental care in *Ichthyophis* sp.
Photograph by Dr. S.D. Biju

Why Caecilians Matter?

Despite their ordinary worm-like look, they are a group of remarkably specialized vertebrates built for a hidden fossorial lifestyle and play crucial ecological roles. As soil dwellers, they contribute in maintaining soil health by constant burrowing that helps in soil aeration, creating small channels and allowing air and water to pass easily through soil. Thus, they also support the growth of microorganisms, making the underground condition more fertile and balanced. As active predators, they regulate invertebrate populations and thus control the subterranean ecosystem. Moreover, their sensitivity to the changes in underground

“ However, caecilians remain as one of the least studied vertebrates due to their cryptic lifestyle and difficult taxonomy, leaving many aspects of their biology and diversity still poorly known. ”

environment makes them a significant bio-indicator of habitat health. However, caecilians remain as one of the least studied vertebrates due to their cryptic lifestyle and difficult taxonomy, leaving many aspects of their

biology and diversity still poorly known. This highlights the sincere need for further research and exploration to better understand this amazing yet important group of amphibians.



Sun, Sand and Toughies: Mammals of the Indian Desert

Indu Sharma

Deserts looks lifeless but with single small shower/dew seeds grew with greeneries and various lives come out in this wilderness, so rain act as induction to unlock the hidden life of the desert. Insects appears and animals resume their feeding and breeding activity, so there is sudden burst of biodiversity in the dry terrain. Consequently, in the arid region fauna mostly is in the dormant stage during the period of long summer to cope up with harsh environment such as high temperature, high velocity of wind (loo) and water scarceness. Here rate of evaporation is double than rate of precipitation. Due to harsh unpracticable and extreme climatic conditions, it is one of the most fragile and vulnerable ecosystems. Beside this, desert supports rich diversity adapted to survive in the inhospitable conditions of the area. Though, except birds and some large

mammals, fauna is not easily visible to casual observer but all the creatures from microscopic Protozoa to Mammals are found in this arid region. They constitute invaluable stock of rare and resistant, repository of germplasm that have evolved over ages to survive in the extreme environmental stresses.

Further, animals to withstand in this harsh climatic condition reside in burrows, tunnels, under stones, on plants and leaves and water bodies etc. Long legs, flashy footpads of the animals are helpful to conserve the water and is the adaptation in the desert. They have specialized morphological, behavioural and physiological adaptations.

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Desert supports rich diversity adapted to survive in the inhospitable conditions of the area. Though, except birds and some large mammals, fauna is not easily visible to casual observer but all the creatures from microscopic Protozoa to Mammals are found in this arid region.

Deserts cover about 20% of earth's land and is located in every continent of the earth. It is one of unique Ecosystem and one out of ten major biogeographic zones of India. It (Desert Biogeographic zone) in India is represented by the *Indian Desert Zone or Thar Desert*. Thar desert is biogeographically the eastern most edge of the Sahara-Arabian Desert belt and is situated at the meeting point of Palaearctic and Oriental biogeographic realm. It has an area of 1,96, 150 sq. km. and comprises 4.6% of geographical area of India and positioned 9th largest subtropical hot desert among the world's desert. It comprises about 85% of the Desert in India and mainly in State of Rajasthan (61%), Gujarat (20%) and Punjab & Haryana (9%).

It is encompassed by the salt marshes of Rann of Kachchh, north west by the Sutlej River, east by the Aravalli ranges and west by the Indu River. State of Rajasthan is divided into four main physiographic zones i.e. the western Desert (Thar

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Desert), the Aravalli hill, the eastern plains and south-eastern plateau (Hadoti Plateau). All the zones with different ecological niche, habitats and climates contains rich and unique mammal fauna.

The mammals of the desert are divided into 15 orders. It primarily comprises Rodentia, Eulipotyphla, Lagomorphs, Artiodactyla, Cetartiodactyla, Carnivora and Primates. The key desert animals of the Rajasthan are Indian Desert Gerbil, Hairy-footed gerbil; Dwarf gerbil or Pygmy gerbil; Indian gerbil, Soft furred rat, Bush rat, Bandicoot rat, Short-tailed bandicoot rat, Lesser Bandicoot rat, Crested porcupine, Desert hare, Chinkara, blackbuck, Neelgai, Wild Boar, Tiger, Jungle cat, Desert Cat, Striped hyaena, Grey

Mongoose, India Civet, Otter, Honey Badger/Ratel, Sloth Bear, Bengal Fox, Red fox, Wolf, Pangolin, Desert Hedgehog etc.

Desert Rats known as gerbils, jirds and sand rats and is the most dominating group in the desert of Rajasthan. They belong to subfamily Gerbillinae under order *Rodentia*. Rodentia is the largest order of the Class Mammalia and also one of the most significant and abundant group of the desert animals in Rajasthan. Gerbils are small dominated species of thar of Rajasthan. They are characterized by small size with short legs and mainly gnawing teeth. All gerbils can swim however, this behaviour in desert is rare. Gerbils in the desert comprises *Meriones hurrianae* (Jordon, 1867)-*Indian Desert Gerbil* is one of the small rodents of the desert. *Gerbillus gleadowi* (Oldfield Thomas, 1913)- *Indian Hairy-footed Gerbil* have well developed large eyes, long busy tail, large ears. *Gerbillus nanus* Blanford, 1875 are also called *Pygmy gerbil* or *dwarf gerbil* are small in size, tail longer than body and tufted at the tip. *Tatera indica* (Wilhelm Peters, 1852)-*Indian gerbil* is medium size, strong rodent and hind limbs are long and strong. *Millardia meltada* Gray, 1877-*Soft furred rat* is

small with velvety fur is social rodent kept as pet. *Golunda ellioti* (Gray, 1837)-*Bush rat* has strong forelimbs and clawed toes for digging and short tail. These all gerbils live mostly in burrows that it digs in the ground, which protect it from heat during the day and cold at night. It is mostly active at night, which helps it avoid extreme daytime heat. It can survive without directly drinking water, as it gets moisture from seeds and plant material it eats and has efficient kidneys. It well camouflage with desert since its fur is usually light brown or sandy in color, which helps it blend into desert surroundings and avoid predators. *Hystrix indica* Kerr, 1792- *Crested porcupine* is large terrestrial rodent and proficient swimmer with long multi-layered defensive quills. It has large sturdy body with low surface area to body which is supportive to reduce the heat in arid environment and helps in heat conservation

Eulipotyphla order includes shrew, moles and hedgehogs. These animals have generally small eyes and poor vision. *Hemiechinus auritus* Gmelin, 1770-*Desert Hedgehog* is distributed throughout the desert. They live inside the burrow in the form of ball dig by them created beneath

the trees/bushes. They came outside the burrows during dusk and in danger withdraws their snout and limbs inside and roll up in form of ball with spines outwards. When someone disturb them inside the burrow, they make a hissing sound to mimic with snakes. The young are born deaf and blind, and with the quills placed under the skin to avoid damage to the female during birth.

Lepus nigricollis dayanus (Blanford, 1823)- *Desert hare* is mid-sized hare, long ears with black tip and with long hind limbs. They come under order Lagomorphs comprises numerous species- Rabbits, Pikas and Hares are herbivorous animals and can be differentiated by having tooth structure with upper four incisors versus Rodentia with two incisors. Eyes are large and prominent. It lives under bushes in depressions. Chinkara- *Gazella bennettii* (Sykes, 1831) under order *Cetartiodactyla* and family Bovidae also known as the Indian gazelle, is important herbivore of the desert of Rajasthan. It is a small and graceful antelope. These animals are herbivores and feed on grass, leaves, fruits, and shrubs. One special feature of Chinkaras is that they can survive for long periods without drinking water,

Various animals of the order Carnivores are well adapted to the desert. These animals have sharp teeth, strong jaw and very good scavengers

as they get enough moisture from the plants they eat. They are very fast and alert animals, able to run quickly and make sharp turns to escape predators. Chinkaras are usually seen alone or in small groups and are most active during the early morning and evening to avoid the heat. They are shy and cautious by nature. They play an important role in maintaining the balance of desert ecosystems and are a beautiful example of adaptation to harsh environments.

Various animals of the order Carnivores are well adapted to the desert. These animals have sharp teeth, strong jaw and very good scavengers. *Vulpes vulpes* Blyth, 1854-Desert fox have large ears to adjust with severe heat, camouflage and survive with little water. They are known for being very smart and quick. They have thick tail with white tip often called a “brush” which helps it keep warm and maintain

balance. *Canis lupus pallipes*-*Indian Wolf* has a robust body, strong jaws and well-developed long limbs adapted for running helps in travelling long distance. They live in groups called packs and each pack has a leader

known as the alpha. Wolves work together as a team to hunt animals. Wolves are loyal to their pack and depend on teamwork for survival. Even though they may seem dangerous, they usually avoid humans and play an important role in maintaining balance in nature. In desert regions, populations show adaptations such as reduced body size, lighter fur, and increased nocturnal activity to cope with heat stress and water scarcity. *Hyaena hyaena* (Linnaeus, 1758)-*Striped hyaena* inhabits in scrubland and is characterized by sturdy body with long legs vertical

Mostly all the animals of the Desert come under Wildlife Protection Act (WPA) 1972 and therefore require sustainable conservation to preserve the unique fauna of this fragile ecosystem of the thar desert. Conservation measures include habitat restoration; establishment of protected areas; control of illegal mining, poaching and hunting; continuous systematic surveys; research and documentation and awareness among the local people can be helpful for effective conservation of fauna.

long black stripes, sloping back and with thick mane and Camouflage in the desert. *Felis lybica* Forster 1780- *Desert cat* looks similar to a domestic cat but has a slender body, longer legs, and a sandy or pale-yellow coat with dark spots and stripes, which helps it blend into the desert surroundings. The desert cat is mostly active at night, which helps it avoid the extreme daytime heat. It is a shy and secretive animal, so it is rarely seen by humans. It lives alone and marks its territory. *The Caracal- Caracal caracal* (Schreber, 1776) is the beautiful medium sized, hunting cat with reddish brown colour. It is mainly recognized on the basis of long, erect and tuft of hairs on the tip of the ears. It has light, flexible body with powerful legs, run fast and can take jump up to 11 feet in the air. The tail is short. It inhabits in scrub and grassy lands. *Pangolin-Manis crassicaudata* (Geoffroy, 1803) known as the “scaly anteater”, unique mammals covered by

hard, overlapping scales made of keratin (the same material as human nails). They have strong claws for digging and a thick long tail that helps for balance, especially to climb on trees. It has a long, sticky tongue that it uses to catch ants and termites, which make up most of its diet. When threatened, a pangolin curls into tight ball, using its tough scales as armour to protect itself from predators. Pangolins have a very good sense of smell, which helps them find food in the dark. *Wild ass- Equus hemionus* (Pallas, 1775) is found in Rann of Kachchh in district Kachchh is a strong and fast animal that lives mainly in dry desert. Its light brown body helps it blend with sandy environment, and its long legs allow it to travel long distances. They also have a high tolerance for dehydration, which helps them live in places where water is scarce. It survives on dry grasses and salty plants, showing their ability to use different types of desert plants.

Wild asses usually live in small herds, which helps them protect each other and find resources more easily. They live in open plains as well as in rocky or hilly deserts. This diversity helps the species survival in changing environments and makes it an important part of desert ecosystems.

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Blue Bull- *Boselaphus tragocamelus* (Pallas, 1766)



Chinkara-*Gazella bennettii* (Sykes, 1831)



Guardians of the Canopy: Primate Diversity in the Western Ghats

Ranjana Bhaskar

The Western Ghats are one of the global biodiversity hotspots and home to various endemic and threatened taxa. Non-human primate inhabitants include slender loris, Lion-tailed macaques, Hanuman langur, Nilgiri langur, bonnet macaques, and so on. They provide countless ecological services that determine the overall fitness of the entire ecosystem. However, human activities such as deforestation are disrupting their movement and diet and challenging their existence. This article compiles and reviews existing knowledge on primate diversity in the Western Ghats, highlighting their ecology, distribution, adaptive behaviours, and conservation challenges.

Western Ghats is an escarpment with a length of 1600 km from north to south and with an east to west width of 30- 80

km running parallel to the western coast of southwestern India. It traverses six states: Maharashtra, Goa, Gujarat, Karnataka, Kerala, and Tamil Nadu. In the rain shadow regions of the eastern slopes of the hill system, deciduous and scrub forests are observed, whereas on the western slopes, it is tropical rainforests. Well known for possessing remarkable species diversity and endemism, with surreal landscapes and climatic

conditions, it is designated as a UNESCO Site of Heritage.

Due to the unbroken canopy and availability of fruiting trees throughout the year, the Western Ghats are home to tree-dwelling primates, including slender loris (*Loris lydekkerianus*), bonnet macaque (*Macaca radiata*), lion-tailed macaque (*M. Silenus*), southern plains gray langur (*Semnopithecus dussumieri*), black-footed gray langur (*S. hypoleucos*), tufted gray langur

This article compiles and reviews existing knowledge on primate diversity in the Western Ghats, highlighting their ecology, distribution, adaptive behaviours, and conservation challenges.

Due to the unbroken canopy and availability of fruiting trees throughout the year, the Western Ghats are home to tree-dwelling primates, including slender loris (*Loris lydekkerianus*), bonnet macaque (*Macaca radiata*), lion-tailed macaque (*M. Silenus*), southern plains gray langur (*Semnopithecus dussumieri*), black-footed gray langur (*S. hypoleucos*), tufted gray langur (*S. priam*), and Nilgiri langur (*Trachypithecus johnii*). They play an instrumental role in the wellness and equilibrium of an ecosystem because they serve several ecosystem services, like seed dispersal and regeneration of forests.

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However, anthropogenic actions such as deforestation and fragmentation endanger them, so strategic conservation activities and monitoring are implemented to protect them at all costs. This article outlines primate diversity in the Western

Ghats, highlighting distribution, ecology, species composition, and conservation challenges.

1. Diversity of Primates in the Western Ghats

1.1 Evergreen Forest Specialists

Lion-tailed macaques are indigenous to a narrow strip of evergreen forests of the Western Ghats in the states of Kerala, Tamil Nadu, and Karnataka. They are specialist arboreal species and rarely come to ground, disturbances in the canopy will threaten the

movement, feeding, and even the existence of the species.

1.2 Mid-elevation and Montane Species

Nilgiri langurs are arboreal folivorous primates living in all forest types from 300 to 2,000 m in elevation. They are sympatric with lion-tailed macaques but maintain a segregated niche, mainly in diet and activities.

1.3 Habitat Generalists

Bonnet macaques are generalists distributed widely in the Western Ghats, settling in all forest types except high altitude shola and scrub forest. Their adaptive behaviour and opportunistic diet help them to survive in human-dominated landscapes successfully.

1.4 Nocturnal Habitat Use

Slender loris is small, solitary, night active primate inhabiting scrub forests, cultivated lands, and dry deciduous habitats. The Malabar slender loris is located in the wet forests of Kerala, Karnataka, Maharashtra, Goa, and possibly some regions of Tamil Nadu.

