

## STUDY ON BIODIVERSITY ON HINGOLGADH NATURE EDUCATION SANCTUARY

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### Introduction

Hingolghadh Nature Education Sanctuary, covering an area of 654 ha is located in Jasdan Taluka of Rajkot District in the Saurashtra region of Gujarat State in India. The small area falling under 4-B Gujarat Rajwada Biotic Province of the semi-arid zone is the only preserved forest ecosystem in the District. The sanctuary is historically known as 'Motisari Vidi' which was managed as grassland in the past by Ex-princely State of Jasdan.

Hingolghadh is the only sanctuary in the country which is managed by Gujarat Ecological Education and Research (GEER) Foundation, a registered society under Societies Act of 1860 and Bombay Public Trust Act of 1950. Government of Gujarat has allotted this notified sanctuary to the Foundation in 1984, on lease basis primarily for management and development to meet the specific objective of nature education. Total 379 nature camps educating 24,049 campers have been conducted in the sanctuary by the Foundation from the year 1984 to 1997. The WWF, Rajkot and other nature clubs also conduct similar camps regularly. At present, the wilderness area has been developed as an excellent centre for nature education in the region where about 70 camps, each of about three days, are conducted every year by the institutions.

The climate of the sanctuary is arid to

semi-arid, characterized by a hot summer and dryness in non-rainy season. Average rainfall is 425 mm, which is erratic and lasts for short period. Temperature varies from average minimum of 10°C to average maximum 40°C. The area falls in drought prone region, and water does not last even upto the month of February in any stream or check dams. Rainfall during the monsoon of 1997 was 538 mm from first week of June to second week of September. Soil in the sanctuary originates from the basalt rocks which are in a partially decomposed state, forming loose pebbles. Average pH value of soil is 7.4, with a variation from 6.5 to 8.0. Also, the average carbon content in the soil is estimated at about 0.74% only, which is less than the normal content in good soil.

The sanctuary has biological spectrum closer to that of dry deciduous scrub and Savannah type of dry thorny scrub. Forest types of the sanctuary are : 5DS1- dry deciduous scrub, 9E<sub>2</sub>-*Acacia senegal* forest, and 5DS2-Dry Savannah type vegetation (Champion and Seth, 1968). It is open low forest in which thorny, usually *Acacia senegal*, *A. nilotica*, *Maytenus emarginata*, *Rhus mysurensis*, *Grewia damine*, *Balanites aegyptica*, *Eurphobia nivula* and *Zizyphus* sp. dominates among vegetation. Originally, area had mixed dry deciduous forest of *Boswellia serrata*, *Lannea coromandelica*, *Wrightia tinctoria*, *Anogeissus pendula*, *Comiphora wightii*, *Zizyphus nummularia*, *Acacia nilotica*, *Moringa oleifera* etc., which

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was destroyed in the beginning of this century, and it is now replaced by set of new plant communities through secondary succession.

