



Diversity of Sanjay Gandhi National Park in Disturbed and Undisturbed habitat

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Abstract: The study intends to investigate the floristic diversity of the Sanjay Gandhi National Park by calculating the Diversity Indices of two distinctly identified areas, one being disturbed (Main Road leading towards Kanheri Caves denoted as Site A) while the other area being undisturbed (Shilonda Trail denoted as Site B). The study further aims at drawing a conclusion in terms of the differences in the Floristic Diversity calculated by the Simpson's reciprocal index and the Shannon-Weiner Index of the study areas during the monsoon season. On calculation, the Simpson's Reciprocal Index for Site A was estimated to be 25.04 while Shannon - Weiner Index was recorded to be 30.2537 while Site B showed a diversity of 29.82 expressed by the Simpson's Reciprocal Index and 40.253 by Shannon - Weiner Index. Through the study it has been observed that the Shilonda Trail houses species identified under the IUCN Red Data List of Threatened Plants, namely, *Gloriosa superba* L., *Dipcadi saxorum* Blatt. and *Chlorophytum borivilianum* Santapau & R.R.Fern. For example, *Gloriosa superba* L.; enlisted as threatened and *Dipcadi saxorum* Blatt. and *Chlorophytum borivilianum* Santapau & R.R.Fern., both endemic and endangered species have been recorded in Site B. It can however, be concluded that though the undisturbed habitat harbors several exclusive species, both areas show high Diversity Indices.

Key Words: Floristic Diversity, disturbed and undisturbed areas, Simpson's Reciprocal Index, Shannon-Weiner Index, IUCN Red Data List.

Introduction

One of the important protected area networks in Maharashtra is the Sanjay Gandhi National Park (SGNP) as it is amidst the busiest metropolis of the country, Mumbai. The SGNP covers 103.36 km² and contains 82.39 km² of reserved forest, 0.21 km² of protected forest and 20.76 km² of un-classed forest. A core zone (CZ) of 76.92 km², Eco - Tourist Zone (Eco - TZ) of 0.45 km², Buffer Zone (BZ) or multiple use zone of 5.89 km² has been identified (Pande P., 2005).

The park faces a problem of encroachments and other illegalities such as agriculture, quarrying, plying of buses, construction of commercial buildings and laying of telephone lines. There are four entry points at the SGNP - Borivli, Aarey Gates, Bhandup Complex and Yeur Naka, of these only Borivli and Yeur Naka are open to people. From the two mentioned, the Borivli end is easily accessible. It is used for morning walks, school and college picnics, lion and tiger safari and for nature walks. The forests at the Borivli end are classified under un-classed and reserved forest type. The Yeur

Naka is accessible for research and educational purpose and is classified under reserved and protected forest type. Also, since the Yeur Naka is restricted to tourists, the extent of disturbance is low. Hence, the Borivli area was selected to carry out this study due ease of access and a high influx of people that visit the park daily for jogging, recreation or for tourism. The scope of this paper is to study the differences in plant diversity largely the annual ones which make an appearance during the monsoons between two habitats, disturbed and un-disturbed areas within the park.

Study Area

To determine vegetation differences in disturbed and undisturbed areas, a survey was carried out initially from the Borivli gate upto Kanheri caves to identify possible disturbance areas between June to August. Areas were identified viz., a disturbed habitat namely the main road leading to Kanheri caves and an area identified as undisturbed namely the Shilonda trail. The details of the identified areas for study are given in Table 1

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Table 1: Areas selected for the study

S. No.	Areas Selected for study	Disturbance status
1.	Main Road leading towards Kanheri Caves (denoted as A)	Highly disturbed as the road leads to Kanheri caves which is a tourist attraction. It is the only route towards Kanheri caves from the Borivali gate.
2.	Shilonda Trail (denoted as B)	Restricted to public. Access to this part the park is strictly for educational and research purpose.

