

RESEARCH ARTICLE

Quantitative analysis of diversity during seasonal variations of Sanjay Gandhi National Park (SGNP) by Quadrat Method

Joshi Ambika¹, Kalgutkar Anudnya¹ and Joshi Nitesh²

¹Department of Botany, Jaihind College, Churchgate, Mumbai 400020, Maharashtra, India.

²Department of Botany, Rizvi College of Arts, Science and Commerce, Bandra (west), Maharashtra, Mumbai 400050, India.

*Corresponding author email : niteshcjoshi@gmail.com

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ABSTRACT

The Study intends to identify changes in biotic factors, especially in floristic diversity during different seasons with help of quadrat study in Shilonda trail of SGNP that is protected by Park Management. The study further aims at drawing a conclusion in terms of differences in Floristic Diversity of the Site calculated by Simpson's Reciprocal Index and Shannon - Weiner Index during monsoon, post - monsoon and winter seasons. On calculation, Simpson's Reciprocal Index for the Site during monsoon was estimated to be 29.82 while Shannon - Weiner Index was recorded to be 40.253. During post - monsoon the diversity expressed by the Simpson's Reciprocal Index was 29.1 and 38.0 by Shannon - Weiner Index. Similarly for winter, Simpson's Reciprocal Index was calculated to be 12.75 and Shannon - Weiner Index was 14.839. Through the study it has been observed that Shilonda Trail houses species identified under IUCN Red Data List of Threatened Plants, namely, *Gloriosa superba* L.; enlisted as threatened. *Dipcadi saxorum* Blatt. and *Chlorophytum borivilianum* Santapau & R.R.Fern., both endemic and endangered species have also been recorded in the Site, during the monsoon season. It can be concluded that seasonal variations have a profound effect on species and genetic diversity of the Site under study.

Keywords: Seasonal variations, quadrat study, diversity, Shannon-Weiner Index (eH'), Simpson's Reciprocal Index, IUCN Red Data List.

INTRODUCTION

Sanjay Gandhi National Park (SGNP) also popularly known as the Borivali National Park is encircled by the Thane City and Mumbai Metropolis. It is divided into an outer recreational zone, a buffer zone

and a core zone. SGNP is an example of one of the least represented biographic zones – the Malabar Coast of the Western Ghats which forms only 0.4% of the Protected Area network. The official area of the park has expanded by five times since pre – independence era and presently covers around 104 sq. km., housing many rare, threatened and beautiful species (Monga, 2000).

Since the vegetation pattern and diversity depends majorly on the climatic conditions of the area, the study intended to identify the changes in the biotic factors, especially in the floristic diversity during different seasons with an objective to quantitatively estimate diversity by applying quadrat sampling and further analyzing data by employing various diversity indices. Differences hence achieved by use of indices will aid in developing comparisons between seasonal variations in the chosen site.

MATERIALS AND METHODS

Some areas inside the park at the Borivali entrance are manned by park officials who restrict the entry of visitors without appropriate permission from the Nature Information Center one of which is the Shilonda trail and access to this part of the park is strictly for educational and research purpose. To get complete representation of flora in different seasons, quadrats were laid in three different seasons viz., Monsoons: June to August; Post Monsoon: October to November and Winter: January to March. 30 quadrats of 1m x 1m were laid along the Shilonda trail during the three seasons. Flora was identified with aid of the Bombay Natural History Society (BNHS), Agharkar Research Institute (Pune) and Blatter Herbaria. 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 and diversity indices like the Simpson's Reciprocal Index, the Shannon – Weiner Index, Species Richness and Species Evenness.

Simpson's Reciprocal Index:

In Simpson's Diversity Index, value of **D** (Diversity) ranges from 0 to 1. With this index, 0 represents infinite diversity and 1 represents no diversity, i.e., the bigger the value the lower the diversity. Since values obtained by Simpson's Diversity Index would not

appropriately represent the raw data for comparative analysis of disturbed and undisturbed habitats, floral diversity was quantified using *Simpson's Reciprocal Index*. In 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, 2009).

Shannon – Weiner Index:

The uniqueness of floral species in sampled areas was incorporated by using index of evenness (equitability) called *Shannon's Index* or *Shannon – Weiner Index*. Main objective of the Index is to try to measure the amount of *order* (or disorder) contained in a system (Margalef, 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 system with lower **H** may be perfectly ordered but has no diversity (Bradshaw & Brook, 2010).