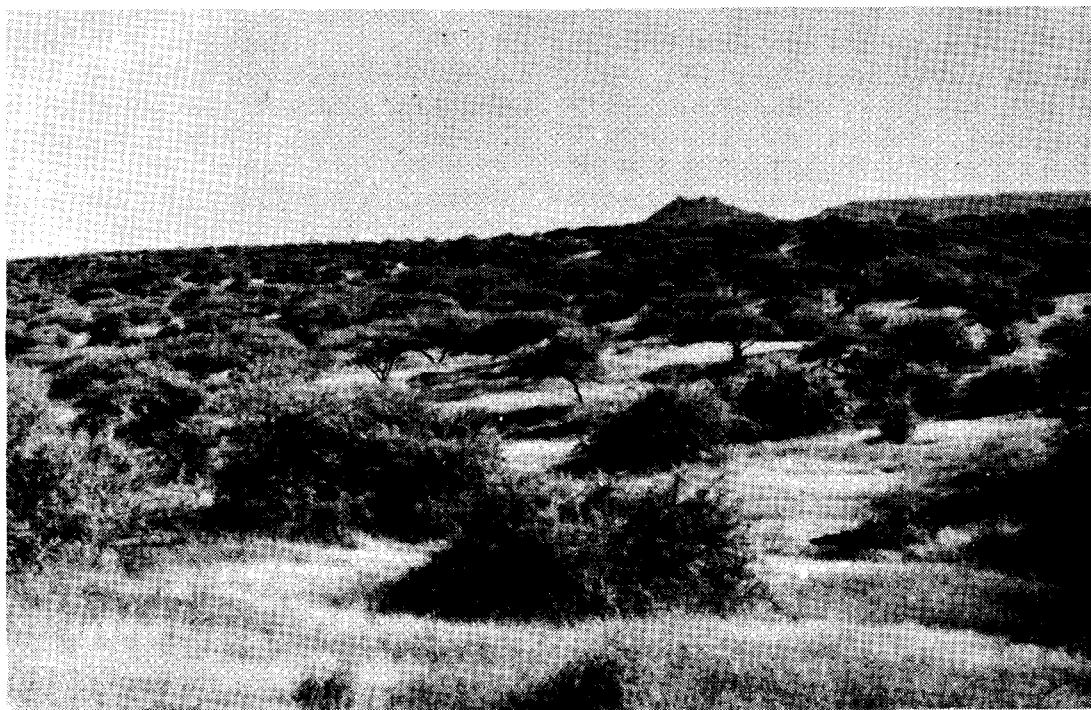
The anthropogenic disturbances that operate in the region are far beyond the capacity of evolutionary adjustment. Livestock population belonging to people from peripheral villages put tremendous amount of pressure on the sanctuary for grazing. Management of the area was handed over to the GEER Foundation in 1984 by the Gujarat State Forest Department. The Foundation carried out intensive soil and moisture conservation and habitat development works during the period which resulted into recovery of

habitat and wildlife therein. The Foundation organised ecological study during 1997 by involving scientists and experts with an objective to know the population of flora and fauna, their distribution, abundance rarity and degree of threat.

### Methodology

First part of ecological study was completed from March 1997 to January 1998. Remote sensing study was carried out to assess different types of vegetation covers in the sanctuary. Data of November 1984, November 1987 and October 1996 have been used to know the trends of change in vegetation cover.

Fig. 1



6 B/C<sub>1</sub> - Desert Thorn Forest of Hingolghadh in rainy season

Systematic random sampling has been applied for enumeration of vegetation. It was planned to carry out 5% enumeration for trees, shrubs and climbers. 36 strips of 10 m width were laid down at interval of 200 m, perpendicular to the baseline in East-West direction, covering all vegetation types and topography. The strips laid across forest from the baseline to be boundary measuring 32,533 m covered 32.53 ha (4.97%) of the forest area.

Trees were enumerated in 10 cm girth classes of GBH (girth at breast height). Less than 10 cm GBH has been considered as regenerated plant. Enumeration of trees, shrubs and climbers was carried out from March 1997. Regeneration survey for all trees and shrub species were carried out to assess the trend of development of the forest. Also, heights of 438 dominant trees and woody shrubs belonging to different species were recorded in different sites to study the canopy composition of the forest.

Quantum and duration of monsoon decides composition of herbaceous vegetation. Delay in monsoon causes negative impact on regeneration of several species. In scarcity period, hardy species compete and survive better than others. In the background of the fact, it was planned to carry out enumeration in three phases in different stages of rainy season. Counting of plants was carried out in quadrats of size 1 m x 1 m laid down systematically on strips which were demarcated on the ground.

Counting of seasonal plants in quadrat in some of the strips was done in last week of July and another one third in month of August. Rest of strips were covered during last phase of rainy season in the month of September. For most of the species, August is ideal period in this area because majority

of the plants flower during the month. Total 183 quadrats were marked in 36 strips to enumerate seasonal plants including grasses. Botanists also carried out extensive survey to record other species which are rare to the area and could not be encountered during enumeration.