2. Endemic Species

2.1 Nilgiri Langur (*Semnopithecus johnii*)

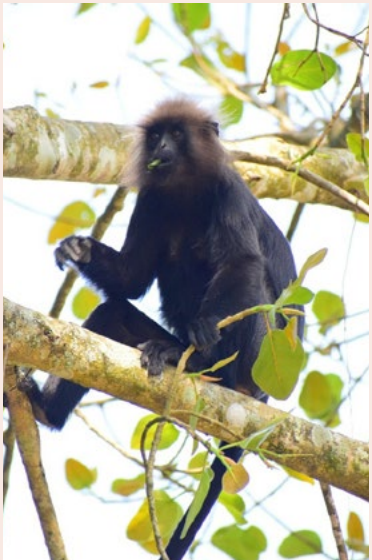
The Nilgiri langur is a diurnal, arboreal, leaf-eating monkey

endemic to the Western Ghats of south-west India, inhabiting forests from about 300 to 2,000 m, including evergreen, moist deciduous, and shola habitats. It has glossy black to dark brown fur with a lighter brown-yellow head, while females show a cream thigh patch; young are reddish-brown and darken within a few months. The species faces threats from hunting and habitat loss due to human activities and natural events. It is protected under CITES Appendix II,

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2.2 Lion-tailed Macaque (*Macaca silenus*)

The lion-tailed macaque is an endangered primate endemic to the evergreen forests of the southern Western Ghats. It has a black body with a distinctive grayish mane and a tufted tail like a lion. Highly arboreal, it



spends most of its time in the forest canopy and coexists with Nilgiri langurs by occupying different ecological niches. The species is threatened by habitat loss and hunting, and is listed as Endangered on the IUCN Red List, included in CITES Appendix I, and protected



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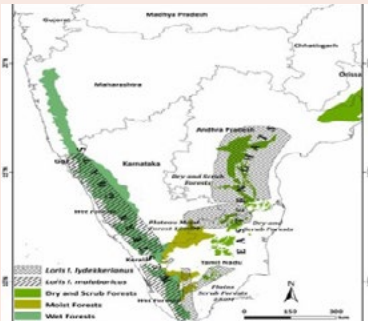


Appendix I, and protected under Schedule I of the Indian Wildlife (Protection) Act, 1972.



2.3 Slender Loris (*Loris lydekkerianus malabaricus*)

The slender loris is a small nocturnal primate found in southern India and Sri Lanka, with two subspecies in the Eastern and Western Ghats. It inhabits scrub, deciduous forests, and dense vegetation, feeding mainly on insects. About 25 cm long with large eyes and slender limbs, it is threatened by habitat loss and hunting. The species is listed as Endangered on the IUCN Red List and protected under Schedule I of the Wildlife (Protection) Act, 1972.



3. Widely Distributed Species

3.1 Bonnet Macaque (*Macaca radiata*)

The bonnet macaque is a highly adaptable primate found

across southern India, including forests and urban areas. It has grey-brown fur, a cap-like hair tuft, large ears, and long limbs. Widely distributed across peninsular states, it often lives near humans. The species is

listed as Vulnerable due to population decline, mainly from human-related threats such as habitat loss, hunting, translocation, and capture for trade, though natural predators also pose risks.



3.2 Hanuman Langur Complex (*Semnopithecus spp.*)

The Hanuman langur complex includes species such as *S. priam* and *S. hypoleucos*. These langurs occupy a range of habitats from dry deciduous forests to human-dominated landscapes. *S. hypoleucos* occupies the central Western Ghats, utilizing moist deciduous

and transitional forest types, and demonstrates moderate ecological flexibility. *S. priam* occurs along the eastern slopes and peripheral regions of the Western Ghats, extending into dry deciduous and human-modified landscapes beyond the mountain range. The southern plains gray langur (*Semnopithecus priam*), also known as the Madras gray

langur, is a species of Old World monkey native to southern India and parts of Sri Lanka. They are generally found at low to moderate altitudes, typically ranging from 180 m to 1,200 m above sea level. The species is listed as Near Threatened on the IUCN Red List, with declining populations due to habitat fragmentation, hunting, and agricultural expansion.

Semnopithecus priam



Semnopithecus hypoleucos



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Ecological Roles of Western Ghats Primates

Primates of the Western Ghats play a vital role in supporting the patterns, constancy, and functioning of the tropical forest ecology. Interactions of primates across different tropic levels help in the complexity and sustainability of forest environments. Their feeding behavior, movement patterns, and interactions with vegetation influence key ecological processes within these forests.

• **Seed dispersal:**

plant-animal interactions both help maintain species diversity in ecological communities. Seed dispersal and seed predation by fruit-eating animals are important for plant population dynamics. In tropical forests, the lion-tailed macaque and other primates has a large amount of the frugivore biomass by eating different kinds of fruits

and seeds over wide regions. By spreading seeds of rare species and destroying seeds of common species, both primates may help maintain plant diversity. Conserving primates that play important ecological roles is essential for keeping ecosystems healthy.

• **Trophic Interactions:**

In tropical type forests, primates have variety range of food resources, fruits, including

leaves, flowers. The eats sometimes insects also. Due to the various type of food diet, they migrating in different parts of the ecosystem. Their feeding habits are influencing the plant growth and regeneration and help in insect diversity.

Keystone Ecological Role:

The Western Ghats are internationally recognized as one of the most significant biodiversity hotspots for the conservation of biological diversity, partly due to the presence of keystone species. Primates are also considered the keystone species in tropical ecosystems because their ecological impact is largely on abundance. If the keystone species are decreased in population, that shows effects on reduced seed dispersion, changed vegetation structure, and decreased biological diversity are only a few of the

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Habitat and Distribution Patterns of Western Ghats Primates

Primates of the Western Ghats are distributed across a range

of forest types, from lowland evergreen forests to montane and fragmented landscapes. Their distribution is largely influenced by habitat type, altitude, food availability, and human disturbances. These factors shape both species richness and population structure across the region.

• **Evergreen Forests:**

Evergreen forests have endemic primates, and the least

considered primates are highly adapted to forest habitats. The Western Ghats of evergreen forests are classified based on the deep canopy cover, heavy rainfall, and year-round resource availability. This type of forest is suitable for Nilgiri langur and lion-tailed macaque, which are the dominant species in a evergreen ecosystem. Strong arboreal adaptations are displayed by these species, which rely knowingly on ongoing canopy connectivity for mobility and feeding. Because these monkeys have a low tolerance for ground movement, habitat fragmentation in evergreen forests has a negative effect on them.

• **Moist Deciduous Forests:**

Western Ghats moist deciduous forests act as transition zones between evergreen and dry habitats to a variety of primates that can be sustained. Many diverse primates, langurs and macaque, occur in these kind of forest, taking advantage of the fruits and leaves available seasonally. They eat more nutritional adaptability than the evergreen forest primates and have a greater degree of behavioral diversity as well.

• **Dry deciduous Forests and Scrublands:**

The bonnet macaque and Hanuman langurs are abundant

in dry deciduous forests and scrub habitats, whose characteristics are an open canopy and limited resources throughout the year. The primates can make use of different types of food sources, including vegetation and fruit as well as anthropogenic resources, because they spend much time on the ground and show high environmental plasticity. The wide range of generalists in the Indian Peninsula is attributed to their ability to survive under tougher conditions.

• **Urban and Human-Modified Interfaces:**

The bonnet macaque is well known for its ability to persist in human-modified landscapes and is frequently observed in areas such as roadsides, agricultural fields, temple premises, and urban fringes. These populations often depend on anthropogenic food sources, which can alter their natural foraging behaviour, social dynamics, and health conditions. While this adaptability enables survival in disturbed habitats, it also leads to increased interactions with humans, often resulting in conflict situations

• **Ecological and Conservation Implications:**

Dispersal and diversity of primate is closely related to the

Habitat loss and deforestation, urbanization and fragmentation are the major threats to primates in the Western Ghats. These activity reduce habitat quality and isolate the populations in small patches that restrict the movement and gene flow.

ecological environments, with clear relations between specific habitat features and species occurrence. Species that survive in very specific ecological conditions and habitats are particularly susceptible to disturbances such as deforestation, fragmentation, and changes in land use. These pressures is restricting their habitat and reduce population sustainability. This type of spatial patterns is essential for developing effective conservation strategies, maintaining habitat corridors and managing interactions between humans and primates in landscapes areas.

Threats to Primate Diversity

Although their importance in ecology, primates of the Western Ghats is facing several threats:

Habitat Loss and Fragmentation

Habitat loss and deforestation, urbanization and fragmentation are the major threats to primates in the Western Ghats. These activity reduce habitat quality and isolate the populations in small patches that restrict the movement and gene flow. This has a damaging interaction among arboreal primates, such as the Nilgiri langur and lion-tailed macaque, limiting gene flow and limiting the chance of inbreeding. Other species, like the bonnet macaque, is domineting by humans, that make in conflicts. Maintaining habitat connectivity and protecting the forest patches are essential for conserving primate species and populations.

Human-Wildlife Conflict

Human-wildlife conflict with primates in Western Ghats

Human-wildlife conflict with primates in Western Ghats are increasing as human populations grow and habitats decline. The reduction and destruction of forests often push these primates into agricultural fields and urban environs in search of food. Managing these conflicts is essential to protect communities, prevent escalation, and reduce harm to wildlife. Effective solutions must consider ecological, social, cultural, and economic factors.

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Hunting and Illegal Trade

Predation and poaching still pose significant risks to primates in certain areas of South Asia. The primates in the Western Ghats might be preyed upon for meat consumption,

cultural purposes, or even be captured for local sale. Despite legislation protecting them from this kind of predation, there is laxity in enforcing this law, thereby leaving them vulnerable to poachers and traders. This form of predation can result

In the Western Ghats, roads cutting through or adjacent to forests make primates vulnerable to getting injured by vehicles, especially when moving between habitat fragments or searching for food in the corners of the mountain.

in a reduction in their number as well as disruption of social structure in primate species that breed slowly. The threat posed by predation can also change their behavior pattern, making them elusive.

Road Mortality and Electrocution

The linear nature of structures like roads and power lines has made them a danger for primates living in forested environments. In the Western Ghats, roads cutting through or adjacent to forests make primates vulnerable to getting injured by vehicles, especially when moving between habitat fragments or searching for food in the corners of the mountain. Power lines are also dangerous for primate populations because arboreal animals might accidentally get electrocuted after touching live wires while moving through

trees or gaps within the tree canopy. Such events not only lead to animal deaths but might influence population dynamics by killing individual members of fragmented primate communities.

Conservation Status and Efforts

The International Union for Conservation of Nature and Indian Wildlife (Protection) Act, 1972, lists several Western Ghats primates as threatened:

- Lion-tailed macaque – Endangered (IUCN) and Schedule I, Part I of the Indian Wildlife (Protection) Act, 1972.
- Nilgiri langur – Vulnerable (IUCN) and Schedule I, Part I of the Indian Wildlife (Protection) Act, 1972.
- Slender loris – Endangered (IUCN) and Schedule I of the Wildlife Protection Act, 1972, in India

Because of their unique nature and requirement for definite types of forests, they become very susceptible to habitat fragmentation, deforestation, and other human activities such as road development and plantation development, causing their population to decline and become fragmented.

Conservation Measures Include:

- Formation of protected zones such as Silent Valley National Park and Anamalai Tiger Reserve
- Habitat restoration and corridor development
- Community-based conservation programs
- Awareness campaigns to reduce human-wildlife conflict
- Strengthening anti-poaching measures and wildlife law enforcement
- Long-term population monitoring and scientific research (e.g., genetic studies, habitat use)
- Reforestation using native plant species to improve habitat quality
- Regulation of tourism and human activities in a sensitive forest area
- Mitigation of roadkills through wildlife crossings and traffic control in forest regions
- Control of invasive species that degrade primate habitats
- Capacity building and training for forest staff and local conservation groups

- Promoting sustainable livelihoods to reduce forest dependency (e.g., eco-tourism, agroforestry)
- Use of technology like GIS and remote sensing for habitat monitoring and planning
- Conservation education programs in schools and local communities

Research and Future Directions

Advances in molecular and genetic techniques have significantly enhanced our knowledge regarding the evolutionary affinities and population structure of primates. The application of both mitochondrial and nuclear DNA has been effective in resolving taxonomic confusion in the genus *Semnopithecus*. Future research directions should focus on

- Long-term population monitoring
- Climate change impact assessment
- Landscape-level conservation planning
- Integration of local communities in conservation strategies

Primates of the Western Ghats represent an important component of this region’s biological wealth. Their limited distribution and important ecological roles make them key to maintaining forest dynamics and diversity. Ensuring their future depends on sustained efforts that combine research, effective governance, habitat protection, and local community participation. Long-term conservation planning will be essential to safeguard these species and the ecosystems they support.

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Red Panda: A Magical Creature of Mountain

Swagata Dutta

Native to the temperate forests of Eastern Himalayas and Southwestern China there is a bamboo munching arboreal mammal who hold the title of only true panda -the red panda, a monotypic species in the family Ailuridae. 'Nigalya Ponya'-is the Nepalese word from where the term Panda has been originated, it means bamboo eater. Due to their charismatic appearance and immense popularity, Red panda is a celebrity in animal kingdom.

Covered with rusty brown orangish fluffy far all along the body with black limbs and belly, bushy tail and mask like brown far surrounding their cute button eyes, white fur in chubby cheeks, red pandas are one of the cutest animals found in nature. Their cute antics sometimes become meme for netizens.

Often termed as creature of camouflage as red, brown colour of their body help them to blend

into the mossy green-orange foliage of the jungles. Black belly keeps them hidden in the canopy shadows when view from the below. They disguise themselves so well in the branches that their sighting in wild to humans often termed as a rare event.

Despite belonging to the Order Carnivora they adapted themselves to be 98% the bamboo eating vegetarian . Their diet is mainly based on

bamboo shoots and leaves along with grass, fruits.

Hanging on a bamboo plant, eating and sleeping most of the day is what they do best , that is why often we humans want to be a panda. Scientifically that is how they act as an umbrella species as munching on bamboos help to regulate growth of the bamboo plants, dispersal of seeds, which in turn maintain the balance of the biodiversity of the Eastern

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With a population of only 10,000 Red pandas are enlisted as endangered species according to IUCN Red list. In India Red Pandas are spread across the high altitudes of WestBengal, Sikkim and Arunachal Pradesh with a no of2500roughly. In the last two decades50% of their population has been tumbled due to several reasons.

Himalayan broadleaf forests and protect numerous other threatened species of that area.

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live in a fragmented habitat, death of a female red panda can wipe out the entire clan living in that pocket. Poaching for their fur is another reason for their decreasing number, as the auburn coat is traded for a hefty amount and being a charismatic species red panda always stays in the limelight due to these they are the soft target of the poachers.

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There is always light in the end of the dark tunnel. WWF, Red Panda Network and people all over the world are leaving no stone unturned for saving the creature of the mountain. Red pandas are legally protected in their habitat across the world. Habitat restoration i.e planting trees, making biological corridor, expanding forest, awareness program aims to encourage the local communities to care for the animal, community based patrol and, anti poaching patrol are also in the place. Ex situ conservation like captive breeding, reintroduction program in wild going on for genetically diverse and stable population to prevent extinction from Earth. All types of initiatives are taken to protect this chubby animal, still that is not enough, children of mother nature we have moral obligation and commitment to protect all the species that are on this planet.



Fig: Red Panda in nature (Source: Unsplash)



When Rhinos Roamed the Mangroves: A Zooarchaeological Journey into the Sundarbans

Supriya Nandy

Present human settlement in the Sundarbans is, in fact, quite recent—just a couple of centuries old. It began when the British, driven by revenue and expansion, started clearing the dense mangrove forests to convert them into agricultural land. People were brought in from outside, forests were cleared and gradually *badabon* - the wild mangrove - gave way to cultivation. Through this process, the landscape of Sundarbans, took shape, as we see it today.

But this is not the real beginning of its story. Long before this phase—at least since the Shunga–Kushan period, and possibly even earlier—humans had already set foot in this region. Traces of those early settlements still lie scattered across the deeper, less accessible parts of the forest. Credit of piecing together this



Just as archaeologists can shed light on the people of a bygone era and their way of life by examining fragments of terracotta pottery or the remains of a broken sculpture, so too can a solitary animal bone or a broken shell—hidden amidst these artifacts can tell us just as much, if not more. There comes zooarchaeology, a specialized branch of science devoted to this kind of study, a discipline largely unfamiliar to the common people.