Species Richness (SR):

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

Evenness Index:

It measures the relative abundance of various populations present in an ecosystem. A community in which each species is equally abundant has high evenness; a community in which species differ widely in abundance has low evenness (Heip Carlos 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, 1968; Ambashtet al., 1984; Dalvi et al., 2012):

Data obtained from 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 AND DISCUSSION

Monsoon Season (June to August):

The monsoon season is marked by the growth and proliferation of a myriad of diverse floral species. Water is a key and also a limiting factor that regulates the growth and development of plants. Hence, the onset of rains in Mumbai in June, results in a significant increase in the floristic diversity of the park. From the values obtained after quantitative analysis by quadrat study during the monsoon season, it has been observed that the *Geissaspis cristata* Wight & Arn. showed the highest values of RD, RF and RA, which were at 8.1855, 4.6812 and 0.0819. *Smithia sensitiva* Aiton also showed high values of RD calculated to be 6.9944, RF to be 4.000 and RA to be 0.0699. The species which showed the lowest distribution in the site were *Tirchosanthes cucumerina* L., *Aeschynomene indica* L. and *Pedilanthus tithymaloides* (L.) Poit.. The RD, RF and RA values calculated for all the three species were 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 were species with lower RD, RF and RA values as compared to other species except. The values of RD, RF and RA for these species were recorded to be 0.0507, 0.0290 and 0.0005 respectively.

Post – monsoon Season (October to November):

The monsoon season is followed by a period of warmer climate during the post – monsoon months of October to November. This results in decline of the species diversity and abundance due to fall in the favorable conditions that follow post the rains. From the values obtained, it was noticed that *Neuracanthus sphaerostachys* was recorded with the highest values of RD, RF and RA, which were at 6.5808, 2.5536 and 0.0658. *Alternanthera sessilis* (L) R.Br. ex Dc. also showed high values of RD calculated to be 5.0621, RF to be 1.9643 and RA to be 0.0506. The species which showed the lowest distribution were *Gloriosa superba* L., *Lindernia crustacea* (L.) F.Muell. and *Pedilanthus tithymaloides* (L.) Poit.. The RD, RF and RA values calculated for all the three species were 0.0460, 0.0179 and 0.0005 respectively. Also species like *Carrisa congesta*, *Hemidesmus indicus* (L) R.Br. ex Schult.,

Eupatorium odoratum, *Breynia retusa* (Dennst.) Alston and *Smilax ovalifolia* Roxb. ex D.Don were 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 were 0.0920, 0.0357 and 0.0009 respectively.

Winter (January to March):

The season of winter is the most unfavorable season for the growth and development of plants as an important factor like water is a scarce resource during this time. Due to this, there is a drastic shift of diversity of species from being the maximum during the monsoons, gradually declining through the post – monsoons and further declining during winter. *Urena lobata* L. had been recorded as the species with the highest values of RD, RF and RA. The values of the three parameters for the species were calculated to be 14.9068, 2.2857 and 0.1491 respectively. *Sida acuta* Burm.f. was yet another species found to have high values of RD, RF and RA, viz., 11.8012, 1.8095 and 0.1180 respectively. On the other hand species like *Eranthemum roseum*, *Breynia retusa* (Dennst.) Alston and *Smilax ovalifolia* Roxb. ex D.Don had the lowest and identical RD, RF and RA values which when calculated were 0.6211, 0.0952 and 0.0062 in that order. *Achyranthes aspera* L. was yet another species with low distribution with RD of 0.9317, 0.1429 and 0.0093.

During monsoon, the Shilonda Trail, regarded as an area of high species and genetic diversity illustrated an astounding 69 species of plants belonging to 33 families. 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.; enlisted as threatened and *Dipcadi saxorum* Blatt. and *Chlorophytum borivillianum* Santapau & R.R.Fern., both endemic and endangered species have been recorded only during the monsoon in this site. During the post monsoon season the abundance of vegetation differed as compared to that found during the monsoon season where 56 species belonging to 29 families were recorded at the Site. On analyzing the data obtained during the winter season i.e. between January and March, it can be observed that number of species have fairly declined at the Site, i.e. only 21 species belonging to 13 families were recorded. For the sake of convenience the values of the important species and of significant values are discussed above.

Index of Dominance, Species Richness and Evenness:

The values of various parameters are represented in Table 1 and Fig 1.

Table 1: Species Dominance, Richness and Evenness recorded at the Shilonda Trail during monsoon, post-monsoon and winter season by quadrat method.