Materials and Methods

To measure the diversity of the park in both disturbed and undisturbed habitats, quadrats of 1m x 1m were laid along the main road and Shilonda trail. 30 quadrats were laid at each site during monsoon season – June to August. The values of flora obtained from quadrats and tally marks were further expressed by use of indices like Relative Frequency, Relative Density, Relative Abundance, Index of Dominance, the Simpson's Reciprocal Index, the Shannon – Weiner Index, Species Richness and Species Evenness.

Simpson's Reciprocal Index: The value of D ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1 represents no diversity. That is, the bigger the value the lower the diversity. Since the values obtained from the use of Simpson's Diversity Index would not appropriately represent the data obtained for comparative analysis of the disturbed and undisturbed habitats, the diversity of plants was quantified using the

Simpson's Reciprocal Index In the use of Simpson's Reciprocal Index, a high value of D suggests a stable ecosystem and a low value of D suggests degraded ecosystem or habitat (Rutherford J., 2009).

Shannon-Weiner Index: The uniqueness of the floral species in the sampled areas was incorporated by using the index of evenness (equitability) called the *Shannon's Index* or the *Shannon – Weiner Index*. The main objective of information theory is to try to measure the amount of order (or disorder) contained in a system (Margalef R., 1958).

The index provides a measure of the amount of disorder in a system, such that communities with more unique species have higher H while a system with lower H may be

perfectly ordered but has no diversity (Bradshaw & Brook, 2010).

Species Richness (SR): This is the oldest and the simplest concept of species diversity – the number of species in the community or the region. McIntosh (1967) coined the name species richness to describe this concept. It is therefore the base currency used for most biodiversity assessments (Krebs, C.J., 2013).

Evenness Index: It measures the relative abundance of the various populations present in an ecosystem. A community in which each species is equally abundant has high evenness; a community in which the species differ widely in abundance has low evenness (Heip Carlos H.R. et al., 1998).

Relative Frequency (RF), Relative Density (RD) and Relative Abundance were calculated for each plant species using the respective the following formulae (Misra R, 1968; Ambasht R.S. et al., 1984; Bhalerao S.A. et al., 2012). Data obtained from quadrats and transects was further quantified for dominance by use of *Index of Dominance*. The relation between diversity and dominance lies in the fact that low dominance indicates high diversity whereas high dominance indicates low diversity (Bradshaw & Brook, 2010).

Results

The study undertaken in the selected sites show great variations in the species observed. The vegetation of Site A, an disturbed habitat is characterized by 43 different species belonging to 21 families. The vegetation of the area is typified by species herbs, shrubs and climbers dominated by members of families Acanthaceae, Amaranthaceae, Convolvulaceae, Fabaceae, Malvaceae and Tiliaceae., Malvaceae is the most prevalent family at site A and dominant with highest species richness and diversity with 1137 individuals belonging to 9 species, while Fabaceae (4species), Acanthaceae (4 species), Amaranthaceae (3 species), and Convolvulaceae and Tiliaceae (2 species each) respectively were recorded.

Site B, regarded as an area of high species and genetic diversity illustrated an astounding 69 species of plants belonging to 33 families. Unlike as seen in Site A where Family Malvaceae showed dominion in its

presence than other families; here, the vegetation dominated by members of Family Fabaceae with 1344 individuals belonging to 10 different species. 9 species of plants were recorded family Malvaceae, while Acanthaceae showed only five. 3 species were recorded from both Families Amaranthaceae and Convulvulaceae and members of the Tiliaceae family belonged to 2 species.

On calculating the parameters from data collected for site A identified as disturbed habitat, it is observed that *Vigna radiata* (L.) R.Wilczek shows the highest occurrence in Site A during monsoon. The Relative Density (RD) of the species was 6.4803 while the Relative Frequency (RF) and Relative Abundance (RA) were 4.7442 and 0.0648 respectively. *Abutilon indicum* (L.) Sweet is also seen to have a high RD of 6.1626, RF of 4.5116 and RA of 0.0616. The species recorded as least abundant in site A is *Rauvolfia serpentina* (L.) Benth. ex Kurz with a RD calculated to be 0.1271 and RF and RA calculated to 0.093 and 0.0013 respectively. Similarly, *Mukia maderaspatana* (L.) M.Roem. is seen to show identical values of RD, RF and RA as *Rauvolfia serpentina*, while, *Helicteres isora* L. has a RD of 0.2224, RF of 0.1628 and RA of 0.0022.