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In fact, they take us back roughly ten to eleven thousand years, into the Holocene epoch—a crucial time when human societies were taking shape in ways that still influence us today.

fragmented past undoubtedly belongs to the archaeologists, through their work over many years.

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It deals with animal remains that are not fully fossilized, often referred to as sub-fossils. These may be ‘recent’ in geological terms, but they are invaluable when it comes to understanding human history.

In fact, they take us back roughly ten to eleven thousand years, into the Holocene epoch—a crucial time when human societies were taking shape in ways that still influence us today. By studying these remains, we can see how closely the life of ancient people was intertwined to animals. Not just in terms of food, but in everyday survival. Bones and shells reveal what people ate, how they hunted or fished, whether they practiced animal husbandry, and even how they cooked their food. Sometimes, cut marks on bones can tell us about the tools they used. Animal remains also show how people used resources beyond food—animals helping

in transport or farming, skins for clothing, bones for tools, fat for fuel, even for use as ornament or role in religious practices. They tell us whether animals were domesticated or hunted, and even hint at the kind of environment those species lived in.

The most striking is this fundamental relationship of human and animals has changed a little and even today, humans continue to rely on animals in the same ways, bridging the present to past.

All the animals we are familiar with can broadly be divided into two groups: wild species and domesticated ones. The first group—those that live freely in nature, following their own instincts—is by far the larger in terms of the number of species. Wild animals include not just mammals and birds, but also turtles, fish, and even creatures like snails, molluscs, crabs, and insects.

In contrast, the number of domesticated species is surprisingly small—almost countable on one’s fingers. Yet the process of domestication—of turning wild species into animals that live alongside humans—marks one of the most significant turning points in the history of human civilization.

In early times, survival depended on gathering fruits or hunting fast-moving animals with rudimentary stone tools—both highly uncertain ways of securing food. Moreover, when a group of people stayed too long in one place, the natural resources of that area would inevitably become depleted. This forced them to move constantly in search of new sources of food. On top of that, they had to contend with storms, rains, and other natural hardships.

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The twin innovations of agriculture and animal domestication fundamentally changed this way of life. Together, they enabled humans

to transition from a nomadic existence—wandering in search of food—to a more stable, settled village life. This transformation did not happen overnight; it unfolded over thousands of years.

The long-term results of these processes are clearly visible today. Different breeds of cattle, goats, and dogs—genetically related, yet often strikingly different in appearance and function—are all products of this long history of human intervention.

When we think of domesticated animals, the first things that come to mind are their practical uses: food in the form of meat and milk, materials like leather, transport and load-bearing, and labor such as ploughing fields. But interestingly, the first animal to be domesticated was the dog—and its relationship with humans was not based on food, but on companionship.

Dogs likely played roles in warning humans of danger from other predators, guarding settlements, assisting in hunting, and later even helping in herding livestock. Over time, other animals such as horses, goats, cattle, camels, asses, pigs, sheep, ducks and chickens were domesticated. Gradually, the list of domesticated species grew longer.

As human societies progressed, nearly every aspect of daily

life evolved—tools became more refined, dwellings more structured, trade expanded, and transport systems developed both on land and across waterways. At the same time, domesticated animals did not remain unchanged. Under sustained human influence, they were gradually reshaped through selective breeding and crossbreeding, making those better suited to specific purposes and, in many cases, more reproductively efficient.

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Animals are considered truly “domesticated” when their survival and reproduction are entirely under human control—when most of their wild traits have been lost, and they have become fully dependent on humans. Examples include cattle, buffalo, goats, sheep, horses, and dogs. In many cases, the wild ancestors of these domesticated animals have completely disappeared from the Earth—such as the original wild forms of horses, camels, or cattle.



Yet somewhere along the path to what we call “civilization,” this relationship began to change. Today, in the drawing rooms of the affluent, we see tiger skins or deer hides displayed as decoration, antlers mounted on walls, and luxurious fur garments worn by those who can afford them



At the same time, there are animals that humans tame and live alongside, but which are not truly domesticated. We often refer to them casually as “pets” or “tame animals”—such as elephants, otters, or mongooses. Historical accounts even suggest that kings once kept cheetahs. These, however, remain basically wild animals. Though they may be trained to assist humans, they are not domesticated in the true biological sense.

So it becomes clear that the relationship between humans and animals goes back a very long way. Early humans learned to hunt out of necessity—for food and survival—much like a tiger hunts a deer. For the tiger, the deer’s flesh alone is enough to satisfy its hunger. But early humans went further: they used not just meat, but also skin, fur,

and other parts of animals—perhaps for clothing or other essential needs. Humans, after all, are the only species capable of adapting themselves to almost any environment or climate.

Yet somewhere along the path to what we call “civilization,” this relationship began to change. Today, in the drawing rooms of the affluent, we see tiger skins or deer hides displayed as decoration, antlers mounted on walls, and luxurious fur garments worn by those who can afford them. What was once a matter of necessity has, in many cases, turned into an expression of indulgence—often cruel and unnecessary. Beyond that lies the notion of “sport hunting,” where animals are killed not for survival, but for amusement, aided by modern weapons like guns. The consequences of



In ancient times, the Sundarbans looked very different from what we see today. After the formation of this delta in relatively recent geological history, the sea advanced into the land and retreated multiple times. These shifts caused dramatic changes in the landscape—altering islands, creeks, rivers, and coastlines. Other factors, such as changes in land gradient, also led to shifts in river courses and a reduction in navigability.



such practices, sustained over centuries, are evident today: many species across the world are now endangered. Our own country is no exception.

One might argue, if predator–prey relationships are a fundamental and enduring feature of nature and humans are part of the natural food chain, what harm is there in humans killing and consuming certain wild species? After all, we eat fish, prawns, crabs—many of which are still caught directly from rivers or the sea, and therefore qualify as wild species. Yet even these populations are gradually declining. Their numbers and reproductive rates are still high enough that we may not

immediately notice the loss, but the trend is unmistakable. Several indigenous fish species that were once abundant in local markets have now become rare. Hilsa is a striking example. If unregulated harvesting continues, extinction is not an unlikely outcome.

Turtles, too, were once widely consumed. They were hunted relentlessly—sometimes even large migratory individuals that came ashore to lay eggs. As a result, many such species now stand on the brink of extinction. What began in ancient times as a survival-driven practice has, over time, escalated beyond limits for growing demands and intensified methods, threatening the delicate balance of nature.

At the same time, human expansion has steadily reduced natural habitats. Forests have been cleared, rivers altered, land reclaimed. The equilibrium that once existed no longer holds.

There was a time when humans were simply part of nature. Today, they reshape it.

Let us return to the thread we began with—zooarchaeology.

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All these processes together shaped the present-day Sundarbans. The traces of civilizations that existed here in pre-Christian era gradually disappeared under the passage of time. Nature reclaimed those inhabited islands, covering over the marks of human presence.

Then came the colonial period and with it, a new phase of human settlement. Much of what we see today dates from that time.

After all, every species—vertebrate or invertebrate—requires a specific habitat to survive. Identifying a species from archaeological remains allows us to infer the nature of that habitat: whether the area was once dense forest, wetland, or even part of the sea. For this reason, the preservation of these ancient biological remains is not merely important—it is essential.

considerable archaeological significance.

Yet, in this entire context, one important point cannot be overlooked: animal remains are strikingly underrepresented in these collections. In many cases, they are entirely absent. Some artifacts made from animal materials—such as shell ornaments or conch objects—do exist, as they are traditionally valued in archaeology. But actual faunal remains are rare.

In the private collections of some renowned archaeologists in and around Sundarbans, a very small number of excavated

And yet, the past has not completely vanished. Even now, deep within the forests—or sometimes in unexpected places—fragments of that earlier history emerge: old bricks, coins, terracotta pieces, broken sculptures.

Unlike many other ancient sites in India, systematic archaeological excavation in the Sundarbans has been limited. The terrain is difficult, often hostile. Dense forests, shifting land and the presence of dangerous wildlife make large-scale work challenging.

Among them, the late Kalidas Dutta stands out as a pioneer. Many others have since collected artifacts and continue to study them. Across the North and South 24 Parganas, there

are private collectors whose personal collections are of

For instance, the lesser one-horned rhinoceros, commonly known as the Javan rhinoceros (*Rhinoceros sondaicus*), smaller in size than the Indian one-horned rhinoceros (*Rhinoceros unicornis*), both species are today endangered—but their fates differ starkly. The Indian rhinoceros still survives, though in limited numbers, in regions such as the Dooars, northeastern and northern India, and Nepal. The Javan rhinoceros, however, once found in considerable numbers across the Sundarbans of both India and Bangladesh, has vanished completely from the Indian subcontinent.

animal bones are preserved, compared to the number of other artifacts. One local fisherman and enthusiast, who hoarded a huge number archaeological artifacts since his childhood, admitted that in earlier days, he would often discard such bones, not realizing their importance.

This, perhaps, reflects the broader reality: these remains have not been given the value they deserve. Yet their significance is profound. For instance, the discovery of domesticated animal bones emerging from eroded soil near a densely forested island could indicate the presence of an ancient, thriving human settlement in that area.

On the other hand, bones of animals that once roamed the Sundarbans—but are now locally extinct—are sometimes unearthed during pond excavation or while digging foundations for houses in densely populated regions. Not only large animal bones, but also remains of certain mollusc species have been found in places that are no longer their natural habitats.

Through scientific analysis of these remains, it is possible to determine whether a species was native to the area or introduced from elsewhere. Techniques like carbon dating can also

establish the time period during which these organisms lived. Such findings, in turn, help reconstruct the past geography and climate of the region.

After all, every species—vertebrate or invertebrate—requires a specific habitat to survive. Identifying a species from archaeological remains allows us to infer the nature of that habitat: whether the area was once dense forest, wetland, or even part of the sea. For this reason, the preservation of these ancient biological remains is not merely important—it is essential.

In the southern part of the Ganges delta, the Sundarbans has, over time, lost many of its large mammals. The primary reason for this disappearance is not difficult to trace: indiscriminate hunting over the past few centuries, combined with the steady encroachment on their natural habitats. After all, species that had survived for thousands of years in this complex network of forests and waterways do not simply vanish without cause.

It is zooarchaeology that provides us with scientific evidence of the former presence of these animals in the Sundarbans. Without it, we might have had to rely solely on oral traditions and scattered historical accounts to

believe that such species once roamed these lands.

For instance, the lesser one-horned rhinoceros, commonly known as the Javan rhinoceros (*Rhinoceros sondaicus*), smaller in size than the Indian one-horned rhinoceros (*Rhinoceros unicornis*), both species are today endangered—but their fates differ starkly. The Indian rhinoceros still survives, though in limited numbers, in regions such as the Dooars, northeastern and northern India, and Nepal. The Javan rhinoceros, however, once found in considerable numbers across the Sundarbans of both India and Bangladesh, has vanished completely from the Indian subcontinent.

Even more alarming is the fact that the Javan rhinoceros is now one of the most critically endangered mammals on Earth. Only about 74 individuals survive, confined to a single location—the Ujung Kulon National Park at the western tip of Java. A single natural disaster in this region could wipe out the species entirely. And yet, not very long ago in geological terms, this animal ranged across vast parts of Southeast Asia and India.

Historical accounts suggest that even in the 18th century, this rhinoceros could be seen in areas around Kolkata. Early

Physical evidence supports these accounts. Bones of the Javan rhinoceros have been recovered from several locations in the Indian Sundarbans—Sagar Island, Harinarayanpur, and many others. Some of these specimens are preserved in some private collections such as the Khari Chhatrabhog museum and the Sundarban archaeological collections. British expedition reports from the 1830s also mention rhinoceros hunts on Sagar Island.

naturalists like Jerdon and various colonial-era hunters documented encounters and hunts. Specimens found their way into museums in London and the Indian Museum in Kolkata; some animals were even captured alive and transported abroad. Records from roughly the 17th to the late 18th century indicate that sightings and hunts were not uncommon. In regions that are now part of Bangladesh—such as Ishwaripur, Khulna, Mongla, and Barishal—there are also accounts of these animals being hunted or captured. However, many of these descriptions did not clearly identify specific locations within the Sundarbans.

One particularly noteworthy account comes from 1892, when D. Poncins reported seeing several rhinoceroses in the Pijankhali forests south of Ishwaripur—and, remarkably, chose not to hunt them. Later, around 1900, an officer of the Survey Department is believed to have made the last recorded sighting of a rhinoceros in the Sundarbans.

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Further north, at Chandraketugarh in North 24 Parganas, excavations have yielded terracotta plaques depicting rhinoceroses. Similar finds have been made at the Clive House site in Dum Dum. These artifacts strongly suggest that rhinoceroses were once a familiar presence across this broader region.

Another large mammal that once likely thrived throughout the Sundarbans is the wild water buffalo (*Bubalus arnee*). The reason for assuming its widespread presence lies in the evidence itself: among the faunal remains collected from the region, buffalo bones are the most abundant. Today, this species too is endangered, surviving precariously in parts of Assam and Chhattisgarh. Numerous sites across North and South 24 Parganas—Panihati, Barasat, Raidighi, Boral, Tangrakhali, Gosaba, Dhanche, Halliday Island, and many more—have yielded wild buffalo remains, sometimes even in recent times. A particularly striking discovery was made a few years ago

Remains of invertebrates—such as molluscs, and crabs—are also found beneath the soil. Unfortunately, these are rarely collected or preserved. Yet the presence, or abundance of those species, can provide direct evidence about the changing ecological conditions of a region.

near Gosaba, where excavation revealed a large number of bones belonging to what turned out to be a single huge skeleton. At first glance, and perhaps influenced by its sheer size, some even speculated—rather dramatically—that it might belong to a dinosaur, a claim that briefly made its way into newspaper headlines. In reality, it was the skeleton of a massive wild buffalo, its skull especially imposing. The specimen is now preserved in the palaeozoology museum of the Zoological Survey of India in Kolkata. Like many others, this species too fell victim to relentless hunting.

The Sundarbans has also lost more delicate creatures. The hog deer (*Axis porcinus*), once present in the region, has now disappeared from the Indian Sundarbans, though it still

survives in parts of northern and northeastern India. Fragments of antlers have been recovered from sites in North and South 24 Parganas.

Among other notable losses is the barasingha or swamp deer (*Rucervus duvaucelii*). Many tools made from deer antlers—recovered from places on the banks of the *Adi Ganga* (the ancient channel of river Ganga) with remains of important ancient settlements revealed many locally extinct species, including barasingha. Discoveries of wild buffalo, saltwater crocodile, and various turtle remains in these areas confirm the existence of dense mangrove forests once. At the same time, remains of ancient pre-Christian settlements—along with numerous bones of domesticated cattle and

buffalo—point to thriving human habitation. Similar patterns are seen in other parts of the Sundarbans, where bones of domesticated animals are found buried deep within the soil layers.

Not only large mammals, but also fragments of shells of various species of turtles—many now nearly extinct in the Sundarbans—have been recovered across different sites. Even more intriguing are remains of freshwater species discovered in areas now close to the sea.

Remains of invertebrates—such as molluscs, and crabs—are also found beneath the soil. Unfortunately, these are rarely collected or preserved. Yet the presence, or abundance of those species, can provide direct evidence about the changing ecological conditions of a region.

Zooarchaeology, therefore, does much more than trace the history of human–animal interactions over the past ten thousand years. It serves as a powerful tool for reconstructing ancient environments and understanding the role humans have played in shaping ecosystems over time. It reveals how deeply biodiversity is intertwined with climatic and environmental changes—from

ancient times to the present. And perhaps most importantly, it offers lessons for the present.

Because if we understand what has been lost—and how, it becomes easier to think about what can still be protected.

