

Neglected Habitats: Coastal Plateau

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The concept of biodiversity and conservation biology matured during the mid 20th century. Since then, a variety of habitats have been identified and brought under formal protection through global, national, or regional conservation strategies based on their structural complexity, high endemism, and levels of threats. In India, conservation efforts are largely forest-centric in order to cover maximum diversity in minimal areas. This is the reason why in spite of a well-defined network of wildlife sanctuaries, national parks and biosphere reserves in India, some critical habitats lack due attention and protection. For example, India's shoreline has rocky outcrops, coral beds, mudflats, sandy shores, seagrass, rocky shores, and several such neglected habitats, which are ignored and little understood even today, and are facing various levels of threats due to the lack of adequate protection strategies. Some such neglected habitats of the Konkan region of Maharashtra will be discussed through a series of articles in *Hornbill*, starting with this one.

Konkan, as it is popularly known, is a rugged segment of the western coastline of Maharashtra, resting between the Sahyadris (Western Ghats mountain range) and the Arabian Sea. The region exhibits peculiar physiographic setup with varied undulating terrain along its entire stretch. The area

ranges in elevation from sea level to above 1,425 m and is characterised by various landforms having gently undulating low plateaus and cliffs in the west, to steep slopes, ridges, and high hills towards the eastern portion. The most remarkable of all these variations of landforms are the lateritic (rocky) plateaus, which cover the largest land surface in the central and southern Konkan (Ratnagiri and Sindhudurg districts), and are locally known as *sadas*.

What do we know so far of rocky outcrops or *sadas*?

Rocky outcrops are generally defined as portions of exposed bedrock protruding above the soil level, due to geological activities. The term includes landforms ranging from cliffs, isolated hills, inselbergs, and rocky platforms of diverse nature. It is a recognised habitat category under IUCN's habitat classification. In India, open rocky areas in the form of naturally exposed plateaus, monoliths, kopjes, and cliffs are major components of the landscape. Large monolithic inselbergs and kopjes are common in southern India. Cliffs are the dominant outcrop type in the mountainous regions. The rocky plateaus or *sadas* in the Konkan region and the southern parts of the Northern Western Ghats have basalt as their base rock, capped with laterite.



The seasonal transformation of these habitats is drastic and splendid with a huge turnover of life forms throughout the year

Habitat diversity

Rocky outcrops are known to be rich in their microhabitat diversity. A combination of factors such as the absence or presence and thickness of the soil layer, surface characteristics, and duration of water availability give rise to these microhabitats. The short-lived rock pools, puddles formed in shallow depressions, streams, rock surfaces with or without a thin film of soil and water, crevices and furrows between two rock surfaces, cliffs and pockets of woody vegetation wherever thick soil layer is available, are some of the distinct features. The species composition of these microhabitats remains more or less constant and specific, which adds to the overall biodiversity of the region. The classification of the microhabitats is based on papers published by Dr. Aparna Watve during 2003 to 2013.

Exposed rocks

The exposed rock surfaces look completely lifeless during the dry season. However, variously coloured patches of lichen and cyanobacteria which become more distinct during the rainy season form the pioneering communities of this habitat.



Luxuriant growth of lichens on rock surfaces

Seasonal Rock Pools

Rock pools are formed by accumulation of rain water in shallow depressions or concavities within the rocks, and hence are ephemeral. These have small amounts of soil accumulated at the bottom which supports fewer species, mostly growing with high abundance. The species growing within the rock pools are mainly *Rotala malampuzhensis* and *Eriocaulon* spp. The species growing in the damp soils surrounding these rock pools are common with those near deep pools and ponds, such as *Geissaspis tenella*, *Smithea* spp., and *Eriocaulon* spp.

Rock crevices and cavities

A thin layer of soil accumulated in small cavities and crevices within rocks provides suitable substratum for establishment of some species. Cavities are usually seen occupied by lower plants such as colonies of blue green algae and mosses, and some flowering plants such as *Lindernia ciliata*, *Murdannia pauciflora*, *M. semiteres*, *Mollugo pentaphylla*, *Neanotis lancifolia*, and *Pulicaria nightiana*, *Begonia* species are found on rocks in more moist places near water bodies.



Rock crevices

The crevices are colonised by *Eriocaulon* spp., *Geissaspis tenella*, *Impatiens* spp., *Lepidagathis* spp., *Neanotis lancifolia*, *Senecio* spp., *Smithea* spp., and many grasses and sedges.