Computing the Index of Dominance for the two different sites to estimate the dominant species of vegetation, it was observed that *Vigna radiata* (L.) R.Wilczek was the most dominant species in Site A with the Index of Dominance at 0.0042. Furthermore, *Abutilon indicum* (L.) Sweet, *Smithia sensitiva* Aiton and *Celosia argentea* L. were other dominant species found at Site A with the Index of Dominance calculated to be 0.0038, 0.0037 and 0.0035 respectively.

In Site B, *Geissaspis cristata* Wight & Arn. was dominant over other species where the Index of Dominance calculated for the species was 0.0067. Other species that showed close dominance were *Smithia sensitiva* Aiton (0.0049) and *Desmodium triflorum* (L.) DC. (0.0047).

Site B has been identified as an undisturbed habitat. *Geissaspis cristata* Wight & Arn. was the species with the highest values of RD, RF and RA, which are at 8.1855, 4.6812 and 0.0819. *Smithia sensitiva* Aiton also shows high values of RD calculated to be 6.9944, RF to be 4.000 and RA to be

0.0699. The species which show the lowest distribution in Site B are *Tirchosanthes cucumerina* L., *Aeschynomene indica* L. and *Pedilanthus tithymaloides* (L.) Poit. The RD, RF and RA values calculated for all the three species are 0.0253, 0.0145 and 0.0003 respectively. Also species like *Breynia retusa* (Dennst.) Alston, *Gloriosa superba* L., *Lindernia crustacea* (L.) F.Muell. and *Smilax ovalifolia* Roxb. ex D.Don are species with lower RD, RF and RA values as compared to other species except for the former. The values of RD, RF and RA for these species are 0.0507, 0.0290 and 0.0005 respectively.

Diversity Index calculated for species recorded at SGNP during Monsoon

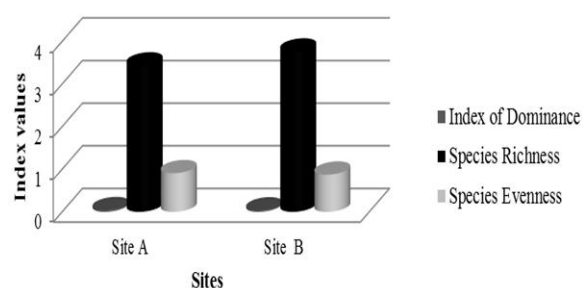


Figure 1: Calculated values of indices for species recorded by quadrat method during monsoon at SGNP at two selected sites

Diversity measurements such as Index of Dominance, Species Richness and Species Evenness form an integral part in the study of biodiversity of an area. The relation between Index of Dominance and biodiversity lies in the fact that an area with *low dominance indicates high diversity while that with high dominance will have less diversity*. The Index of Dominance for all the two sites has been lower viz., the Index of Dominance has been 0.400 and 0.0338 for sites A and B, respectively, where site B is an area of low disturbance due to limited access and site A is an area of high to moderate disturbance. This negligible difference in values of dominance can be solely shouldered by the monsoon where the favorable season results in voracious and prolific growth of flora throughout the park ensuing high diversity.

A relation of this high diversity can also be observed from the results obtained by calculating Species Richness which is defined as *the number of species in the community or the region*. On comparing sites A and B, site B, which is protected by the laws of the park management authorities, its Species Richness

is the higher while the Index of Dominance is the lower than site A. It can be suggested that the Index of Dominance is inversely proportional to the Richness of Species from the recordings obtained during the monsoon season.