Unfortunately, many of these remains never reach researchers. They are lost during construction, discarded during excavation, or simply ignored. This is where awareness becomes crucial. Not just for archaeologists or scientists, but for anyone who encounters these materials. Even small finds—a fragment of bone, a piece of shell—can carry important information and message. If enthusiasts can help recover

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such materials, raise awareness about their importance, and ensure that these finds get preserved and studied, they too can contribute to the larger

story still being uncovered - and thus, piece by piece brings the forgotten past of Sunderbans back



Echoes of the Tethys Sea: Unearthing Marine Fossils in the Heart of Central India

Debashree Dam

The first sight of a marine fossil in the dry heartland of Central India felt almost unreal. Yet, as the saying goes, seeing is believing. Standing amidst dusty rock outcrops under the scorching sun of Madhya Pradesh, holding in my hand the fossilized remains of creatures that once lived beneath an ancient sea, I realised I was witnessing one of Earth’s greatest stories written in stone.

A Journey into the Unknown

It was my first field expedition to the rugged landscapes of Dhar District in Madhya Pradesh—an unforgiving terrain where summer temperatures often touch 44°–45°C and long dry months stretch from October to May. As a scientist from the Paleozoology Section of the Zoological Survey of India, journeys into remote terrains

in search of fossils have always carried a sense of adventure and scientific excitement. Our team consisted of three women scientists, energetic, united by curiosity and a shared passion for exploring Earth’s ancient past. After travelling nearly 1900 kilometres across India by air and hectic road travel, we finally reached the famous Bagh Beds, renowned for preserving fossils from a vanished world.

The Thrill of Discovery

Excitement filled the air from the moment we arrived. Sleep became almost impossible that night as thoughts of the next day’s exploration raced through our minds. At dawn, armed with field notebooks, GPS devices, cameras, geological hammers, chisels, fruits, bottles of ORS, and endless enthusiasm, we set off toward the fossil beds.

After hours of driving along rough, dusty roads and trekking through rocky terrain, we finally reached the designated site.

The heat was intense despite it being November, a month normally associated with winter. Every field expedition is a challenge and tests not only scientific skills but also physical endurance. The blazing sun was strong and rugged landscape tough to trek but not enough to diminish our excitement. Soon, scattered among the rocks, we reached the fossil beds and began spotting for fossils. What we first see are all stones in front of our eyes and bit by bit as the focus intensifies we can slowly distinguish a fossil hidden amongst the heap of stones. Amidst the stones my eyes suddenly spotted one which had something drawn on it. I picked up the stone and

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amazed to discover it was a fossilized echinoid. Echinoids are marine animals related to modern sea urchins and sand dollars belonging to the phylum Echinodermata. Then came an excited shout from one of my colleagues. Embedded within the rock layers were fossilized marine molluscs. Moments later, we discovered ammonites. Ammonites are shelled marine cephalopods closely related to present-day squids, octopuses, and cuttlefish. They vanished from Earth around 66 million years ago during the fifth mass extinction that also wiped out the non -avian dinosaurs. To suddenly encounter them in one of the driest regions of Madhya Pradesh was astonishing. What we had previously known only through scientific papers now lay before our eyes in stone.

Questions flooded our minds and curiosity knew no bounds. How could marine creatures exist hundreds of kilometres away from the nearest coastline?

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The present-day landscape of Dhar district appears dry, rocky, and harsh, swept by hot winds where thorny vegetation struggles to survive. Yet millions of years ago, this very region lay beneath a warm, shallow sea. The echinoids once crawled across ancient seafloors while ammonites, corals, molluscs, and countless marine organisms thrived in these waters. The rocks of the Bagh Beds belong largely to the Late Cretaceous Period, around 66 million years old—a time when dinosaurs still roamed the Earth. Holding a fossilized echinoid in my hand, I could almost imagine waves washing across the ground beneath my feet.

The mystery of marine fossils in inland India opens a fascinating window into one of the greatest scientific revelations in Earth’s history—the theory of continental drift and plate tectonics.

The Theory of Drifting Continents

The mystery of marine fossils in inland India opens a fascinating window into one of the greatest scientific revelations in Earth’s history—the theory of continental drift and plate tectonics. Proposed by Alfred Wegener in 1912, the theory suggested that Earth’s continents were once united into a giant supercontinent called Pangea. Over millions of years, this enormous landmass gradually broke apart and drifted into the continents we see today.

Around 252 million years ago, nearly all the world’s continents were fused into Pangea, surrounded by a vast global ocean known as Panthalassa. On its eastern edge, a vast, wedge-shaped embayment known as the Paleo-Tethys existed as an extension of the Panthalassa basin. Pangea began breaking

up roughly 200 million years ago, splitting into two large masses: Gondwanaland (south) and Laurasia (north). Roughly 280–260 million years ago a string of continental fragments, termed the Cimmerian Terranes (including parts of modern Turkey, Iran, Tibet, and Southeast Asia), detached from the northern margin of Gondwana. As the Cimmerian plates migrated northward

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toward Laurasia, the Paleo-Tethys crust was subducted beneath the Eurasian margin. This “slab pull” created a back-arc basin effect and slowly the Paleo-Tethys began to close in the north and the Neo-Tethys (the “true” Tethys Sea) opened in the south. About 180 million years ago in the early Jurassic Period the Gondwanaland began fragmenting. The eastern half (including India, Madagascar, Antarctica, and Australia) separated from the western half (Africa and South America). The Indian subcontinent broke away from Madagascar and Antarctica approximately 120 million years ago and moved northward at an intense speed of nearly 15-20 cm/year across the ancient Tethys Ocean, faster than the average tectonic plate speed. Later, Pangaea split into two

major landmasses—Laurasia in the north and Gondwanaland in the south. India was once an integral part of Gondwanaland along with Africa, Madagascar, Antarctica, and Australia. During the Jurassic and Cretaceous periods, the Indian plate broke away and began an extraordinary northward journey across the ancient Tethys Sea at remarkable geological speeds.

Life in the Ancient Tethys Sea

The Tethys Sea was not merely an ocean; it was one of the richest marine ecosystems of the ancient world. Stretching across regions now occupied by the Mediterranean, Middle East, and parts of Asia, it supported an extraordinary diversity of life. Ammonites, echinoids, brachiopods, gastropods, corals, sharks, marine reptiles, and countless other organisms flourished within its warm shallow waters. The sediments accumulating on its seafloor eventually became repositories of fossils.

As the Indian plate drifted northward during the Mesozoic and early Cenozoic eras, its northern margin was bordered by the vast Tethys Sea. During periods of high global sea levels and episodes of localized basin subsidence, seawater advanced far inland across central India. This included regions such

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as the Narmada trough and adjacent rift basins, which acted as low-lying, gradually sinking depressions. These basins accumulated thick layers of marine sediments, including limestones, marls, and shales. Over millions of years, these sediments preserved fossils of ammonites, bivalves, foraminifera, echinoids, and many other marine organisms. Today, those fossil-bearing rocks stand exposed far inland, silently recording a time when central India lay beneath the sea.

The Birth of the Himalayas

The geological history of India during this period was dramatic. Between 130 and 90 million years ago, high global sea levels allowed marine waters to spread

across parts of peninsular India. Later, around 66 million years ago, massive volcanic eruptions created the Deccan Traps, covering vast regions of western and central India with layers of basaltic lava. Some marine sedimentary layers survived beneath or between these lava flows, preserving invaluable fossil records.

Eventually, around 55–50 million years ago, the Indian plate collided with Eurasia. This monumental collision closed the Tethys Sea and gave birth to the Himalayas. Marine sediments that once lay beneath the ocean floor were uplifted thousands of metres above sea level, explaining why marine fossils are found today in the Himalayan ranges. The sacred Shaligram Shilas, worshipped

as manifestations of Lord Vishnu and found mainly in Nepal's Kali Gandaki River, are fossilized ammonites from the ancient Tethys Ocean.

Fossils as Evidence of Continental Drift

The theory of continental drift is supported by multiple lines of evidence. The coastlines of South America and Africa fit together remarkably like pieces of a giant jigsaw puzzle. Fossils of identical species such as Mesosaurus, Glossopteris, and Lystrosaurus occur across continents now separated by vast oceans, demonstrating that these landmasses were once connected. For example, fossils of Mesosaurus, a freshwater reptile, have been found both in South America and Africa, indicating these continents were once connected since such species could not have crossed the ocean. Similarly, fossils of Glossopteris, a type of ancient plant, are found spread across southern continents like South America, Africa, Antarctica, Australia, and India. Additionally, the land reptile Lystrosaurus is found in Antarctica, India, and Africa, further demonstrating that these landmasses were once joined. Continental drift explains ancient climates, ecosystems, and why continents

fit like a giant jigsaw puzzle. These discoveries transformed our understanding of Earth as a dynamic and constantly changing planet.

Unearthing the Ancient Past

Our own expedition to the Bagh Beds became part of this larger scientific narrative. Over the course of nearly a week, our team collected and identified more than 500 invertebrate fossil specimens representing around 30 species which are housed in Zoological survey of India as part of National Zoological Collections. Among the remarkable finds are echinoids belonging to the extinct

genus *Hemiaster*, ammonites identified as *Placenticerias* and *Prionocyclus*, and brachiopods belonging to *Malwirhynchia*. Detailed scientific investigations are continuing to study their taphonomy, paleoecology, and paleoclimatic significance.

Preserving Earth's Geological Heritage and way forward

Each fossil carries within it the memory of an ancient world. They are not merely stones but priceless archives of Earth's history, preserving stories of vanished oceans, drifting continents, evolving life forms, and catastrophic extinctions. Yet many fossil-bearing rock

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formations are under threat from mining, construction activities, and unchecked human interference. Precious geological treasures that survived for millions of years may disappear forever within a few decades if not protected. Scientists and palaeontologists have repeatedly highlighted that India still lacks a strong, independent, and comprehensive legal framework exclusively dedicated to fossil conservation. There is an urgent need for stricter regulations and stronger laws to conserve and protect fossil-bearing regions across the country. Fossil sites should be safeguarded from mining, encroachment, commercial exploitation, unscientific collection practices, illegal

excavation, damage, or removal of fossils. India possesses an extraordinary geological heritage and important fossil localities must be declared protected geoheritage parks and conservation zones with proper scientific monitoring, public awareness programmes, and controlled research access. Further India's fossil heritage offers immense scope for advanced scientific research and conservation. Modern techniques such as biomolecular studies, isotope analysis, paleoclimatic reconstruction, and microfossil research can help scientists to better understand ancient marine ecosystems, climate change, continental drift, and mass extinction events linked to the

Tethys Sea and the movement of the Indian plate. Future studies should also focus on radiometric dating, paleoecology, paleomagnetism, and the impact of Deccan volcanism on biodiversity loss. The use of modern technologies like CT scanning, 3D digital imaging, AI-based fossil reconstruction, and GIS mapping can greatly improve fossil documentation and preservation. Fossils are far more than scientific curiosities—they are keys to understanding the evolution of our planet and the history of life itself. Preserving them is not merely a scientific responsibility but a commitment to safeguarding humanity's connection with Earth's deep and ancient past.



Some glimpses from field days



Spiny Survivors: Echinoid Fossils of Indian Subcontinent

Dola Roy

80 million years from now, the ocean floor looked entirely different from today. The water was warm, shallow and teeming with life. A strange globe-shaped creature entirely covered in spines crawled slowly across the seafloor. They are the sea urchins and they tell the most extraordinary stories in all of paleontology. Paleontologists have documented more than 130 distinct genera of fossil sea urchins from the Indian subcontinent in the past 175 years.

What is a sea urchin?

Sea urchins, scientifically known as echinoids, belong to the phylum Echinodermata, a group that also includes sea stars, sea cucumbers and brittle stars. Their name comes from the Greek word for 'spiny egg', a fitting description for an animal that looks rather like a hedgehog crossed with a tennis ball.

Today, sea urchins are familiar sights on rocky coastlines and coral reefs from the Arctic to the tropics, living everywhere from tidal pools to depths of over 5,000 metres. They play a vital role in marine ecosystems by grazing algae, burrowing through sediment and serving as food source for the sea otters, fish and even humans.

The hard internal skeleton of a sea urchin, called a test, is made of interlocking calcite plates. When a sea urchin dies, these plates sometimes remain intact and become buried in sediment. Over millions of years, they mineralize into fossils that can preserve astounding external detail: the tiny holes through which the tube-feet once

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Regular Echinoids	Irregular Echinoids
	
• Shape: Symmetrical, spherical 'globe' shape. • Symmetry: Five-fold radial symmetry (mouth and anus at opposite poles). • Ecological Niche: Surface grazers on rocky coastlines and reefs. • Fossil Dominance: 44 Genera found in the Indian subcontinent.	• Shape: Flattened, oval, or heart-shaped body. • Symmetry: Bilateral symmetry. • Ecological Niche: Soft-sediment burrowers. • Fossil Dominance: 82 Genera found in the Indian subcontinent (the dominant fossil type).

protruded, the patterns of pores and ridges, even the attachment points for individual spines. This durability makes echinoids excellent candidates for the fossil record and extraordinarily useful tools for understanding ancient environments.

Palaeontologists divide fossil sea urchins into two broad categories.

1. **Regular echinoids** have a roughly spherical shell with a five-fold symmetry and the mouth and anus at opposite poles.
2. **Irregular echinoids** broke away from this plan, evolving flattened, heart-shaped or oval bodies adapted for burrowing in soft sediment. Sand dollars, sea biscuits and heart urchins all belong to this group and the irregular echinoids

dominate the fossil record of the Indian subcontinent.

The ancient lineage

The sea urchins appear long before the dinosaurs. The earliest echinoderms appear in the fossil record around 530 million years ago and true echinoids had evolved by the Ordovician Period, roughly 450 million years ago. However, this

did not happen overnight. For much of the Paleozoic Era, sea urchins were relatively rare and ecologically minor survivors. It was other echinoderms, especially the flower-like crinoids, which dominated the ancient seafloors in dense forests, that ruled the Paleozoic seas.

During the great Permian extinction (252 mya) nearly

The sea urchins appear long before the dinosaurs. The earliest echinoderms appear in the fossil record around 530 million years ago and true echinoids had evolved by the Ordovician Period, roughly 450 million years ago.

The oldest sea urchin fossils from the region come from the Salt Range of northern Pakistan and the Karakoram mountains. Dating to the Permian Period, some 270 to 250 million years ago, these fossils belong to ancient forms such as *Archaeocidaris* and *Cidaris*, close relatives of the very first true sea urchins.

wiped echinoids out entirely. Yet they survived and in the subsequent Mesozoic Era they flourished. The Triassic Period left almost no echinoid fossils anywhere in the world, but by the Jurassic and especially the Cretaceous, sea urchins had diversified explosively. New body plans evolved, new ecological niches were occupied and the irregular echinoids in particular radiated into an astonishing variety of forms suited to burrowing, swimming and inhabiting soft-sediment environments.

In the Indian subcontinent, this story unfolds with a dramatic geological backdrop. For much of the early Mesozoic, India was part of the great southern supercontinent Gondwana, separated from the rest of the

world by vast oceans. This isolation shaped the evolution of its fauna. But around 130 million years ago, India began its famous northward drift towards Eurasia — a journey that would eventually raise the Himalayas and profoundly reshape the planet's climate. As India drifted into warmer, equatorial waters, conditions became ideal for sea urchins, and their diversity exploded.

Where are they found?