The larger crevices have prostrate forms of scandents and climbers, such as *Cayratia trifolia*, *Gymnema sylvestre*, *Ipomoea coptica*, and *Tylophora indica*.



Seasonal rock pools

Conservation Notes



Deep pools

Deep pools

Deep pools are formed by accumulation of rain water in the larger depressions, which also have more soil accumulated at the bottom. These pools retain water for some time after the monsoon. Their vegetation is mostly similar to shallow rock pools described earlier. Thus, almost all species found in rock pools are also seen in deep pools. However, during the dry season, unlike that of rock pools, the floor is populated by *Polygonum plebeium*, *Heliotropium supinum*, *Coldenia procumbens*, *Euphorbia* sp., and others. During the rainy season, high abundance of *Cleome chelidonii* was observed along these pools, which is a common weed of paddy fields in this area. The aquatic peridophyte *Marsilia quadrifolia* was recorded from here.



Many ephemerals crowd along the course of drainage channels

Drainage channels

Sadas are characterised by a number of seasonal streams running across them. On the gently sloping outcrops drainage channels of very little depth run down the slope. The sides of such channels are occupied by *Cryptocoryne* spp., *Dipcadi concanense*, *Crinum* spp. and *Murdannia nudiflora*. Like in deep pools, *Cleome chelidonii* was also seen midstream along these channels. Sedges are also abundant along these streams.



Ponds with *Nymphaoides* spp.

Ponds

These retain water almost till the end of winter and are inhabited by hydrophytes such as *Nymphaoides* spp. Species of *Ludwigia*, *Crinum*, and several sedges line the periphery.

Soil filled depressions

The depressions on the plateaus are more or less evenly filled with deep soil. These microhabitats contribute significantly to the overall diversity of plateaus, as there are several guilds of species occurring in these depressions.

During the dry period, the vegetation is represented by a few perennials such as species of *Lepidagathis*, *Phyllanthus* spp., and annuals such as *Blumea lacera*.

During the rainy season, these areas have tall herbaceous vegetation. Cryptogams are represented by several species of fungi and carpets of liverworts. The gregarious populations of *Camptorrhiza indica*, *Dipcadi concanense*, and *Habenaria* spp. are seen during early and mid September on many of the selected sites. The other flowering species such as *Drosera indica*, *Impatiens* spp., *Neuracanthus sphaerostachyus*, *Polygala elongata*, *Rhaphicarpa longiflora*, and several species of grasses and sedges are common, in most sites of this microhabitat.

Due to the thick soil layer, this microhabitat provides an opportunity to plants with deep rootstock, bulbiferous and rhizomatous plants to grow, which survive the dry season through their underground rootstock. *Curcuma* spp., *Chlorophytum* spp., *Gloriosa superba*, *Kaempferia scaposa*, *Typhonium roxburghii*, and *Crinum latifolium* occupy spaces between isolated rocks and soil filled depressions.



Soil filled depression with Pink-striped Trumpet Lily *Crinum latifolium*



Thickets on deep soil

Thickets on deep soil

The coastal rocky outcrops are typically seen dotted with thickets of woody plant species supported by deep soil in the depressions. These thickets are composed of species like those of the moist deciduous forest or scrub vegetation of adjacent areas, comprising of stunted individuals of *Bridelia hamiltonia*, *B. retusa*, *Breynia retusa*, *Garuga pinnata*, *Hymenodictyon obovatum*, *Ixora brachiata*, *Lansea coromandelica*, *Memecylon umbellatum*, *Morinda pubescens*, *Securinega leucopyrus*, *Strychnos nux-vomica*, *Terminalia* spp., and *Grewia* spp. Scandent species dominate this vegetation, which includes *Argyrea* sp., *Cayratia trifolia*, *Dioscoria* spp., *Capparis moonii*, *Carissa congesta*, *Cissus repanda*, *Ziziphus* spp., and *Smilax ovalifolia*. The vegetation along cliffs is very similar.

The herbaceous species recorded from the edges of these thickets are distinct from those on the actual rocky habitats. *Arisaema* spp., *Ceropegia attenuata*, *Pimpinella tomentosa*, *Protasparagus racemosus*, *Tacca leontopetaloides*, ferns like *Adiantum* sp., *Asplenium* sp., and *Lygodium* sp. are species commonly seen on edges of these thickets.