Season	Index of dominance	Species Richness	Species Evenness
Monsoon	0.0338	4.2341	0.8727
Post - monsoon	0.031	4.0254	0.9037
Winter	0.0813	3.0445	0.8859

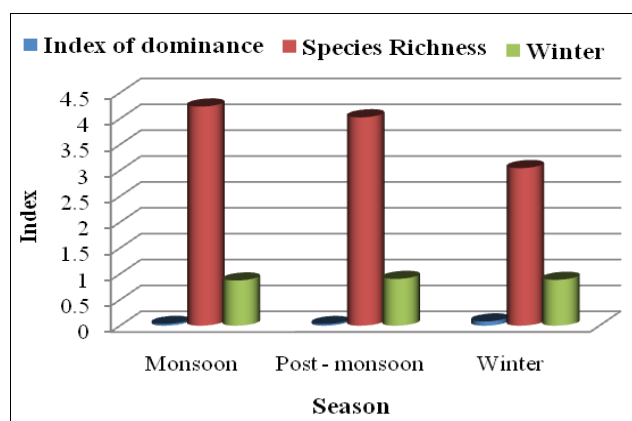


Fig. 1: Presentation of calculated values of indices for species recorded at the Shilonda Trail during the three seasons by quadrat method.

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*. As for the diversity indices calculated for the Site, the Index of Dominance was computed to be 0.0338. The Site showed a Species Richness of 4.2341 and Species Evenness of 0.8727. As for the diversity indices calculated during the post - monsoon season, the Index of Dominance was computed to be 0.031. The Site showed a Species Richness of 4.0254 and Species Evenness of 0.9037. The diversity index studies during the winter season showed that the Index of Dominance was 0.0813, while Species Richness and Species Evenness were recorded to be 3.0445 and 0.8859 respectively.

Diversity Indices:

The various indices calculated during the study are represented in Table 2 and Fig 2.

Table 2 : Diversity indices for species recorded at the Shilonda Trail during monsoon, post-monsoon and winter season by quadrat method

Season	Shannon - Weiner Index	Shannon - Weiner Index as eH'	Simpson's Reciprocal Index
Monsoon	3.6952	40.253	29.82
Post - monsoon	3.6376	38.0006	29.1
Winter	2.6972	14.8385	12.75

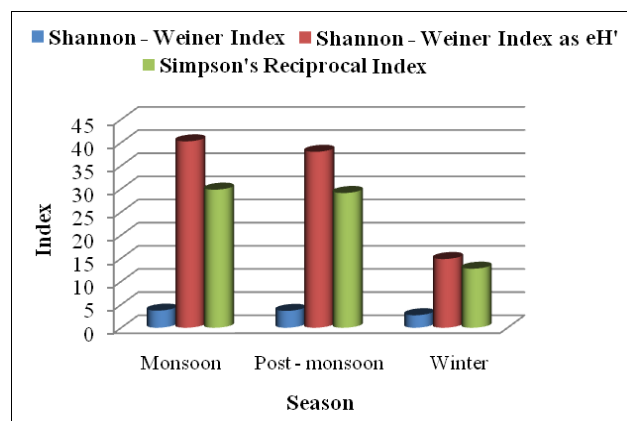


Fig.2: Presentation of calculated values of diversity indices for species recorded at the Shilonda Trail during the three seasons by quadrat method

During the monsoon season, the Shannon Weiner Index is 3.6952 and when expressed as eH' was at 40.2530, while the Simpson's Reciprocal Index was at 29.82. The Shannon Weiner Index during the post - monsoon season was recorded to be 3.6376 and when expressed as eH' was at 38.0006, whereas the Simpson's Reciprocal Index was at 29.1. While the diversity indices during the winter were recorded as: The Shannon - Weiner Index and as expresses in eH' were calculated to be 2.6972 and 14.8385. The Simpson's Reciprocal Index showed a value of 12.75.

CONCLUSION

Fig.1 and 2 clearly depict how seasonal variations have a proportional and exponential change in growth and development of flora. During monsoon, the Shilonda

Trail, regarded as an area of high species and genetic diversity illustrated an astounding 69 species of plants belonging to 33 families. 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.*; enlisted as threatened and *Dipcadi saxorum Blatt.* and *Chlorophytum borivilianum Santapau & R.R.Fern.*, both endemic and endangered species have been recorded only during the monsoon in this site. During the post monsoon season the abundance of vegetation differed as compared to that found during the monsoon season where 56 species belonging to 29 families were recorded at the Site. On analyzing the data obtained during the winter season i.e. between January and March, it can be observed that number of species have fairly declined at the Site, i.e. only 21 species belonging to 13 families were recorded. Thus, it can be reiterated that the diversity of the park depends on seasons and hence variations in species composition with variation in season can be observed from Figures 1 and 2. In conclusion, therefore, the protection of the Shilonda Trail is vital for conservation of heterogeneity and the inimitable flora thriving in it. Furthermore, the diversity has immensely changed from the monsoon season to the winter season, marking the fact that seasonal and climatic conditions have a profound effect on the diversity of the area.

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