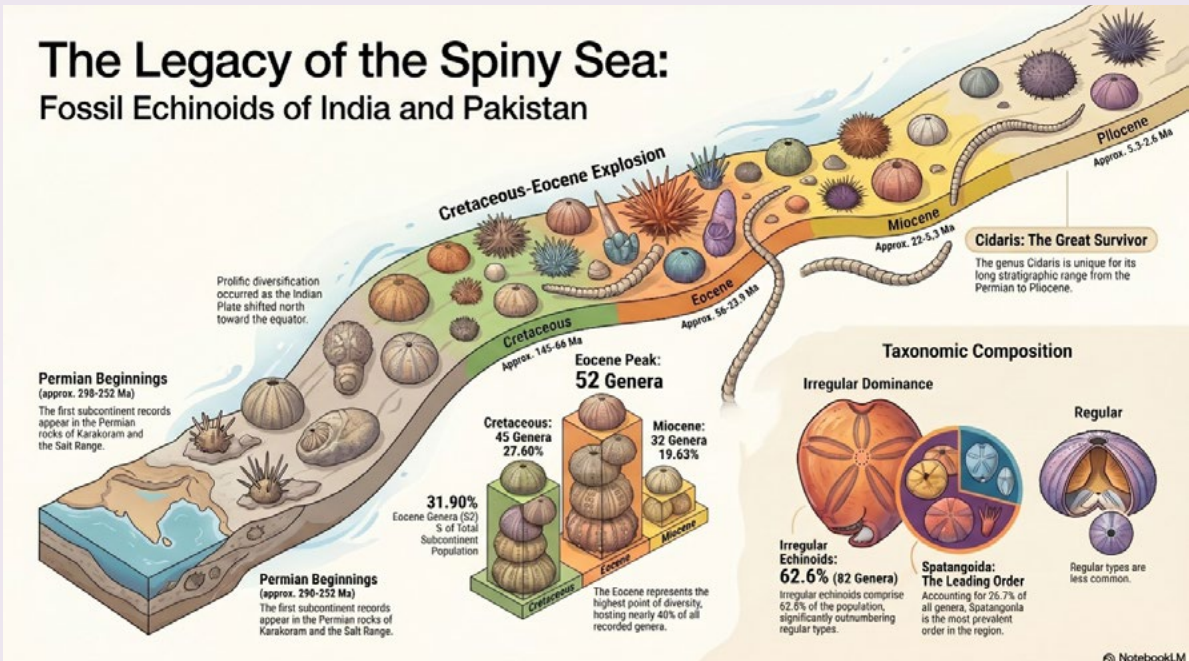
Fossil sea urchins have been found across an enormous swath of the Indian subcontinent — from the desert basins of Rajasthan to the tropical coasts of Tamil Nadu, from the mountains of Kashmir and the Karakoram to the coastal plains of Gujarat and Sind (now in

Pakistan). Each region tells a different chapter of the story.

The oldest sea urchin fossils from the region come from the Salt Range of northern Pakistan and the Karakoram mountains. Dating to the Permian Period, some 270 to 250 million years ago, these fossils belong to ancient forms such as *Archaeocidaris* and *Cidaris*, close relatives of the very first true sea urchins. The Permian seas of this region were part of the great Tethys Ocean, a warm, shallow epicontinental sea that stretched from what is now Europe through the Middle East and into the Indian subcontinent.

The Jurassic Period (about 200–145 million years ago) saw the first appearances of irregular echinoids in the region, found mainly in the ancient coral-reef limestones of Kachchh (Kutch) in present-day Gujarat. The spectacular gorges and badlands of Kachchh have long been a favourite hunting ground for fossil collectors: the eroded escarpments expose layer after layer of ancient seafloor sediments, rich in shells, corals, and echinoids.

The great flowering of echinoid diversity, however, came during the Cretaceous Period (145–66 million years ago), especially in the sediments



of the Bagh Beds of Madhya Pradesh, the Trichinopoly rocks of Tamil Nadu and the marine strata of Baluchistan and Sind. These warm, shallow Cretaceous seas teemed with life and the echinoid fauna was strikingly diverse — over 45 genera have been documented from Cretaceous rocks of the subcontinent alone. The Eocene Epoch (56–34 million years ago) that followed was equally rich, with more than 52 echinoid genera recorded, reflecting the warm tropical seas that flooded large parts of the region as the Tethys Ocean retreated.

175 years of discovery

The scientific study of fossil sea urchins from India and Pakistan began in 1837, when a military

officer named Colonel C. W. Grant published the first geological map of Kachchh and included descriptions of several echinoid fossils. Grant was part of a remarkable generation of British officers and administrators who, while serving in India,

threw themselves into scientific pursuits with extraordinary energy.

Among the most important early contributors were Peter Martin Duncan and William Percy Sladen, who between 1882 and 1886 published a monumental,

Among the most important early contributors were Peter Martin Duncan and William Percy Sladen, who between 1882 and 1886 published a monumental, multi-volume work on the fossil echinoids of Western Sind and the Persian Gulf coast.

Palaeontology is a science of names. Before you can study the history, ecology and evolution of ancient organisms, you need to be able to identify and distinguish them reliably. This is harder than it sounds. Fossils are often fragmentary. Individuals of the same species can look very different depending on age, sex and environmental conditions. Older classifications, made before modern analytical tools were available, are sometimes wrong or inconsistent.

multi-volume work on the fossil echinoids of Western Sind and the Persian Gulf coast. Running to nearly 400 pages with 58 detailed plates of illustrations, this work remains a foundational reference to this day. Duncan and Sladen described scores of new species, established many of the genera still in use, and laid out the basic stratigraphic framework for understanding when and where different echinoid faunas lived.

Other key figures include Ferdinand Stoliczka, a Czech palaeontologist who described the extraordinary Cretaceous echinoid fauna of South India in the 1870s; Fritz Noetling,

who worked on the Cretaceous fauna of Baluchistan in the 1890s; and a long line of Indian scientists through the twentieth century — Chiplonkar, Badve, Aziz, and Srivastava among them — who have continued to

Seven species of the genus *Gongrochanus* described by Badve and Aziz in 1983 have all since been shown to be the same species as one described more than 140 years earlier under a completely different name.

refine and expand the picture. The bibliography compiled by Srivastava (2012), which forms the basis of this article, lists hundreds of publications spanning nearly two centuries.

The science behind naming them

Palaeontology is a science of names. Before you can study the history, ecology and evolution of ancient organisms, you need to be able to identify and distinguish them reliably. This is harder than it sounds. Fossils are often fragmentary. Individuals of the same species can look very different depending on age, sex and environmental conditions. Older classifications, made before modern analytical tools were available, are sometimes wrong or inconsistent.

The echinoids of the Indian subcontinent have been particularly bedevilled by taxonomic confusion. Many

species were described multiple times under different names by different authors who were unaware of each other's work. Others were placed in the wrong genus, sometimes repeatedly. Srivastava's 2012 bibliography identifies dozens of such cases and documents recent corrections, for example, seven species of the genus *Gongrochanus* described by Badve and Aziz in 1983 have all since been shown to be the same species as one described more than 140 years earlier under a completely different name. Such synonymies are not merely academic housekeeping: they reveal how our understanding of ancient diversity has evolved, and they are essential for any serious attempt to reconstruct ancient ecosystems.

A particularly important revision has been the work of palaeontologist Andrew Smith of the Natural History Museum in London, who in 2000 introduced sweeping changes to the classification of Cretaceous and Palaeocene echinoids. Smith's revisions, based on a comprehensive re-examination of museum collections worldwide, reassigned dozens of species to new or different genera, synonymized many long-accepted names and provided detailed descriptions that allow



Sea urchins are sensitive indicators of environmental conditions. Different species prefer different water temperatures, depths, salinities and substrate types. By documenting which species occur in which rock layers, palaeontologists can reconstruct the environments in which those rocks were deposited: whether the seafloor was shallow or deep, warm or cool, sandy or muddy, nutrient-rich or impoverished.



specimens to be identified unambiguously. His work has greatly clarified the picture for the Indian subcontinent.

Why do they matter?

Sea urchins are sensitive indicators of environmental conditions. Different species prefer different water temperatures, depths, salinities and substrate types. By documenting which species occur in which rock layers, palaeontologists can reconstruct the environments in which those rocks were deposited: whether the seafloor was shallow or deep, warm or cool, sandy or muddy, nutrient-rich or impoverished.

This information is invaluable for understanding the geological history of the subcontinent — for mapping the palaeoclimate and understanding the tectonic forces that shaped the landscape we see today.

The echinoid record of the Indian subcontinent also provides important evidence for understanding how life responds to major geological and climatic events. The dramatic increase in echinoid diversity during the Cretaceous Period, for example, coincides precisely with India's northward drift into equatorial waters — providing beautiful confirmation of the link between plate tectonics, climate and biodiversity that

was first proposed by James Valentine in 1970. The equally rich Eocene fauna reflects the warm, greenhouse conditions that prevailed globally during that epoch, before the climate began its long cooling trend towards the Ice Ages.

More practically, echinoids and other fossils are used by petroleum geologists to date and correlate rock sequences — essential for finding oil and gas. The Indian subcontinent sits atop some of the world's most significant hydrocarbon reserves, and the accurate identification of fossil echinoids in borehole samples has real economic consequences. A misidentified fossil can mean a misidentified rock age, which can mean drilling in the wrong place.

A Living Legacy

The fossil sea urchins of the Indian subcontinent are not merely relics of a vanished world. They are windows onto deep time — onto the ancient oceans that once covered much of southern Asia, onto the extraordinary journey of the Indian Plate as it



KEY FACTS AT A GLANCE

Total echinoid genera recorded from India and Pakistan: 131 | Regular echinoids: 44 genera | Irregular echinoids: 82 genera | Earliest fossils: Permo-Carboniferous (~300 Ma), Karakoram | Peak diversity: Eocene Epoch (56–34 Ma), with 52 genera | Most widespread genus: *Cidaris* — present from the Permian to the Pliocene



drifted northward and collided with Eurasia, onto the great Cretaceous and Eocene hotspots of marine biodiversity that rank among the most remarkable in the history of life. The work of compiling, correcting and extending our knowledge of this fauna is far from over. New analytical techniques, CT scanning, geometric morphometrics, molecular phylogenetics applied to living relatives, are opening up new ways of understanding ancient diversity and ecology.

Most importantly, there is a new generation of Indian palaeontologists who are bringing fresh energy and new ideas to the study of these ancient animals. The bibliography compiled by Srivastava in 2012 — the most comprehensive ever assembled for this region — provides them with an essential roadmap: a record of everything that has been discovered and described over 175 years of inquiry, and a guide to everything that remains to be done.



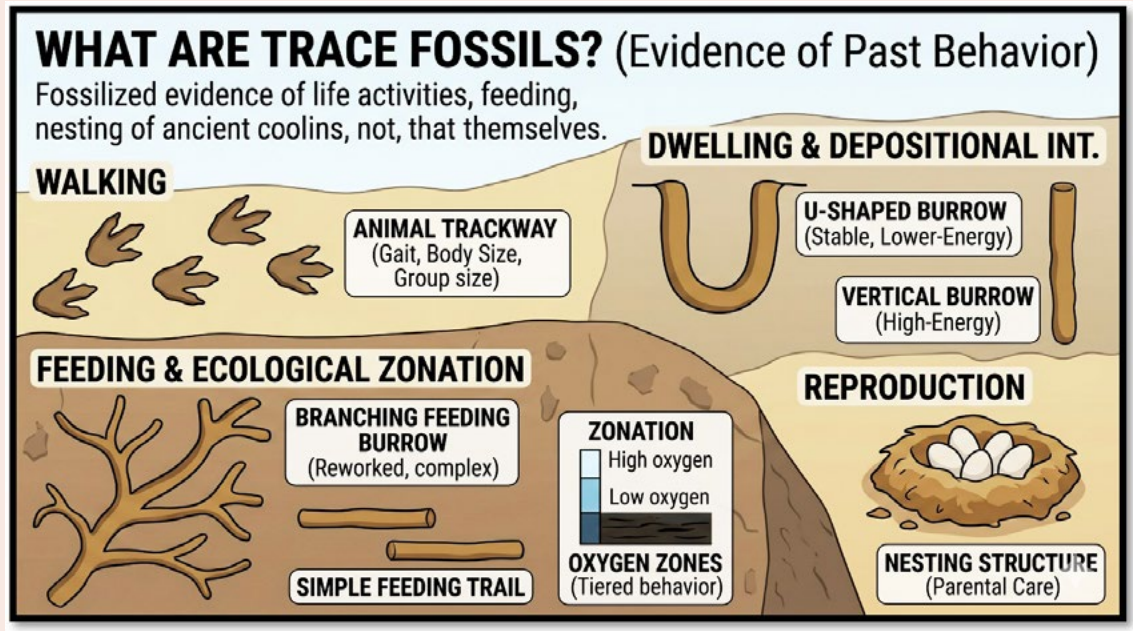
Burrows, Tracks and Trails: Reading the Ancient Life through Ichnofossils

Anubarna Dutta Chowdhury

Ichnofossils or Trace fossils are a very specific category of fossilized remains. They are not the preserved remains of organisms themselves but the evidence of their activities or rather behaviour performed by them millions of years ago. Ichnofossils include burrows,

tracks, trails, borings and other modifications made by organisms interacting with sediments or hard substrates. Unlike body fossils, which reveals the anatomy and morphology of the organism, trace fossils provide direct insight into the behaviour of the

animal. In many sedimentary layers, where body fossils are poorly preserved, rare or absent, trace fossils become the primary means of reconstructing ancient ecosystems and the paleoclimate.



Overview of trace fossil (generated using Nano Banana AI)

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The study of trace fossils, termed as ichnology, is derived from the Greek word “ikhnos” which means footprint or track. The term came into use during the early 19th century as naturalists, including William Jardine, began classifying fossilized footprints and often called them as ichnites.

Ichnology focuses not only on identifying the structures themselves but also on interpreting the behaviour and the environmental conditions under which such extensive structures are formed and preserved. Since behaviour is much more sensitive to environmental changes than the body form, trace fossils are particularly valuable indicators of paleoenvironmental conditions such as energy levels, oxygen availability, sedimentation rates and substrate consistency.

Trace fossils are commonly classified based on the behaviour they represent:

- » Dwelling structures or *domichnia*, such as *Skolithos* and *Diplocraterion*, indicate organisms that lived within burrows, often in high-energy environments.
- » Feeding traces or *fodinichnia*, including

Planolites and *Palaeophycus*, reflect organisms ingesting sediment to extract organic matter.

- » Grazing traces or *pascichnia* record surface feeding patterns, often forming intricate, looping trails.
- » Locomotion traces or *repichnia* capture movement across substrates, such as crawling or walking.
- » Resting traces or *cubichnia* preserve temporary impressions of organisms at rest.
- » Escape structures or *fugichnia* document rapid movement in response to sudden burial or environmental stress.

This behavioural classification allows ichnologists to interpret about the activities and the reason behind those activities performed by the organism.