Ephemeral flush vegetation make the landscapes spectacular for a short period

Ephemeral flush vegetation (EFV)

EFV is a highly seasonal plant community on the rocky plateaus. An important precondition for the development of EFV is the continuous supply of seepage water during the rainy season. On the coastal rocky outcrops, it is dominated mainly by *Utricularia* spp. and *Eriocaulon* spp. In addition, species like *Drosera indica*, *Trithuria konkanensis*, and other ephemerals form this community.

Conservation Notes

Very recently, the rocky outcrops of Maharashtra have started gaining the attention of the scientific community as special habitats. They are characterised by seasonality, appearing totally barren during the dry season and followed by drastic changes in physiognomy over a period of four months during the rainy season. Lack or scarcity of woody species make rocky plateaus appear barren or ‘wastelands’ for eight long months covering winter and summer. There is a visible dynamism on plateaus during the rainy season as it experiences a sudden outbreak of vegetation and then gregarious flowering of different species at different times. The first few showers transform the entire area. The new carpet of green takes on a cover of changing hues — from green to white to pink, purple, and yellow as flowers of different species blossom gregariously at different times. Kaas plateau of Satara district is a popular example of such dynamism of vegetation cover on the crest of Western Ghats, which attracts thousands of tourists every year. However, Konkan is comparatively less known for this reason. The monsoon also invites a lot of faunal activities back to life, especially insects, amphibians and reptiles.

The extreme microclimatic conditions are one of the several reasons which make these plateaus special habitats. Both rock and air temperature, and humidity, fluctuate widely throughout the year as well as in a day’s time. During the monsoon, the area remains partially or totally flooded. Thus, the microclimatic conditions on these plateaus are distinct from the surrounding habitats. Consequently, the communities that dwell on coastal rock outcrops across the world have learned to deal with a wide array of adverse environmental conditions, such as very high and low temperatures, fluctuating humidity, flooding, drought, harsh wind, salinity, and lack of nutrients. As a result, these communities are known to harbour habitat specialist plants that can cope with these extremes and flourish. The plants include ephemerals, which complete their life cycle as quickly as within four favourable months, or geophytes that survive the dry period through their underground parts, such as bulbs and rhizomes. Many of these species show certain adaptive strategies like carnivory, desiccation tolerance, succulence (high water content), etc.

In spite of these adversities, rocky plateaus harbour high biodiversity, which corresponds to their microhabitat diversity. A combination of factors such as absence or presence or thickness of the soil layer, duration of water availability, and surface characteristics give rise to these microhabitats. The short-lived rock pools, puddles formed in shallow depressions, streams, rock surfaces with or without a thin film of soil and water, crevices and furrows in between two rock surfaces, cliffs and pockets of woody vegetation

wherever a thick soil layer is available, are some of the distinct features. Different forms of life that occupy and thrive in different microhabitats at different times in a year remain invariable and add to the overall biodiversity of the region. There is another special characteristic that adds to the biological uniqueness of these plateaus – their high endemism. The biological richness is underscored with high number of plant and animal taxa whose occurrence is confined to these habitats.

Conservation issues

Recently, most of these coastal rock outcrops are experiencing heavy pressures and disturbances such as their rapid conversion for settlements, paddy fields, orchards, quarries, grazing lands, windmill farms, and industrialisation. Lack of awareness about their role as special habitat and consequent absence of baseline understanding regarding their ecology are the main hindrances in bringing them under a formal framework of protection. The ownership patterns further underscore the difficulties as the majority of these lands are privately owned. Some of the most severe threats can be listed as follows:



Sadas are important grazing grounds for livestock

Grazing and tourism

Grazing is the most common threat to the plateaus of Ratnagiri and Sindhudurg, as these serve as grazing grounds for livestock of this region. The other threat is from tourism. The Ambolgad Plateau is popular for its sea-facing steep cliffs and scenic beauty, and many tourists visit it regularly, especially during the monsoon. These result in ‘trampling’ of the soil by cattle, humans, and vehicles, and litter dumping is severe and causes a lot of damage to the fragile communities. The disturbance encourages entry of invasive species from surrounding scrub areas, which may cause damage to the habitat specialists of plateaus.

Agriculture

The plateaus with a thick top soil layer are extensively utilised for paddy cultivation. The area under such patches varies depending on the availability of suitable land, ranging from small islands of fields to the entire plateau. The weeds associated with the paddy fields are another serious threat to plateau vegetation. For instance, *Cleome chelidonii* which is a common weed of paddy is seen invading plateau vegetation, especially occupying the seasonal pools and streams, which may suppress the growth of specialist species of these habitats.