Furthermore, Species Evenness is yet another factor that plays a vital role in determining the wellbeing of the diversity in an area. The Evenness Index *measures the relative abundance of the various populations present in an ecosystem*. From the results attained from the study of quadrats in the four selected areas of study during the monsoon, it can be noted that site A has a higher Evenness Index, as compared to the other site B, being 0.8727. A community in which each species is equally abundant has high evenness; a community in which the species differ widely in abundance has low evenness. Thus in conclusion it can be stated that, the species are equally abundant in site A as compared to site B, however, showing close resemblances in the values of Evenness Index. Fig 1.

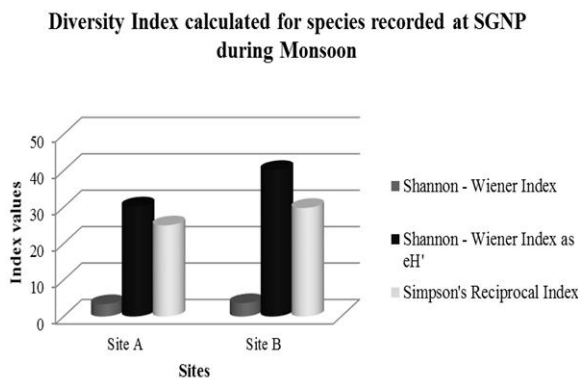


Figure 2: Calculated values of indices for species recorded by quadrat method during monsoon in SGNP at two selected sites

The Simpson's Reciprocal Index and the Shannon - Wiener Index of diversity were applied to the data collected with quadrats. The Simpson's Reciprocal Index is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. In the Simpson's Reciprocal Index a high value of D (diversity Index) suggests a stable ecosystem and a low value of D suggests degraded ecosystem or habitat. Similarly, the Shannon-Wiener Index (H') or the Shannon's Diversity Index (H') provides a measure of the amount of disorder in a system, such that communities with more unique species have

higher H while a system with lower H may be perfectly ordered but has no diversity. Site B (Shilonda Trail) shows the maximum diversity at 40.253 (expressed by Shannon's Diversity Index) and 29.82 (expresses by the Simpson's Reciprocal Index). Hence, site B reflects high diversity and more unique species. The Shilonda Trail, due to being protected by the park management authorities shows several species that have not been recorded in the other site. Being a protected area, it shows more variations in species and some species that have been noted in the IUCN Red Data list of Threatened Plants have been observed in this trail, namely, *Gloriosa superba L.*, *Dipcadi saxorum Blatt.* and *Chlorophytum borivilianum Santapau & R.R.Fern.* For example, *Gloriosa superba L.*; enlisted as threatened and *Dipcadi saxorum Blatt.* and *Chlorophytum borivilianum Santapau & R.R.Fern.*, both endemic and endangered species have been recorded only in this site. Therefore, the protection of this site is vital for conservation of heterogeneity and the inimitable flora thriving in it. Although categorized as disturbed habitat, Site A also shows high diversity with 30.2537 reflected by the Shannon's Index and 25.04 by Simpson's Reciprocal Index. Thus, sites A and B show a fairly high diversity during the monsoon season from June - August.

Conclusion

With the two sites taken under study determined as disturbed and undisturbed; the undisturbed site is an area which supported exclusive species which the disturbed sites failed to bear. Hence, protection of the undisturbed area is imperative to save these exclusive species like *Gloriosa superba L.*, *Dipcadi saxorum Blatt.* and *Chlorophytum borivilianum Santapau & R.R.Fern.* which have already been included in various categories of the IUCN Red Data List. Also it should be noted that certain species are more suitable to grow and develop in areas of disturbance or degradation than other species and hence see a higher Index of Dominance.

Species identified during course of the study in the park have shown a higher degree of intrinsic value, irrespective of their presence in the disturbed or undisturbed habitat. Thus, it is imperative that all the sections of the park be protected in order to protect the vast variety of goods and services

made available to mankind through forests like the SGNP.

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