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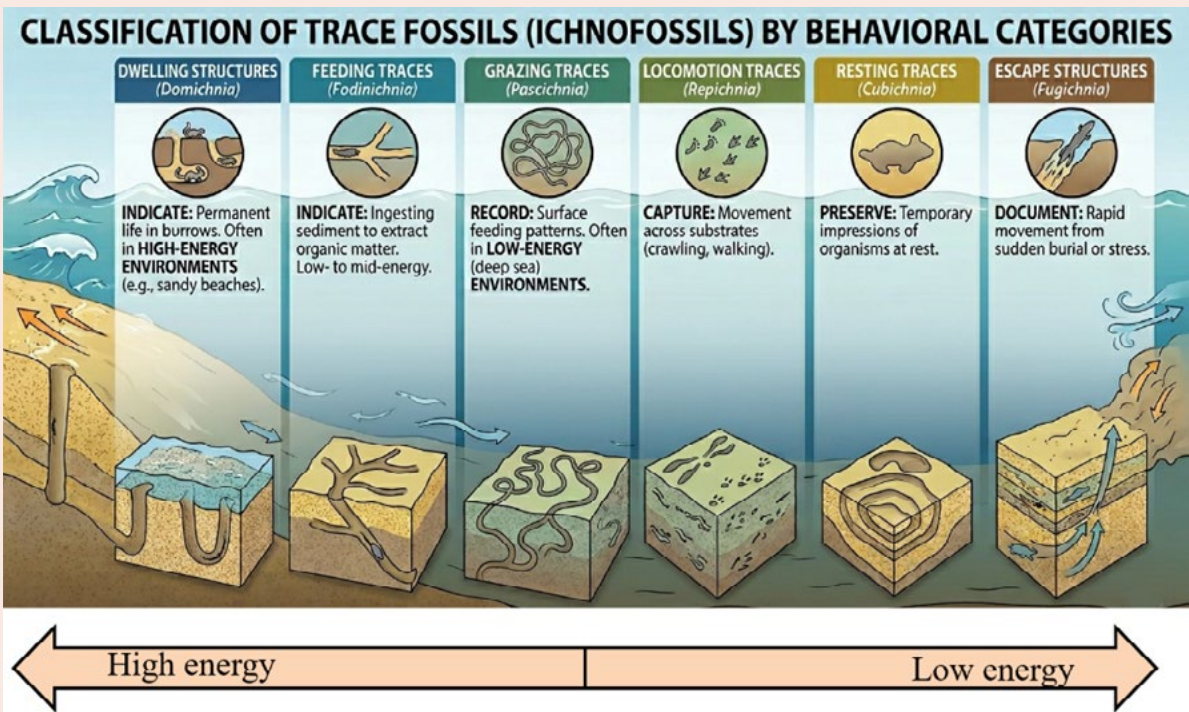


Fig. Schematic representation of types of trace fossils

India preserves a diverse record of trace fossils, spanning from the Proterozoic eon to the recent geological times. In the Vindhyan Basin, which is supposed to be one of the oldest sedimentary basins in the country, simple trace fossils such as *Planolites* sp. and *Skolithos* sp. recorded from this regions, provides the earliest evidence of multicellular life and their interaction with sediments and mark an important evolutionary step in the colonization of benthic environments. Moving towards the Himalayan region, the Spiti Valley of Himachal Pradesh provides an exceptional window

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The Kachchh Basin in Gujarat is another classic locality for ichnological studies

into the marine ecosystem of the Jurassic period. Trace fossils of the genera *Thalassinoides*, *Chondrites* and *Planolites* are abundantly reported from this area.

Thalassinoides sp. represents complex, branching burrow systems often related to crustacean-like organisms, indicating well-oxygenated conditions and active sediment reworking. *Chondrites* sp. forms finely branched, dendritic patterns that are typically associated with low-oxygen environments. The coexistence of these traces within the same stratigraphic units suggests vertical ecological zonation, where different organisms occupied distinct tiers within the sediment based on oxygen availability. The Kachchh Basin in Gujarat is another classic locality for ichnological studies. The Jurassic and Cretaceous sediments of this area preserve a wide range of trace fossils, such as *Diplocraterion* sp., *Skolithos* sp, and *Thalassinoides*

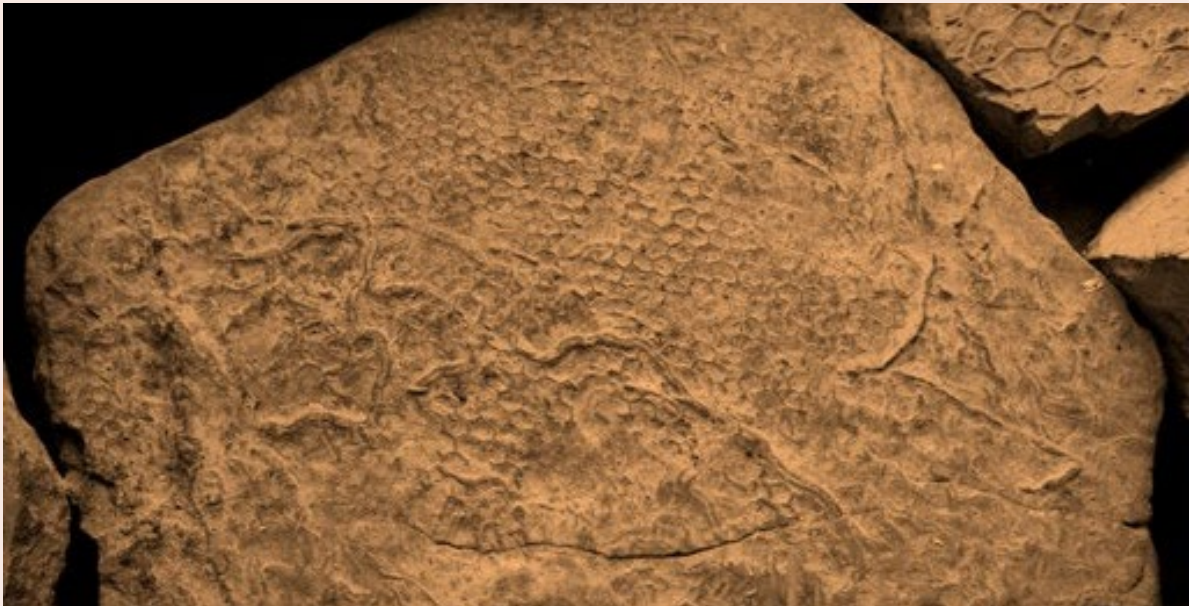
sp. These assemblages are particularly useful in interpreting depositional environments. For instance, vertical burrows like *Skolithos* are typically associated with high-energy conditions, while horizontal and branching burrows indicate more stable, lower-energy conditions. By examining the distribution and orientation of these traces, it is possible to reconstruct changes in sea level, sediment supply and hydrodynamic conditions over time. In the arid landscapes of the Jaisalmer Basin in Rajasthan, marine sandstones yield well-preserved trace fossils

A different environmental setting is represented by the Gondwana basins, particularly in the Damodar Valley. Here, trace fossils occur in association with coal-bearing strata and fluvial deposits.

such as *Ophiomorpha* sp. and *Thalassinoides* sp. *Ophiomorpha* sp. is characterized by its lined burrows, often reinforced with pellets, suggesting active maintenance by the organism. These traces are typically associated with crustaceans inhabiting shallow marine environments. The presence of such well-developed burrow systems indicates stable substrates and a relatively high degree of ecological organization. A different environmental setting is represented by the Gondwana basins, particularly in the Damodar Valley. Here, trace fossils occur in association with coal-bearing strata and fluvial deposits. The traces are predominantly horizontal, including feeding burrows and simple trails, reflecting low-energy, swampy conditions. The Siwalik Group, extending along the Himalayan foothills, offers a unique perspective through the

preservation of vertebrate trace fossils. Trackways attributed to mammals have been reported from fluvial sediments, providing rare insights into the movement and behaviour of large terrestrial animals during the Neogene period. Unlike invertebrate traces, vertebrate footprints can reveal information about gait, speed, body size and even social behaviour, such as

group movement. These traces serve as a valuable complement to skeletal remains, which are often fragmentary or absent.



Trace fossils as seen in the field



Trace fossils also provide valuable information about ecological interactions. The density and diversity of traces within a given layer can indicate levels of biological activity and resource availability.



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diagnostic body fossils. This makes trace fossils an essential tool in sedimentology and basin analysis.

Beyond their scientific importance, trace fossils have a unique ability



The Skolithos ichnofacies is typically associated with high-energy, sandy shoreface environments, while the Cruziana ichnofacies represents lower-energy, offshore settings.



activity and resource availability. Another important aspect of trace fossils is their role in refining stratigraphic interpretations. Certain trace fossil assemblages, known as ichnofacies, are characteristic of specific depositional environments. For example, the *Skolithos ichnofacies* is typically associated with high-energy, sandy shoreface environments, while the *Cruziana ichnofacies* represents lower-energy, offshore settings. By identifying these assemblages in the field, geologists can infer depositional conditions even in the absence of



Despite their significance, trace fossils in India remain underexplored in many regions. There is considerable potential for new discoveries, particularly in lesser-studied sedimentary basins. Systematic documentation, integration with other geological data, and the use of modern analytical techniques can greatly enhance our understanding of these structures.



to connect with a broader audience. Unlike skeletal remains, which may require specialized knowledge to interpret, trace fossils represent actions that are immediately recognizable, i.e. walking, burrowing, feeding. This intuitive appeal makes them powerful tools for education and outreach, helping to bridge the gap between scientific research and public understanding.

Despite their significance, trace fossils in India remain underexplored in many regions. There is considerable potential for new discoveries, particularly in lesser-studied sedimentary basins. Systematic documentation, integration with other geological data, and the use of modern analytical techniques can greatly enhance our understanding of these structures. At the same time, many trace fossil sites are vulnerable to weathering and human activities such as construction and quarrying. Conservation efforts are therefore essential to preserve this valuable component of our geological heritage.



A Heritage Without Custodians: India’s Fossils and the Search for Protection

Soma Das

The fossil record of the Indian subcontinent is, in one word, extraordinary. It spans more than 2 billion years of biological and geological history, from the Precambrian to the Cenozoic, and its geographic spread is equally remarkable, running from the high Himalayan foothills of Himachal Pradesh and Uttarakhand in the north to the marine sediments of Tamil Nadu in the south, and from the arid exposures of Rajasthan and Gujarat in the west to the Gondwana coalfields of Jharkhand, Odisha, and West Bengal in the east.

The oldest chapters of this record are written in the Precambrian carbonate sequences of the Vindhyan Supergroup and the Trans-Aravalli Vindhyan of Rajasthan and Madhya Pradesh, where stromatolites document some of the earliest known life on earth. Moving into

the Palaeozoic, the Gondwana Supergroup formations of peninsular India, exposed across Madhya Pradesh, Chhattisgarh, Jharkhand, Odisha, and West Bengal, have preserved a rich record of Permian to Cretaceous assemblage that links India biogeographically to other Gondwanan landmasses.

The Jurassic sequences of the Kutch basin in Gujarat

represent one of India's most extensively studied marine fossil assemblages, yielding ammonites, bivalves, echinoids, and marine reptiles across exposures that have drawn international attention for over a century. Slightly younger in age, the Cretaceous Lameta Formation of the Narmada Valley and the Deccan region has yielded a remarkable

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The Jurassic sequences of the Kutch basin in Gujarat represent one of India’s most extensively studied marine fossil assemblages, yielding ammonites, bivalves, echinoids, and marine reptiles across exposures that have drawn international attention for over a century.

diversity of dinosaur material, over a dozen species identified to date, including the abelisaurid theropod *Rajasaurus narmadensis* and the titanosaurian sauropods *Isisaurus colberti* and *Jainosaurus septentrionalis*. The Balasinor site in Gujarat’s Raiyoli village alone has produced over 10,000 fossilised dinosaur eggs, and together with nesting sites at Jabalpur and the Dhar District of Madhya Pradesh, forms a titanosaur hatchery corridor stretching roughly 1,000 kilometres, constituting one of the largest dinosaur nesting complexes documented anywhere in the world. The Deccan Intertrappean beds of Maharashtra and Madhya Pradesh have preserved a remarkable assemblage of freshwater invertebrates (Molluscs, Ostracods, Unionids Sponges etc.), fishes (Otoliths,

Notopterids, Percoids etc.), frogs (*Indobatrachus sp.*, and various *Gobioid*, *Pelobatid*, and *Ranoid* frogs), turtles (Pelomedusoides), and early mammals (*Bharattherium bonapartei*, *Deccanolestes* spp.,

The Tertiary sequences of Kutch preserve rare evidence of the earliest known whales, making this region globally significant for understanding the terrestrial-to-marine transition in mammals. The Siwalik Group, exposed across the foothills of Punjab, Haryana, Himachal Pradesh, Uttarakhand, and extending into the Northeastern states, contains one of the richest Cenozoic vertebrate fossil sequences on earth, spanning roughly 18 to 0.5 million years before present.

Indoclemensia spp. etc.) from the Cretaceous.

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Dinosaur eggs found in Balasinor

giraffids such as the giant *Sivatherium*, and a diverse array of large carnivores.

The Narmada Valley, cutting across Madhya Pradesh, Maharashtra, and Gujarat, stands apart for having yielded the only widely reported hominin fossil from the Indian subcontinent, which is a partial calvarium from Hathnora, assigned to *Homo erectus*. In the south, the marine Cretaceous formations of the Cauvery Basin in Tamil Nadu have long been known for their ammonite and bivalve faunas, and more recently for dinosaur

material (Sauropod), extending the known range of India's Cretaceous terrestrial fauna into the peninsula. The cave deposits

of the Kurnool district in Andhra Pradesh have preserved late Pleistocene vertebrate

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When compared with the well-developed legal frameworks that govern other categories of Indian heritage, the absence of equivalent protection for fossil and geo-heritage resources points to a conspicuous gap in the country's regulatory architecture.

assemblages alongside evidence of early human occupation.

Taken together, this is not a fossil record that merely exists. It is one that has shaped global understanding of continental drift, the evolution of major vertebrate lineages, early human dispersal in Asia, and the ecological consequences of mass extinction events. Despite all of this, India's fossil assemblage remains without a dedicated legal guardian.

When compared with the well-developed legal frameworks that govern other categories of Indian heritage, the absence of equivalent protection for fossil and geo-heritage resources points to a conspicuous gap in the country's regulatory architecture. For example, the Wildlife (Protection) Act of 1972 creates an institutional framework with

empowered enforcement agencies, protection schedules and penalties. The Ancient Monuments and Archaeological Sites and Remains Act of 1958 establishes territorial protection guidelines and grants the Archaeological Survey of India authority over cultural heritage locations. The Antiquities and Art Treasures Act, 1972 governs trade, export and possession of

It is precisely this gap that the draft Geo-Heritage Sites and Geo-relics (Preservation and Maintenance) Bill, published by the Ministry of Mines for public consultation on 15 December 2022, seeks to fill. In many ways, the Bill is long overdue.

antiquities and art treasures and is also enforced by Archaeological Survey of India. Fossils, by contrast, have had no equivalent legislative shelter. They are not quite wildlife and not quite antiquities. As a result, they have remained, for decades, without a clear legal identity.

It is precisely this gap that the draft Geo-Heritage Sites and Geo-relics (Preservation and Maintenance) Bill, published by the Ministry of Mines for public consultation on 15 December 2022, seeks to fill. In many ways, the Bill is long overdue. The fact that such legislation emerges only now, after decades of fossil loss, illegal trade and neglect, is itself telling. A first serious effort came in 2009 with the National Heritage Site Commission Bill, after ongoing advocacy from geologists and

In this context, this Geo-Heritage Sites and Geo-relics bill can be seen as something of a pioneer. It is the first serious, structured attempt to define geo-heritage within Indian law. It talks about important concepts of “geo-relics” and “geo-heritage sites,” and places fossils within a wider context of natural heritage

earth scientists who wanted a specific legal tool for geological sites. But the bill was eventually dropped in 2015.

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a non-renewable resource. It shows that the state is starting to care about geo-heritage. But laws alone can't fix deeper structural problems. One of the most striking among these is the absence of a dedicated national natural history museum, and this is not a minor institutional omission.

For paleontology to function as a living discipline, specimens need to be available for comparative

study and collaborative inquiry, and bridging this accessibility gap remains an important institutional challenge for the country.

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For researchers, this creates a peculiar situation. Identifying a fossil, something as specific as a bone fragment, often requires comparison with reference collections that are simply unavailable or simply inaccessible within the country. Indian scientists often depend on foreign institutions for verification and collaboration. Prominent scientists including Ashok Sahni and American researcher Jason Head have been asking the Indian government for years for the creation of a Smithsonian-style national institution, a natural history museum that can function as a research-accessible repository in the way that major natural history museums in Europe and North America do.