Population of major mammals was estimated by conducting census in the area during summer. Three strips covering total length of 5,568 m were marked on ground for regular counting of birds. These three strips covered all types of habitats and terrains occurring in the sanctuary. Birds were counted upto the distance of 15 at both sides from the centre of strips. Thus, total area of 17.7 ha was covered for estimating bird population. Bird breeder from the Foundation carried out bird counting in early morning during fourth week of every month. Data of four months have been analysed in this case but the work would continue to cover all twelve months to study the seasonal population dynamics of birds. Study is also in progress for reptiles, minor mammals and insects.

Shannon-Weiner index of diversity ( $D = - \sum P_i \log_e P_i$ ,  $P_i = n_i/N$ , where,  $n_i$  is population of  $i^{th}$  species and  $N$  is total population of all individuals of all species) and Simpson diversity index ( $D = \sum P_i^2$ ) have been estimated for trees, shrubs, grasses and herbs separately.

## Results and Discussions

*Habitat diversity* : Remote sensing study has revealed that majority of area is under herbaceous cover (416.9 ha in 1996) with sparse growth of trees and shrubs which can be classified as Savannah type of vegetation. Area under the dense tree cover was reduced from 90.5 ha in 1984 to only

28.1 ha in 1987 due to severe drought in 1985 to 1987. Thereafter, it has progressively improved to 78.0 ha in 1996 on account of protection and development effort. Vegetation cover classes as per satellite data of 1996 are : tree dense (11.9%), tree sparse (22.9%), grassland (63.7%) and blank (0.5%).

At micro-level, the vegetation types in the area have been classified as (i) *Acacia senegal* or 'gorad' forests, (ii) *Grewia damine*, *Rhus mysurensis* and *Balanite aegyptica* type, (iii) *Acacia senegal*, *A. leucophloea* and *Rhus mysurensis* type (iv) Savannah type (grassland in patches), (v) mixed dry deciduous forest - a small patch of original forest which is considered rare plant community in the area.

**Floral diversity :** Based on the position of renewable bud-organs on the plants, the plant species are categorized into five life forms : (i) phanerophytes - plants that grow taller than 50 cm, (ii) chamaephytes - plants that remain perennially below the level of 50 cm (iii) hemicryptophytes - perennial with periodic shoot reduction to remnant shoot system that lies relatively flat on the ground surface, (iv) geophytes or cryptophytes - periodic reduction of the complete shoot system to storage organs that are embeded in the soil and (v) therophytes - annual plants whose shoot and root system die after seed production. Of a total 314 flowering plant species in Hingolghadh, 286 are indigenous to the area and their distribution among various forms is given in Table 1.

The area has biological spectrum closer to dry deciduous scrub forest. Predominance of therophytes over other life forms indicates a highly disturbed condition of the habitat. Table 1 also indicates that xeric condition

**Table 1**  
*Life form diversity*

Life form	No. of species	Species (%)	Normal spectrum (%)
Phanerophytes	78	27.2	48.0
Chamaephytes	25	8.7	9.0
Hemicryptophytes	33	13.0	26.6
Geophytes	5	1.7	6.0
Therophytes	147	51.4	13.0

may be one of the main reasons for high percentage of therophytes.

Biodiversity survey provides information that indigenous flora of Hingolghadh is represented by 63 families, 189 genera, 286 species, expressing a ratio of 1:3:4.5 which is very high for small area. Richness in floristic composition, is surprisingly higher than any other such area, though the area falls in semi-arid zone. This figure does not include 28 species introduced through plantation. Distribution of plant species, including 28 introduced species belonging to different families and general is given in Table 2.

Seasonal species dominate in this category of vegetation, and perennials are unable to propagate efficiently due to the frequent droughts and grazing pressure. In all an average density of 434 plants/m<sup>2</sup> has been estimated during rainy season of the year 1997. As per analysis of population dynamics of seasonal plants, 1102 seasonal plants/m<sup>2</sup> (658 grass + 144 herbs) were recorded in first and second week of July. Number progressively reduced to 247 plants/m<sup>2</sup> (157 grasses + 90 herbs) in first week of September. Thus, only 22.4% of seasonal plants reached to flowering and fruiting stage.

