Hard Life, on The Rocks: Exploring the Resilience of Life on Rocky Outcrops with Aparna Watve

Rocky outcrops - harsh, rugged landscapes - are often perceived as barren and lifeless. However, beneath their tough exterior lies a world of resilience, adaptation, and hidden biodiversity. They are not just lifeless terrains, but vibrant ecosystems that tell the story of evolution and human interaction with nature. They have stood the test of time, supporting life in the harshest of conditions. Over three enlightening days, Dr. Aparna Watve who calls herself 'a taxonomist by training, an ecologist by choice' guided us through the fascinating world of these unique landscapes, covering various aspects of rocky outcrops, including their classification, biodiversity, life processes, and their deep-rooted connection with human civilizations followed by the need for conservation of these ecosystems. Dr. Watve has over 25 years of experience working in these landscapes, focusing on the Western Ghats Biodiversity Hotspot. From understanding their formation to exploring the adaptive strategies of life that thrive within them, this journey revealed the true essence of resilience.

Rocky Outcrops - Nature's Sculpted Masterpieces

Dr. Watve introduced us to rocky outcrops as the visible exposures of bedrock or ancient superficial deposits on the Earth's surface. These landscapes are formed through complex geological processes such as weathering and erosion, shaping their unique characteristics. Different types of rocky outcrops discussed include:

Inselbergs: Isolated rock formations rising above plains, commonly composed of granite and gneiss.

Karst Landscapes: Formed from the dissolution of soluble carbonate rocks like limestone and dolomite, resulting in caves, sinkholes, and underground rivers.

Duricrust Plateaus: Hard, flat rocky surfaces such as laterite or ferricrete landscapes seen in peninsular India.

Flood Basalt Formations: Large expanses of basaltic rock resulting from volcanic eruptions, forming plateaus like the Deccan Traps.

Different types of plateau formations include ferricrete laterite plateaus, columnar basalts, coastal laterites, and marble cliffs. Marble cliffs, for instance, are found in Jabalpur. In the Satara district, at about 1,200 meters above sea level, exposed basalt blocks can be observed, which harbor rich endemic flora and fauna. These regions often feature ancient human and crop paintings on cave walls, typically on lateritic rocks. A notable example is the Idukki cave paintings in Kerala.

Rocky outcrops also serve as crucial catchment areas, collecting water that is used for various activities such as drinking and irrigation. Systems like the 'Pat' system in Kerala and Maharashtra utilize the water from these rocky outcrops. Additionally, ancient grinding holes, or 'sursunga' systems, can often be seen on these rocks, used historically for grinding rice, coconut, or other materials. For example, potholes in Pune (e.g., Nighoj potholes) are a significant geological feature.

The Building Blocks – Components of Rocky Outcrops

Rocky outcrops are characterized by a unique interplay of abiotic and biotic components that shape their ecosystems. The macroclimate of these regions is often harsh, with high exposure to sunlight, extreme temperatures, and limited water availability. However, microclimates, such as shaded crevices and depressions, create localized environments where life can thrive. Soil formation on these outcrops is minimal, with edaphic factors significantly influencing vegetation patterns. Rainwater pooling in depressions supports ephemeral life, but the scarcity of nutrients necessitates innovative adaptations among organisms. The flora includes lichens and mosses that form biological crusts, as well as ephemeral plants and succulents adapted to these challenging conditions. Meanwhile, the fauna comprises specialized herbivores, carnivores, and omnivores that rely on these vegetation forms for sustenance, further showcasing the delicate balance of life on rocky outcrops.

The Silent Architects: Ecosystem Processes

Rocky outcrops are dynamic ecosystems shaped by natural processes over time. Soil formation, though slow, is a vital process driven by rock weathering and the decomposition of organic matter, creating the foundation for life. Ecological succession on these outcrops is gradual, influenced by the limited availability of space and resources, leading to the replacement of species over time. Disturbances such as seasonal droughts, grazing, and fire play a significant role in shaping survival strategies, with species like *Tripogon lisboae* exhibiting desiccation tolerance to endure extreme droughts. Plants and animals demonstrate remarkable adaptations to nutrient scarcity, including carnivory, dormancy during unfavourable periods, and succulence for water storage. These habitats also support diverse microhabitats, such as cryptogamic crusts formed by lichens and mosses, seasonal rock pools that harbour aquatic life during rains, and ephemeral flush vegetation that emerges briefly during wet periods, highlighting the complex interplay of ecological processes in these unique landscapes.

Survivors of the Stone: Adaptive Flora and Fauna

The flora and fauna of rocky outcrops demonstrate remarkable adaptations to survive in this challenging environment. The vegetation includes graminoids such as Poaceae and Cyperaceae, which are grass-

like plants capable of thriving on minimal soil, and non-graminoid species like *Ceropegia attenuata* and *Iphigenia ratnagirica*, uniquely suited to the rocky terrain. Succulent plants, with their ability to store water in fleshy leaves, flourish in the dry conditions of these habitats. The fauna is equally fascinating, with freshwater invertebrates like shrimps and insects relying on seasonal pools for survival. Reptiles, such as the endemic gecko *Hemidactylus satarensis*, exhibit remarkable camouflage against the rocks, while amphibians like the Koyna and Amboli toads endure prolonged dry periods by entering dormancy. Together, these species showcase the incredible biodiversity and resilience of life on rocky outcrops.