The early 19th-century removal of Siwalik fossil collections to institutions such as the Oxford University Museum of Natural History is a well-documented historical example

This lack of infrastructure and law also becomes a cause for everyday challenges in the field. Fossil-bearing areas are frequently classified as “wastelands.” In regions like the Narmada Valley, scientifically invaluable strata coexist with active extraction zones of minerals and other resources. The thing is, when damage happens in these situations it is not always against the law. Colonial survey maps categorised lands without forest or tree cover as wastelands, and this classification logic has persisted in post-independence land-use frameworks. Many of India's most fossil-rich landscapes, arid scrublands, semi-arid river valleys, exposures of ancient sedimentary rock, are formally categorised in ways that make them available for mining leases, quarrying concessions, and infrastructure development approvals. And thus, the destruction, in such instances,

is often entirely permissible and quite legal since it does follow the rules that are already in place, that are a part of the existing framework.

Then there is the issue of illegal trade. Fossils, particularly visually striking ones like dinosaur eggs, amber specimens, or complete vertebrate skulls, command significant prices in

international collector markets. The Indian subcontinent's extraordinary paleontological richness makes it a target for unauthorised collection. The problem is compounded by the fact that existing law enforcement capacity has largely been shaped around smuggled antiquities or wildlife trafficking; regulatory and investigative frameworks specific to paleontological material are almost entirely absent. As a consequence, there is a steady outflow of irreplaceable paleontological material from the country. The early 19th-century removal of Siwalik fossil collections to institutions such as the Oxford University Museum of Natural History is a well-documented

With all of this in mind, it's safe to say that the Draft Geo-Heritage Bill is a big step forward in a field that hasn't gotten much attention from lawmakers in a long time. It gives fossils and geo-relics a formal legal framework for the first time, which shows that people are starting to understand how important they are to science and the country.

historical example; the concern today is that analogous losses continue, though through commercial rather than colonial channels.

With all of this in mind, it's safe to say that the Draft Geo-Heritage Bill is a big step forward in a field that hasn't gotten much attention from lawmakers in a long time. It gives fossils and geo-relics a formal legal framework for the first time, which shows that people are starting to understand how important they are to science and the country. As with any new law, there are still areas where the Bill could be improved to make it more effective. So that, when finalised, it should be as rich and layered as the fossil record it seeks to protect.

So what should a well-considered fossil law include?

For one, it must make the governance more inclusive. A multi-institutional framework involving universities, state as well as central agencies, and local communities would likely be far more responsive and effective than a purely centralised model.

Secondly, it must not overlook the fact that not every fossil needs the same level of protection. It doesn't make sense to lock down common invertebrate fossils used in classrooms the same way you'd protect holotype specimens that

define new species. It's just not practical, and scientifically, it's overkill. A better approach is to sort fossils into tiers based on how scientifically important they actually are. The most critical tier, type specimens, holotypes that matter for dating rock layers, and truly one-of-a-kind material, should absolutely have to go into museums, with real legal consequences if they don't. The next tier down, regional treasures or uncommon species, could be collected with permission and notification to authorities, but wouldn't necessarily need permanent storage. Everyday fossils that work great for teaching, could stay available for classroom use with a permit. This way, rules are being focused where they actually matter.



India really needs a proper national natural history museum, one with real funding and serious scientific staff behind it. A place like that becomes both a storage facility and a research center, anchoring fossil preservation within a real institutional network that simply doesn't exist right now.



Equally important is the creation of actual infrastructure to back this up. India really needs a proper national natural history museum, one with real funding and serious scientific staff behind it. A place like that becomes both a storage facility and a research center, anchoring fossil preservation within a real institutional network that simply doesn't exist right now.

Finally, and perhaps most subtly, there's a mindset shift that needs to happen. Fossils get treated like curiosities, decorative objects to admire rather than valuable sources of knowledge. Shifting that perception takes time. Education, getting the public genuinely interested, keeping policy makers focused on it. Honestly, no single law can do that work alone. But without it, even the best legislation won't be enough.



Santragachi Jheel: The Changing Story of Wetland to Wasteland.

Susmita Khanra

Not very long ago, there was a time when thousands of migratory birds travelled across the continents, crossing mountains, rivers, and vast landscapes only for settling peacefully to the quiet Jheel of Howrah: The Santragachi Jheel. During that time Santragachi Jheel felt magical at winter. As the temperature dropped, the sky above the jheel would come alive with the movement of these migratory birds. At that time, Santragachi Jheel offers every essential things for their survival like a peaceful surroundings, ample food, and a quiet place for rest. During that time, this Jheel was not only merely a Stopover site but an ideal winter refuge also. It was the story above the water surface of the Jheel but beneath the water there was a rich diversity of aquatic insects which form the healthy food web, thereby maintains the

ecological balance of the whole ecosystem.

Unfortunately over the past decade this quiet and peaceful habitat changes dramatically. Rapid urbanization reshaped the whole landscape including surroundings of the Santragachi Jheel. The rise of high-rise buildings, expansion of residential areas and construction of highways specially the Kona-Expressway have altered the quiet environment into a busy and

continuously active urban zone. So today, the Jheel is subjected to a constant loud noise from vehicles horns and continuous traffic movement during the day time, even in the night the Jheel is disturbed by the intense artificial light. As the migratory birds are very sensitive to such major environmental changes and it affects their biological rhythms and navigation systems. Consequently the migratory birds leave this place earlier than usual. But during the last



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5 years, they totally avoid this site.

But when all the noticeable changes are visible above the

highly sensitive aquatic insects declines continuously. As these insects play a crucial role in the ecosystem, serving as a

As the migratory birds are very sensitive to such major environmental changes and it affects their biological rhythms and navigation systems

ground, there are an equally serious issue exist within the water itself. Continuous discharge of sewage and daily runoff from the nearby localities deteriorate the quality of water. The water becomes polluted day by day. This polluted water affects the appearance of wetland and at the same time its ecological stability declines. Due to degradation of water quality the population of

Continuous discharge of sewage and daily runoff from the nearby localities deteriorate the quality of water. The water becomes polluted day by day. This polluted water affects the appearance of wetland and at the same time its ecological stability declines.

primary food source for many migratory birds, when their population declines, foods for birds becomes shortage and as a result population of birds declines. This type of declination of animal diversity gives a clear signal of environmental stress. Basically, this is not only just the visible changes of landscape but it is actually ecological shift which affects the whole ecosystem.

“Can the Jheel Breathe Again?” despite all these challenges, Santragachi Jheel is not beyond recovery. If we gives a chance to the Jheel, it recovers quickly from the difficult situation and it returns to its original shape. But it needs proper management of controlling pollution, proper maintainance of drainage system, and most importantly reducing disturbance by protecting its surrounding habitat. So, the

story of Santragachi Jheel is not just transformation of Wetland to Wasteland, indeed it reflects the end product of rapid urbanization. The changing story points out clearly that the degradation of natural habitat for upgradation of our life style actually affects us in large scale. Now its time for us to rethink about the whole situation. We have to try for our best for developing our surroundings and give the value for maintaining ecosystem that quietly support our life and we remain hopeful that one day Santragachi Jheel will breathe again. We hope to witness thousands of migratory birds arriving from distant lands, finding in it a safe and peaceful habitat to rest and thrive.

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Santragachi Jheel then (Source:flickr)



Santragachi Jheel then (Source:flickr)



Santragachi Jheel Now



Santragachi Jheel Now



Silent Witnesses: What DNA Reveals About Wildlife Crimes

Sutithi Mitra

The world’s largest international police organization INTERPOL had warned that globally wildlife-related crime is booming as one of the world’s biggest and most profitable crime sectors. It rank highest among the most widespread forms of illegal activity worldwide, encompassing poaching, illegal breeding, and trafficking of protected species. Despite the implementation of several international and national control measures, wildlife poaching and related trade continue to escalate throughout world. A new report from the United Nations’ Office on Drugs and Crime (UNODC) has found that more than 4,000 wildlife species are targeted worldwide for illegal trade, and about 162 countries have active illegal wildlife trading. During a span of 2015-2021 40% of seized species, were considered threatened or near threatened

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India emerges as a critical region due to its rich biodiversity and strategic position in international trafficking networks. States of Uttar Pradesh, Karnataka, West Bengal, Rajasthan, Madhya Pradesh, and Assam have many transit routes through wildlife trafficking function in India, in both domestic and international markets.

black market – where goods are exchanged illegally. This high monetary gain from wildlife trade, are often surpassing those from other smuggling activities such as narcotics in international markets, and have strongly attracted attention of the poachers. Inadequate regulation of digital marketplaces and social media platforms have allowed traffickers to connect with sophisticated, international, and well-organized criminal networks. Demand for rare species, species with ornamental parts, and species with medicinal properties is the main reason of expanding illegal wildlife trade. From elephants and rhinos to tigers and pangolins, some of the world's most iconic and vulnerable animals are

relentlessly targeted. Their body parts—skins, bones, claws, horns, and scales—circulate through complex illegal markets, often disguised, modified, or even counterfeited. Excessive wildlife hunting for commercial purposes has negative impacts on biodiversity and may result in species extinction as reported in case of Western Black Rhino, Passenger pigeon, Asiatic Cheetah, and Pink-headed duck. In this backdrop of escalating global wildlife crime, India emerges as a critical region due to its rich biodiversity and strategic position in international trafficking networks. States of Uttar Pradesh, Karnataka, West Bengal, Rajasthan, Madhya Pradesh, and Assam have many transit routes through wildlife trafficking function in India, in

both domestic and international markets. All wild animals in India are protected by the Wildlife (Protection) Act, 1972 and it prohibits the trade of over 1800 species of wild animals, plants, and their derivatives. However, illegal poaching and trade for wildlife parts and products are still silently on, and several animals are being poached every year. The wild animals and their parts that are smuggled out of India includes few highly vulnerable targetted animal species like elephants (African: *Loxodonta africana*, Asian: *Elephas maximas*), rhinos (Indian: *Rhinoceros unicornis*, Javan: *Rhinoceros sondaicus*), tigers (*Panthera tigris*) and pangolins (*Manis crassicaudata*), wild boar (*Sus scrofa*), bear (*Melursus ursinus*) bile, horns of deer (family Cervidae). Carnivores including tigers and leopards are one of the most charismatic yet most vulnerable taxa, experiencing range loss and population decline because of human-caused habitat loss, poaching. Their skin, claws, bones, nails and teeth have maximum demand both in national and international illegal markets. Surprisingly not only charismatic and large mammals are targeted but many reptiles, fish and birds are poached every year at an alarming rate. Few instances

include seizure of Indian grey hornbill (*Ocyrceros birostris*), rosella (*Platycercus eximius*), conure (*Pyrrhura molinae*), macaws (*Ara spp.*), pygmy falcon (*Polihierax insignis*), eclectus parrot (*Eclectus roratus*), and the endangered hoolock gibbon (*Hoolock leuconedys*) by West Bengal Forest Department, recovery of 571 live star tortoise (*Geochelone elegans*) and 52 dead rose-ringed parakeets (*Psittacula krameri*) from Karnataka, radiated tortoise (*Astrochelys radiata*) and the Aldabra tortoise (*Aldabrachelys gigantea*) from Manipur's Chandel district. Other incidents such as seizure of red kangaroo (*Macropus rufus*), blue macaw (*Anodorhynchus hyacinthinus*) in July 2020 at Lailapur, Assam and other exotic species from Champhai, Mizoram in May 2022 indicates illegal trade in exotic wildlife also has emerged as a growing concern in India due to lack of clear provision for punishment.

BUT DNA DOES NOT FORGET:

Building on this alarming rise in wildlife crime, there is a dire need of having advancement in identification tools and strategies. Morphological analysis is a well-established and cost-effective technique for the taxonomic identification of

But DNA does not forget. Even in the absence of distinguishable features molecular techniques play a pivotal role in case of disfigured, distorted specimen where traditional morphological traits fail to identify the species.

wildlife when the part or whole specimens are intact. But in the shadowy world of illegal wildlife trade the most important witnesses frequently lack a voice. Unidentifiable chunks of meat found during raids, powders sold as medicine, and claws fashioned into pendants rarely convey their stories through appearance alone. In many cases, prosecutions in court room have failed at the trial stage due to inadequate training in handling forensic evidence, limited access to modern equipment, and a shortage of experts in specific areas of forensic investigation. But DNA does not forget. Even in the absence of distinguishable features molecular techniques play a pivotal role in case of disfigured, distorted specimen where traditional morphological traits fail to identify the species.

Molecular markers including 16S rRNA, 12S rRNA, cytochrome b, and cytochrome oxidase are frequently employed in wildlife forensics for phylogenetic study and species identification as they show notable interspecific variation. Sequences of unknown samples are compared with reference databases such as NCBI, and, in conjunction with phylogenetic analysis, the specimen of interest can be assigned to its most likely taxonomic position. The sequence of unknown identity is expected to cluster with its nearest neighbour finally identifying the species. Robust genetic evidence has become a cornerstone of modern wildlife law enforcement, significantly improving the accuracy and reliability of investigations. Precise species identification from biological materials

The Zoological Survey of India (ZSI) stands as a vital pillar in the Government of India’s wildlife conservation efforts, functioning as a premier scientific institution for wildlife forensics. Centre for Wildlife Forensics and Conservation Genomics in The Mammal & Osteology Section of the Zoological Survey of India routinely receives confiscated biological materials—such as raw meat, tissue samples, blood, hair, broken ivory, ambergris, cooked meat, skin samples etc from diverse network of enforcement and regulatory bodies—such as the Police, Intelligence Revenue Departments, Customs, State Forest Departments, and the Wildlife Crime Control Bureau (WCCB).

while ensuring fairness and accuracy in the judicial process.

ROLE OF ZOOLOGICAL SURVEY IN INDIA IN WILDLIFE FORENSICS:

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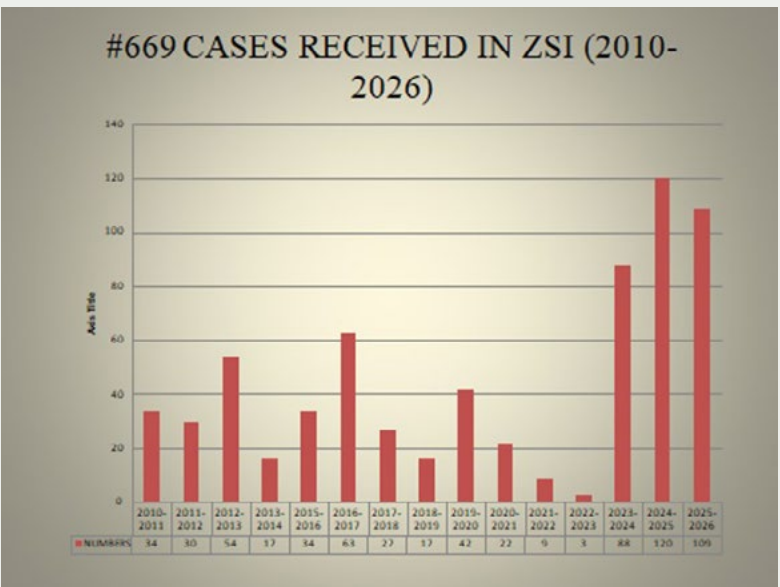
such as hair, claws, blood, bones, or processed meat has ensured compliance with legal frameworks like the Wildlife (Protection) Act, 1972. By providing scientifically validated results, DNA forensics not only strengthens the prosecution’s ability to secure convictions but also safeguards against wrongful accusations by disproving misidentification. Consequently, it plays a dual role in wildlife crime investigations—enhancing legal enforcement

India’s rich biodiversity against rising wildlife crime networks, the Zoological Survey of India (ZSI) is spearheading a futuristic, science-driven revolution in conservation by establishing comprehensive genetic databases, pioneering advanced DNA barcoding techniques, and modernizing its molecular forensic capabilities.