**Table 2**

Number of families and species of different vegetation forms

Vegetation form	No. of families	No. of genera	No. of species
Tree	27	41	53
Shrub	20	32	35
Climbers/ twining/creepers	12	30	43
Herbs	39	96	152
Grasses	1	24	31
Total	67	212	314

Top height of dominant trees of *Acacia senegal* - 'gorad' was estimated at 5.2 m. There is no marked difference in the height of trees and important woody shrubs. Average top height of shrubs is 3.3 m which is close to the average height of trees. Thus, there is no clear stratification of the vegetation. Overall average tree density of the forest is 87.1 trees/ha. *Acacia senegal* (54.4/ha) dominates the composition which constitutes 62% of total tree population. *A. leucophloea* (12.7%), *Balanites aegyptica* (4.4%), *A. nilotica* (5.1%), *Dichrostachys cinerea* (3.6%), *Bauhinia recinosa* (3.1%), are other important trees. Area is not very rich in tree diversity.

Regeneration status of *Acacia senegal* is very good as 804 saplings/ha have been counted which constitutes 96.8% of total regenerated trees. Study also indicates that the plant population of *A. senegal* has increased substantially from 162 trees/ha in 1984 to 858 trees/ha in 1997. From the status of regeneration of *A. senegal*, it can be concluded that the secondary succession of the forest in future would continue to be in favour of 'gorad'. Regeneration status of other tree species is very poor. Some of the shrubs like *Grewia damine*, *Rhus*

*mysurensis*, *Balanites aegyptica* have moderate status of regeneration. Young plants of *Comiphora wightii* were seen in the bushes which indicates that the species has started recovering due to protection.

Among shrubs, *Rhus mysurensis* (23.0%), *Maytenus emarginata* (20.6%), *Grewia damine* (11.7%), *Euphorbia nivula* (10.8%), *Melhania fulleyporencis* (8.5%), *Securinega leucopyrus* (6.5%), *Cassia auriculata* (4.4%), *Zizyphus nummularia* (3.8%) and *Comiphora wightii* (2.4%) are the main species. Average shrub density of the area is 287/ha. Diversity index indicates that the area is rich in shrub composition.

*Boerhavia diffusa* (33.5/ha), *Asparagus racemosus* (26.5/ha), *Dalechampia scandens* (8.6/ha), *Rhynchosia minima* (12.0/ha), *Phyllanthus reticulatus* (12.2/ha), *Cardiospermum halicacabum* (9.5/ha), *Rivea hypocrateriformis* (9.2/ha) and *Pentstemon spiralis* (8.6/ha) are dominant climber species. Average density of all 43 climbers, twining and creepers recorded in the area is estimated at 144.3/ha during rainy season. *Aristida adscensionis* (67.2%) and *Heteropogon contortus* (21.2%) are dominant species among 31 species of grass recorded in the area. Composition of unpalatable grasses in the area is high at present. *Heteropogon contortus* and other palatable grasses started colonising the area due to protection of forests. Grass density during rainy season has been estimated at 250/m<sup>2</sup>.

Area is very rich in herbaceous vegetation. Average density of 184 herbs/m<sup>2</sup> (other than grasses) has been estimated during the study. *Spermacoce stricta* (44.2%), *Indigofera cordifolia* (9.2%), *Heylandia latebrosa* (7.6%), *Zornia gibbosa*

(6.3%), *Cassia pumila* (3.5%), *Viola cinerea* (3.0%) are the main herbs.

314 species of plants have been recorded by this study and diversity index of different vegetation forms has been estimated - (i) Simpson diversity index  $D = P_i^2$  : Trees diversity index = 0.41, shrub's diversity index = 0.14, climbers diversity index = 0.12, grass diversity index = 0.45, herb diversity index = 0.12, and over all plant diversity index = 0.20. In Simpson diversity index, higher the value implies the lower diversity of the species (ii) Shannon-Weiner index of diversity  $D = -\log_e P_i$  : Tree diversity index = 3.50, shrub diversity index = 0.08, climber diversity index = 1.64, grass diversity index = 1.05.