Adapting to Extremes – The Art of Survival

Dr. Aparna highlighted the remarkable survival strategies of plants and animals on rocky outcrops, focusing on their adaptations to the harsh environment. To manage water scarcity, succulents store water in their fleshy tissues to endure prolonged dry spells, while ephemeral plants complete their entire life cycle rapidly during the short monsoon season. Nutrient acquisition is another challenge, addressed by carnivorous plants like *Utricularia* (bladderworts) that derive essential nutrients by trapping insects, and plants with underground storage organs, such as tubers, that conserve energy and sustain them through long droughts. Mass blooming is a striking adaptation, where plants bloom synchronously during brief favorable conditions to maximize pollination opportunities. Aparna also discussed the ecological roles of herbivory and burning, explaining how such disturbances shape the balance of these ecosystems. Life on rocky outcrops is a testament to ingenuity, with species evolving specialized traits to survive and thrive in this challenging environment.

Cultural Connections – Where Nature Meets History

Rocky outcrops are not only ecological havens but also significant cultural treasures, serving as cradles of human civilization for millennia. These landscapes have provided shelter, water, and inspiration, leaving a lasting mark on human history. Ancient water systems, such as the Sursunga grinding holes used for grain processing, are still visible on outcrops in Pune, alongside natural wonders like the famous Nighoj potholes. Architectural marvels like the rock-cut temples of Mahabalipuram in Tamil Nadu showcase the ingenuity and craftsmanship of early civilizations. Additionally, sacred sites such as Uluru in Australia and Pandav Leni in Maharashtra reflect the profound spiritual connections humans have forged with these rugged landscapes, blending nature and culture into enduring symbols of heritage.

Conservation Challenges – A Fragile Future

Despite their resilience, rocky outcrops are highly vulnerable to urbanization, mining, and climate change. Aparna emphasized the Urban Cliff Hypothesis, which suggests that cities have unintentionally preserved structures of these rocky outcrops by incorporating them into urban

landscapes. However, to ensure their long-term survival, more proactive conservation measures are needed. Recognizing rocky outcrops as geo-heritage sites through mapping and legal protection can help safeguard these ecological treasures. Community engagement plays a crucial role in conservation efforts by raising awareness among local populations and fostering a sense of stewardship. Developing sustainable tourism initiatives that encourage responsible exploration can provide economic benefits while ensuring minimal environmental impact. Additionally, continued scientific research is essential to deepen our understanding of the ecological dynamics of these unique habitats, enabling better management and protection strategies. Preserving them ensures that their ecological, cultural, and historical values are maintained for future generations.

Insights from the field – The Ratnagiri Report

Upon our arrival in Ratnagiri district, Maharashtra, we were captivated by the serene environment.

The landscape transitioned from the towering mountain ranges of the Western Ghats to rolling hills with flat tops locally known as "sada". These formations are a result of centuries of erosion, creating a unique ecological and geological environment. In the afternoon, Aparna introduced us to key individuals involved in local conservation efforts: Sonali Mestry (gram sarpanch), Manali Rane (Bombay Environmental Action Group member), and Gurjar Kaka, an engineer documenting the region's biodiversity, including bird diversity. During our informal discussion over vada pav brought by Manali, Aparna explained the significance of the sada landscape and how they have established a strong rapport with the local community to promote conservation. This ecosystem, often dismissed as barren land, supports a unique biodiversity and is crucial to the cultural and natural heritage of the region. We also introduced ourselves and shared details about our mentorship projects, receiving insights on how local communities and researchers collaborate effectively in conservation.

The next day, we visited the Kasheli geoglyphs in the Konkan region, a significant archaeological site discovered in May 2016. We met Sudhir Risbud and his team from Nisarga Yatri Sanstha, who are actively working to preserve these geoglyphs. Aparna and Sudhir elaborated on the region's prehistoric rock art, which dates from the Mesolithic to early historic periods and serves as a key cultural and ecological record. At Kasheli, we observed India's largest geoglyph: a massive elephant figure (18 x 13 meters) containing carvings of various animals like sharks, tigers, and peacocks. These carvings document human creativity and adaptation to the region's ephemeral wetlands and enrich our understanding of the Konkan's prehistoric human activities.

On the final day, we presented our group project objectives to the mentors and experts, receiving valuable feedback to refine our approach. The session highlighted the significance of integrating cultural heritage with ecological conservation and emphasized the role of community involvement. Inspired by the rich knowledge shared by the experts and the breathtaking landscapes, we started our mentorship project with renewed zeal and a deeper appreciation of the challenges and opportunities in conservation work.

Conclusion

Dr. Aparna Watve's sessions were a revelation, offering a profound appreciation for the resilience of life on rocky outcrops. These ecosystems are not just geological formations; they are living museums of evolution, rich in biodiversity and cultural heritage.

As we move forward, it is crucial to recognize their importance and take meaningful steps to preserve these treasures for future generations. As Aparna said 'The rocks have sustained life for millions of years - now it's our turn to sustain them.'

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