Departments, Customs, State Forest Departments, and the Wildlife Crime Control Bureau (WCCB). Through advanced forensic techniques ZSI identifies species from biological remnants that strengthens the prosecution of wildlife criminals. To safeguard India’s rich biodiversity against rising wildlife crime networks, the Zoological Survey of India (ZSI) is spearheading a futuristic, science-driven revolution in conservation by establishing comprehensive genetic databases, pioneering advanced DNA barcoding techniques, and modernizing its molecular forensic capabilities. This will enhance rapid species identification, robust legal convictions and evidence-based conservation strategies. ZSI not only ensures India’s commitment to protecting its rich biodiversity today but also actively shapes India’s proactive policies for the long-term protection and preservation of its rich biodiversity.

CRACKING THE CASE: METHODS BEHIND THE SCENE

The genomic DNA is extracted from the seized specimens after proper registration of the wildlife case Extraction is done using DNeasy Blood and Tissue Kit (Qiagen, Germany)

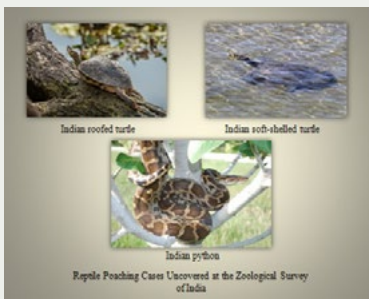
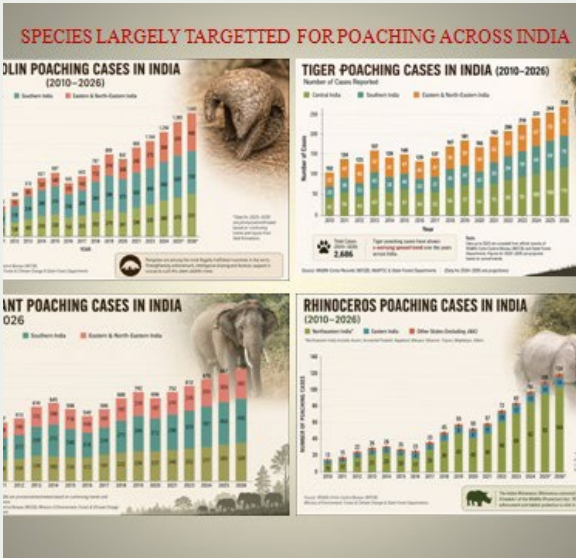
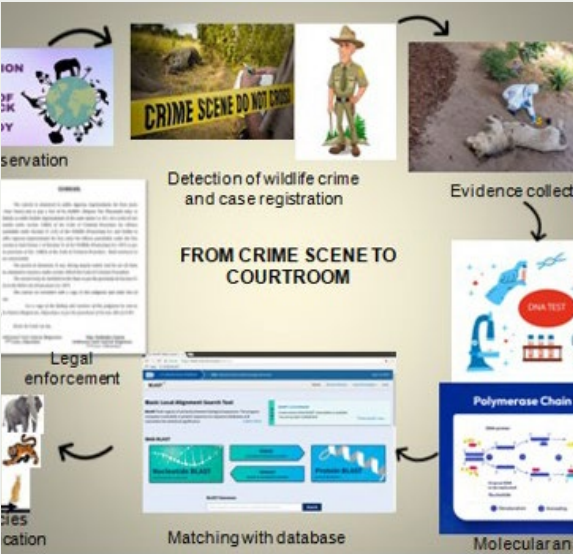


following the manufacturer’s protocol.PCR was performed to amplify the partial fragments of mitochondrial genes used in the experiment for species identification. The PCR amplicons were cleaned up using Exo-SAP treatment

and Sanger sequencing was performed on SeqStudio 24 Flex Genetic Analyzer (Applied Biosystems, USA) using the Big Dye terminator cycle sequencing kit v3.1 (Applied Biosystems, USA).The raw sequences obtained were

checked and cleaned manually using Sequencer version 5.4.6. Generated sequences were matched for similarity search using the online tool 'BLAST' (Basic Local Alignment Sequencing Tool) of NCBI, and the most homologous sequences, considering a threshold of >98% similarity, were downloaded from NCBI and Multiple Sequence Alignment was done by using ClustalW tool as implemented in MEGA X. Maximum Likelihood (ML) or Neighbour joining (NJ) are analysed with the universal primers using suitable

run model in MEGA X. In conjunction with phylogenetic analysis, the specimen of interest is expected to cluster with its nearest neighbour and finally can be assigned to its most likely taxonomic position.



THE FUTURE OF WILDLIFE FORENSICS:

Modern wildlife forensics has emerged as a powerful bridge between science and conservation, transforming silent victims into witnesses. At the core, DNA technologies allow investigators to identify species from even tiny traces of ambiguous biological fragments utilizing them as irrefutable evidence, making it impossible for criminals to hide behind misidentified products. Even in the absence of distinguishable features, genetic analysis can identify species with remarkable precision. Institutions like the Zoological Survey of India, working alongside agencies such as the Wildlife Crime Control Bureau, demonstrate how coordinated scientific and

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enforcement efforts can make a tangible difference. Scientifically validated reports help in faster prosecution. But the future of conservation is not only confined within lab based techniques. Integration of advanced molecular tools like rapid DNA barcoding and comprehensive genetic databases into frontline law

enforcement is mandatory to achieve success in this field. Public awareness and policy support also play inevitable role in amplifying the impact of wildlife forensics. When people understand that wildlife crimes can now be traced with precision, it acts as a deterrent. At the same time, sustained investment

in forensic labs, training, and research ensures these tools remain effective and up to date. With the advancement of wildlife forensics silent witnesses, encoded in genetic material, are reshaping the fight against biodiversity loss, one sequence at a time. While the threat to global biodiversity remains immense, the lab has given us our most potent weapon

“While the threat to global biodiversity remains immense, the lab has given us our most potent weapon yet: the undeniable truth. And with that truth, there is profound hope for the future of our wild species.”

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The Tale of Cities and the Linnaean Shortfall: How Urban Ecology, Sustainability and Conservation interplay.

Florence Suganya R

Only about 2.16 million species have names; we’ve met them, catalogued them, and made them known. But out there, in the quiet corners of this planet, even the urbanised corners, nearly 6.5 million more wait in anonymity.

That staggering absence, this gap, this silence in our understanding, is not just oversight. It has a name. We call it the Linnean Shortfall.

So how can this chasm be abridged? Taxonomy is at an all-time high right now. Setting aside all the bureaucratic red tape, we can all agree that science has never had more funding and visibility than it does today. Apart from the obvious reasons like inaccessibility and exorbitant costs to access, lack of training or skilled manpower, lack of technology, etc., there is another reason why the Linnaean Shortfall is not being

dealt with and is possibly growing with time- The lack of research in urban landscapes and ecosystems. Just like how sacred groves have their own microclimate

and ecosystem that drives the evolution of the animals that reside within their confines, in fact, like every ecosystem that sustains and supports animals living within their realm, urban

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ecosystems also support animals and sustain them

When we talk of surveys and explorations, our minds immediately go to the thickets of the forest, the snow-clad mountains of the Himalayas, or the depths of the Laccadive Sea. Why not the urban ecosystems? Do organisms cease to exist in urban areas? They are not the most scenic or picturesque locales for surveying, but they have the most resistant flora and fauna to pollution. And they keep urban squares breathable and Habitable .

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A new genus of flea beetle was erected in 2025 called *Punctaltica* gen.nov., thanks to research in urban areas. In fact, *P.shenzhenensis* and *P.montana* were found in highly urbanized and anthropogenic microhabitats. I can quote another example from my very own kindred spirits. Scientists at ZSI described *Amolops shillong* (a frog) from the urban forest patches in Shillong, Meghalaya. *Themira lohmanus*, a sepsid fly from New York City parks, *Drapetis bruscellensis*, a dance fly from Brussels Botanical Garden and many more examples can be cited to drive this point home. But what is the use of merely discovering new animals?

“A peek into biodiversity offers insights into the health of the ecosystem. It can also help in urban planning. In cities like Chennai, where the boundaries are laid out by oceans, this makes even more sense.”

A peek into biodiversity offers insights into the health of the ecosystem. It can also help in urban planning. In cities like Chennai, where the boundaries are laid out by oceans, this makes even more sense. An understanding of bycatch and the presence or absence of animals yields invaluable data for the city's sewage planning. The city floods often, which sometimes brings snakes and other creepy crawlies right into our homes. This shows that the sewage system supports certain flora and fauna.



Nowadays, urban ecosystems are being focused on merely for their aesthetics. Plants that boost oxygen production are installed in corporate office spaces, parks, zoos, and even in dividers to provide a greener, lushier look. From metal skyscrapers that took over our cities and skies, the introduction of these cleaner and greener installations, albeit for selfish reasons, i.e., making it better for the eye, promotes a conservation angle. The core principle of urban ecology integrates biology, sociology, and urban planning to understand and accommodate the relationships among flora, fauna, and human activities. From a certain vantage point,

“The three pillars of sustainability are environmental protection, economic viability and social equity.”

urban ecology is the inkling of sustainability. Before you dismiss the idea as far-fetched and utopian, hear me out. The three pillars of sustainability are environmental protection, economic viability and social equity. In layman's terms, that means conserving resources like biodiversity, ensuring the produce is economically viable, and ensuring fair access to resources and opportunities.



Now, let us take a typical urban landscape – a LEED Certified building. This is nothing but a building planned and constructed to strategise and optimise the use of resources. It is energy-efficient, mindful of waste disposal, and mindful of the construction site and the flora and fauna around it. It also helps reduce its carbon footprint and minimise its environmental impact. In a nutshell, it is an environmentally responsible structure.

By way of creating urban ecosystems and being mindful of the culling of trees for its erection, it checks the first pillar.

By serving as a building that generates revenue through normal trades and also creating space for green financing (by addressing concerns that support environmental endeavours), it meets the second pillar.

By making way for all organisms to survive in urban spaces, namely those that were, a few years ago, metal cages of human development, it checks the third pillar.

Sustainability may be a distant reality and a current necessity,

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A 2025 study by Professor Miles Richardson at the University of Derby found that human connection to nature has declined by more than 60% over the past 200 years. The Shakespearean tragedy in this context is that our vocabulary related to nature has fallen by 60% since 1990.

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but green urban spacing, which is tangible and achievable, is within our grasp.

What I feel is that, a by-product of green urban space planning is how the urban population can get back in touch with nature. A 2025 study by Professor Miles Richardson at the University of Derby found that human connection to nature has declined by more than 60% over the past 200 years. The Shakespearean tragedy in this context is that our vocabulary related to nature has fallen by 60% since 1990. That means my grandfather and father spoke more about rivers, forests, plateaus, meadows, brooks, creeks, fishing, milking,

farming, and harvest than I did in my entire lifetime. My father is a CA, my grandfather was in railways, and I am a zoologist by the way.

But is conservation a good enough reason for an investment of this magnitude? After all, it does cost top dollar to install these structures. Let me introduce another vantage point. One that speaks more and one that will definitely sway even the most commercial mind. Urban planning, as a nascent form of sustainability, helps mitigate human-wildlife conflict.



Human expansion is a major driving factor of human-wildlife conflict. When the concept of mindful urban space or any anthropogenic-dominated space is planned and executed, it almost eliminates the problem at its root. A shift towards responsible civic practices takes over communities that live in harmony with nature.

When we talk about island life, what comes to mind? Close-knit communities, responsible tourism, nature, beach, and coconut drinks for sure. This is because on an island, there is no excess. All resources are limited and need to be shared. And the people are very aware of nature and its importance, since it is what sustains them.

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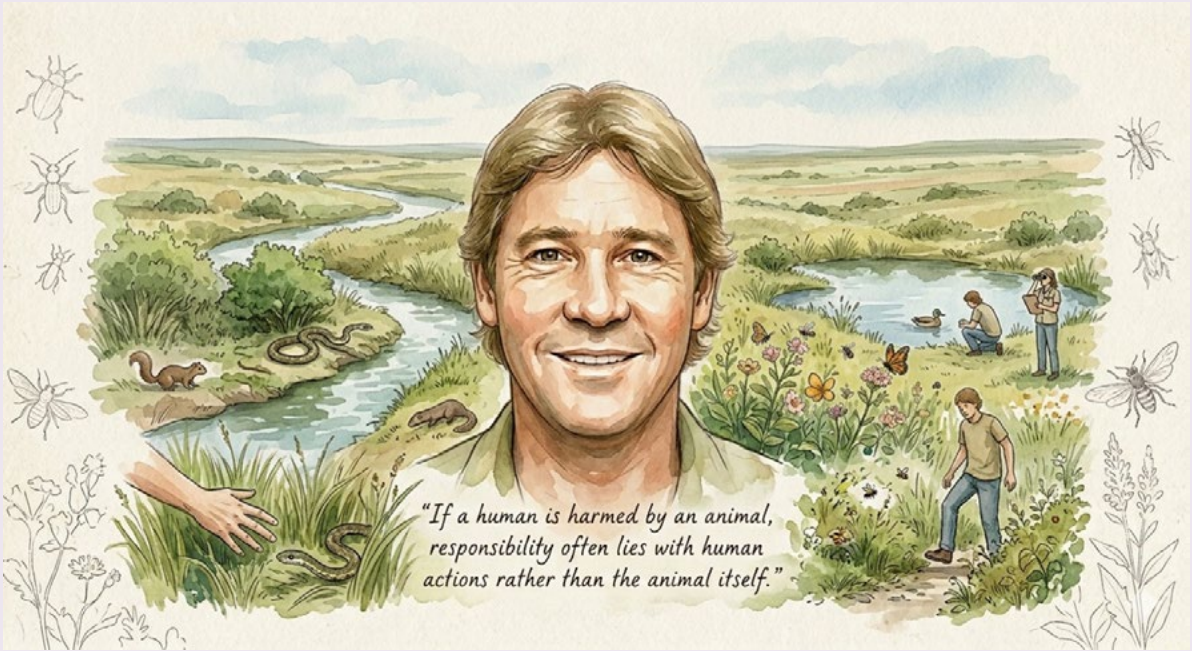
As with everything, an arduous journey begins with a single step. And I believe that an understanding of the biodiversity of urban spaces has a three-pronged benefit: (a) exploration of urban landscape biodiversity, (b) bringing sustainability and conservation to the forefront in urban spaces, and (c) being aware of human-wildlife conflict and designing human-centered spaces around animals so that they can co-exist.

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But this kind of respect is rarely found in urban communities. An excess of resources and the disconnection with nature are staggering. Everything becomes disposable and every resource expendable. This devil-may-care attitude of the majority of the

populace is why climate change is a major global concern. As with everything, an arduous journey begins with a single step. And I believe that an understanding of the biodiversity of urban spaces has a three-pronged benefit: (a) exploration

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Credits: All AI illustrations were done by **Mr Cedric M. Francis**, Loyola College (Chennai) Autonomous.

THE EXTRAORDINAARI of ZSI

With her lens in hand and field boots worn,
The indomitable greets the wild with every dawn.
Through forests, oceans and mountains high,
She captures the fauna beneath the sky.
Beyond the lab, beyond the field,
In every role, her perfection revealed.
In field, lab or home she cares,
Balancing life's challenges with rare flair.
Mira Mansukhani led the way
Breaking barriers in that day.
The first woman scientist of ZSI
Opened doors for dreams to fly.
After one hundred and five remarkable years
History brought out glorious cheers
Dr. Dhriti Banerjee rose to lead
ZSI's first woman Director indeed.
A beacon of vision, courage and grace
Leading the way at a remarkable pace.

ZSI has scaled new heights
Inspiring generations to dream and shine.
Deep archives and AI going hand in hand
Pioneers in faunal taxonomy, they proudly stand
With men as equal partners, side by side,
Together, advancing science with shared pride.

The path they've created shall brightly shine
As future generations will carry the line.
With fearless hearts and challenging dreams
They will protect life in forests, coasts, and streams.
Truly, the pride of ZSI's enduring story
Extraordinaari in all their glory.

Ms. Debashree Dam

Scientist C, ZSI, Kolkata