Mango orchards

The alphonso mango of Ratnagiri and Sindhudurg districts is highly prized for its taste, and is a major export of the region. Large tracts of rocky plateaus are being brought under mango orchards very rapidly. The stone is blasted to dig a pit and filled with soil for planting the sapling. This method is destructive and destroys the biota of that area.

Quarrying

Quarrying has had the largest impact on the entire Konkan region. These quarries operate on different scales depending on private or commercial use. The deep layers of laterite in Konkan are quarried for cutting out bricks, locally known as *jambhyache chire*, for local construction of houses, or are transported to nearby cities. Quarrying is rampant and a major cause of destruction of lateritic plateaus of the Konkan.

Windmills

The rocky plateaus near Girye, Vijaydurg are partially taken up by windmills. These do not form a major threat to the plateaus as the area covered by them in Konkan is small.



Laterite quarries dot the plateaus all over the Konkan

However, looking at their coverage on the plateaus on the Western Ghats, they are likely to be a major threat in the future. Windmills do not directly affect the plateau habitats, but the ancillary developmental activities, such as construction of roads and buildings, and trampling may cause destruction.

Settlements

Rapid increase in urbanisation, industrialisation, and related developments in the Konkan region is resulting in an influx of people to this area from nearby areas and other states in search of job opportunities. This is resulting in new settlements mainly on the rocky plateaus causing permanent destruction to the habitat. Construction of roads also have caused fragmentation.

Mega Power projects

The Maharashtra government's determination to industrialise the Konkan region will have a deep impact on its rich biodiversity. A stretch of about 200 km of this coast



Windmills at Vijaydurg

Conservation Notes



The existing and proposed industries along the Konkan region is the largest threat for coastal plateaus

is dotted with more than 15 existing and proposed mega industries. These include gas and coal-based power plants with a total capacity of almost 21,000 MW. Another 15 coal-fired plants, with a total capacity of 25 MW, are reportedly planned along the Konkan.

Besides this, the mining projects in Mandangad, Dapoli, and Dodamarg talukas in Konkan involve a total of about 1000 ha land area. There are also smaller mining leases.

These developments will largely affect the coastal plateaus. In the absence of forests, the lands are wrongly considered as barren and treated as wastelands, which have resulted in easy and quick granting of permissions for several projects, without serious EIA biodiversity evaluations.

These pressures are shattering this deep-set ecological

routine. There is a general lack of awareness about the importance of these plateaus and even less knowledge about the need for conserving their ecology, which makes it very hard to extend a formal framework of protection for them.

A step forward

The Bombay Natural History Society (BNHS) has recently undertaken an in-depth study of the plant and animal communities on the coastal rocky plateaus of the Konkan, documenting the various above discussed impacts and disturbances to build an effective conservation framework for this ecosystem. Based on the present knowledge, the following steps could be taken to work towards the conservation of these lesser known unique habitats:

Research: More extensive and intensive studies need to be conducted to document the floral and faunal diversity of these habitats. Long term species monitoring projects should be conducted to study population trends of endemic and threatened species and their ecological status. Long-term habitat monitoring should be carried out at a landscape level to study the impact of anthropogenic activities and climate change on species.

Advocacy: Various target groups including local communities, scientists, and policy makers should be educated about the importance of these habitats to reduce those pressures on habitats that may exist merely due to lack of awareness. Formation of small habitat monitoring groups to involve representatives of different target groups in actual conservation programmes could be another initiative.

Conservation: Banning or limiting activities that cause tremendous destruction, such as mining, tourism, constructions, industrial use, burning or blasting on plateaus is a vital step to protect them. Organic and inorganic pollution is another serious threat to the plateau communities. Plastic and urban waste dumping on plateaus should be strictly prohibited. Encouraging community ownership of such ecologically sensitive areas and bringing them under mutually beneficial protection regimes could be another initiative.

With serious and effective implementation of these recommendations, we can hope to carry forward this heritage into the future, or it will be lost forever. ■



Swapna Prabhu is formally trained in the Taxonomy of Angiosperms during her Masters degree, and in Plant Ecology during her doctoral research. Currently she works as a Plant Taxonomist and Ecologist at the BNHS, Mumbai, and is involved in plant research and education activities oriented towards conservation.