**Faunal diversity :** Chinkara, Blue Bull, Wild Boar, Wolf, Jackal, Fox, Common Hare, Jungle Cat, Desert Cat, Hyena, Porcupine, Hedgehog, Ratel, Bats (Flying Fox), and Rodents are mammals recorded in the sanctuary. It is a good habitat for Chinkara, as about 70 Chinkara were counted in the area. Similarly, the population of Blue Bull is estimated at 55. Wolf occasionally visits this area. Jackal, Jungle Cat, Hedgehog, Porcupine and Hare are common mammals. Caracal and Desert Cat were recorded in the past but they were not seen during the recent years. Study on minor mammals, reptiles, insects and birds is in progress which would be completed in the next year. In all, 15 species of mammals, 3 species of amphibians, and 24 species of reptiles have been recorded in the area.

Previous study has recorded 212 species of birds with very high density of Redvented Bulbul in August. In general, the scrub forest of the sanctuary supports exceptionally high population of birds. Many of them breed in the area. Previous study

estimated an average 1029 birds/km<sup>2</sup> in 1989 whereas this study recorded an average population density of 1967 birds/km<sup>2</sup> during period from September 1997 to December, 1997. Out of 82 species of birds recorded during the period of four months, 43 species nest in the sanctuary, and nest-density for some of the species is observed to be very high.

Population of birds varies due to migration and change in condition of food and water. Some of the birds like Redvented Bulbul (146/km<sup>2</sup>), Grey Partridge (129/km<sup>2</sup>), Small Minivet (121/km<sup>2</sup>), Large Grey Babbler (118/km<sup>2</sup>), Jungle Babbler (112/km<sup>2</sup>), Common Iora (102/km<sup>2</sup>), and White-throated Munia (75/km<sup>2</sup>), have high density. Ornithologists visiting the sanctuary have recorded that scrubland with grass patches and fruit species support relatively high population of the bird. Conditions of the habitat of this area can be guiding factor for management of habitats for birds in this region. High population of insects and reptiles attract carnivorous birds. Similarly, flowers and fruits of *Rhus mysurensis*, *Grewia damane*, *Salvadora* sp., *Comiphora wightii*, *Ficus* sp., *Azadirachta indica*, *Tamarindus indica* etc., and seeds of shrubs, herbs and grasses produce adequate food for birds of this region.

**Rarity, endangeredness and vulnerability :** *Comiphora wightii* is an endangered species in the area as per IUCN criteria. *Viola cinerea*, *Monsonia senegalensis*, *Rhus mysurensis*, *Capparis grandis*, *Flacourtia indica* and three species of *Ceropegia* spp. are interesting taxa of the sanctuary as they are rare elsewhere in Gujarat. Some of the species with very low population are threatened in the area but may be very common in other parts of the State. Only one tree of *Flacourtia indica*, two trees of

*Capparis grandis* could be encountered during extensive survey of the area.

*Lannaea coromandelica*, *Boswellia serrata*, *Tecomela undulata*, *Anogeissus pendula*, *Moringa cocina*, *Acacia nilotica*, *Sterculia urens* and *Wrightia tinctoria* were main plants of the forest in the past. At present, only a small patch of about 1 ha contains a few trees of these species with rarity of the community ( $R = 1-P$ ) equal to 0.998. Thus, the patch has become exceptionally rare in the area.

Among indigenous flora each of 17 species of trees, 18 species of shrubs, 22 species of climbers, 20 species of grasses and 122 species of herbs have population less than 0.1% of total population of all species in respective groups with low frequency of distribution. They can be assessed locally rare but regional rarity and degree of threat can be evaluated after knowing their abundance and distribution in other parts of the State.

Lesser Florican, a rare and endangered species of bird was recorded in the past but could not be seen during the year. Pangolin, Ratel and Wolf are rare in the area and regionally threatened. Caracal, a regionally endangered species was sighted in the past but there is no record in last few years. Chinkara, a flagship species of the sanctuary is also vulnerable in Gujarat State. Common Fox and Hyena are occasionally seen in scrub forest of the sanctuary.

## Conclusion

Construction of check dams, nala bundings and gradonies as part of intensive soil and moisture conservation and habitat development works along with protection

of area have brought tremendous qualitative changes in the habitat. The study indicates that increased population of wildlife including birds, regeneration of some of vulnerable species are indicators of improvement of ecosystem. Study revealed that such an area has relatively high diversity of species which is different from similar forest in Saurashtra and Kutch. This scrub forest in the semi-arid zone is interesting to ecologists as such number of species are rarely seen in a small patch of forest.

Comparison of two studies carried out in 1988 and 1997 indicates that tree cover is improved qualitatively and quantitatively and birds population increased by 95%. Composition of trees and shrubs appears to be ideal for excellent habitat in the sanctuary for conservation of fauna of scrubland of the region. Forest is gradually changing in favour of *Acacia senegal* due to adequate regeneration status of the species. To maintain mixed scrub forest with grassland in patches, it is desirable to manipulate vegetation by suppressing the growth of *Acacia senegal* in future. It is also felt that further qualitative changes in habitat can be brought by planting species like *Ficus* sp., *Emblia officinalis*, *Tamarindus indica*, *Carissa cangesta*, *Bauhinia recinosa* without substantial change in the density of tree cover. Similarly, species of original forest, which are exterminated or about to be exterminated, should be planted to built up their population above critical level. There is further scope of habitat improvement by allowing regeneration of palatable grasses, and also by taking up eco-development project in the six peripheral villages to reduce negative impact of local people on the biodiversity.

## SUMMARY

**Biodiversity study on Hingolghadh Nature Education Sanctuary reveals that the biological spectrum of the area is closer to that of dry deciduous thorn scrub and dry Savannah like vegetation. Remote sensing study on vegetation cover indicates that canopy density has improved progressively after severe drought in year 1987, due to fair regeneration of *Acacia senegal*. The small area is exceptionally rich in floral and faunal density as indigenous flora of the sanctuary is represented by 63 families, 189 genera, 286 species, expressing a ratio of 1:3:4:5. The sanctuary also supports high diversity (212 species) and very high density (1967 birds/km<sup>2</sup>) of birds, along with other rich fauna. *Comiphora wightii*, an endangered species and other locally threatened species have started recovering due to improvement of the habitats. The rarity and threat level for various species have also been assessed in this paper.**

## हिंगलगढ़ प्रकृति शिक्षण अभयारण्य की जैवविविधता का अध्ययन

एच०एस० सिंह

## सारांश

हिंगलगढ़ प्रकृति शिक्षण अभयारण्य की जैवविविधता के अध्ययन से पता लगता है कि इस क्षेत्र का जैविकीय वर्णपट शुष्कपर्णपाती कंटक क्षुद्ररोह और शुष्क घास प्रदेश की वनस्पतियों के निकट का है। वनस्पति आवरण का दूर संवेदन अध्ययन संकेतित करता है कि वर्ष 1987 में पड़े भयंकर सूखे के उपरान्त अकेसिया सेनेगल के कुछ अच्छे पुनर्जनन के कारण वितान घनत्व में धीरे-धीरे परिष्कार हुआ है। यह छोटा क्षेत्र पेड़-पौधों और पशु-पक्षियों की दृष्टि से असाधारणतः सम्पन्न है क्योंकि इस अभयारण्य के देशज पौधों में 63 कुल, 189 प्रजातियाँ और 286 जातियाँ 1 : 3 : 4 : 5 का अनुपात दिखाते समाविष्ट हैं। इस अभयारण्य में पक्षियों की अच्छी विविधता (212 जातियाँ) और बहुत अच्छी सघनता (1967 पक्षी/वर्ग किमी) पाई जाती है जिसके साथ अन्य पशुओं की सम्पन्नता भी है। यह संकटापन्न जाति, कोमिफोरा वाइटिआई तथा स्थानीय संकट में पड़ती जातियाँ भी प्राकृतावास में सुधार आने के कारण पनपनी आरम्भ हो गई हैं। अभिपत्र में विभिन्न प्राणि जातियों की दुर्लभता और संकट स्तरों का विवेचन भी किया जाता है।

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