A Double-Blind Peer Reviewed & Refereed Journal

Original Article

I J R B A T, Issue (XIV) Volume (II) May 2026: 07- 21

e-ISSN 2347 – 517X

INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY

PLANT DIVERSITY IN TIPESHWAR WILDLIFE SANCTUARY: ANALYSIS USING SHANNON'S AND SIMPSON'S INDICES FOR SUSTAINABLE MANAGEMENT

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Communicated: 02.01.2026 | Revision: 04.01.2026 & 22.01.2026 Accepted: 27.01.2026 | Published: 31.05.2026

ABSTRACT:

Evaluating the distribution and abundance of plant species is essential for interpreting ecological patterns within forest ecosystems. The present investigation focuses on vegetation diversity in Tipeshwar Wildlife Sanctuary, applying Shannon–Wiener and Simpson indices to understand community characteristics. Data collection was carried out through systematic quadrat sampling across different parts of the sanctuary to capture variations in species occurrence and population size. The study documented 192 species of plants, representing a broad range of taxonomic groups, with 25,460 individual plants recorded from 10 sampling plots during the rainy season of 2025, indicating considerable heterogeneity in species presence and abundance. The Shannon index value (H′ = 3.2467) reflects a notably diverse plant assemblage, while the Simpson index (1–D = 0.8921) points toward a low level of dominance and a relatively even spread of individuals among species. The findings suggest that the vegetation structure of the area is shaped by both widely distributed and less frequent species, influenced by environmental conditions and human activities. The combined use of both indices proved effective in capturing different aspects of diversity, offering a clearer picture of community organization. Overall, the results emphasize the ecological richness of the sanctuary and underline its importance as a site for biodiversity conservation. The information generated through this study can serve as a reference for future ecological assessments and management strategies in similar forest ecosystems.

Keywords:- Tipeshwar Wildlife Sanctuary, Shannon's index, Simpson's index, Ecological assessment, Forest ecosystem.

INTRODUCTION:

Biodiversity forms the structural and functional foundation of all ecosystems, particularly in forest landscapes where species interactions regulate ecological stability and productivity. Quantitative assessment of plant diversity is essential for understanding vegetation structure, ecological processes and conservation priorities (Misra, 1968 & Odum, 1971). In tropical regions, especially in India, vegetation exhibits high spatial and temporal variability due to climatic gradients, edaphic conditions and anthropogenic influences (Champion & Seth, 1968 & Singh & Singh, 1992).

India is recognized as one of the megadiverse countries, harboring a wide range of forest types that support rich plant diversity (Rodgers & Panwar, 1988 & Gadgil & Meher-Homji, 1990). Tropical dry deciduous forests, which dominate large parts of central India, are particularly important for their ecological services and socio-economic value (Puri et al., 1989 & Jhariya et al., 2013). These forests often experience seasonal fluctuations in vegetation, with the rainy season representing a peak period of species richness and biomass accumulation (Jain, 1991 & Reddy et al., 2011).

Assessment of plant diversity using quantitative indices provides a reliable approach to evaluate ecosystem complexity. Among these, the Shannon–Wiener index and Simpson's index are widely accepted tools for measuring species diversity and dominance patterns (Shannon & Weaver, 1949 &

http://doi.org/10.29369/ijrbat.2026.010.2.00002

Simpson, 1949). These indices incorporate both species richness and evenness, offering a comprehensive understanding of vegetation dynamics (Magurran, 2004). Several studies in Indian forest ecosystems have successfully applied these indices to analyze floristic composition and ecological stability (Kumar & Ram, 2005 & Sagar & Singh, 2006 & Panda et al., 2013).

Vegetation analysis through quadrat sampling remains one of the most effective field methods for ecological studies, enabling detailed assessment of species distribution and abundance (Curtis & McIntosh, 1950 & Misra, 1968). In Indian conditions, quadrat-based studies have been extensively used to evaluate plant communities across different forest types, including dry deciduous forests (Singh et al., 1984 & Reddy et al., 2007). Such studies are crucial for identifying dominant species, rare taxa and invasive elements that may influence ecosystem functioning (Jhariya et al., 2014 & Sahu et al., 2012).

Tipeshwar Wildlife Sanctuary, located in the Yavatmal district of Maharashtra, represents a significant yet understudied dry deciduous forest ecosystem. The sanctuary supports diverse flora, including grasses, herbs, shrubs, climbers and trees, which collectively contribute to habitat complexity and wildlife sustenance. Despite its ecological importance, systematic quantitative studies on plant diversity in this region are limited. Seasonal studies, particularly during the monsoon period, are essential to capture maximum vegetation expression and diversity patterns (Jhariya et al., 2015 & Sinha et al., 2015).

Understanding plant diversity patterns is also critical for sustainable forest management. Anthropogenic pressures such as grazing, fuelwood collection, invasive species and habitat fragmentation can alter species composition and reduce biodiversity (Gadgil & Guha, 1995 & Murthy et al., 2016). Invasive species like *Lantana camara* and *Parthenium hysterophorus* have been reported to significantly affect native vegetation structure in Indian forests (Sharma et al., 2005 & Reddy, 2008). Therefore, periodic biodiversity assessments are necessary to guide conservation planning and management interventions.

The present study aims to evaluate plant diversity in Tipeshwar Wildlife Sanctuary using Shannon–Wiener and Simpson indices based on quadrat sampling during the rainy season of 2025. The study provides insights into species composition, dominance patterns and ecological stability, contributing to the scientific understanding and sustainable management of dry deciduous forest ecosystems.

MATERIALS AND METHODS

The study was carried out in Tipeshwar Wildlife Sanctuary with the aim of examining plant diversity across different vegetation layers. Fieldwork was undertaken during the rainy season of 2025, when vegetation is at its peak growth and most species are easier to observe and identify in the field.

Vegetation sampling was done using the quadrat method. A total of ten quadrats were selected randomly to cover different parts of the study area. Each quadrat measured 30 m × 15 m and efforts were made to locate them in sites that represented variation in habitat conditions. The sampling was carried out across the Patanbori and Parva ranges, covering ten forest beats, so that differences arising from local environmental factors and disturbance levels could be taken into account.

Within each quadrat, all plant species present were recorded and individual counts were made as far as possible. The occurrence of each species across quadrats was also noted to understand its distribution pattern. Identification of species was done with the help of standard floras and available taxonomic references. For analysis, the recorded plants were grouped into three categories—herbs, shrubs and trees—based on their growth habit.

The field data were then used to analyse diversity patterns. The Shannon–Wiener index was applied to assess species diversity by considering both

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richness and distribution, while the Simpson index was used to examine the degree of dominance within the community (Magurran, 2004).

$H' = -\sum p_i \ln p_i$

$D = \sum pi^2$

In these expressions, p_i represents the proportion of individuals belonging to a particular species relative to the total number of individuals recorded in the sample. The calculated values were used to interpret diversity patterns and to compare the contribution of herbs, shrubs and trees within the study area.

STUDY AREA

The present study was carried out in Tipeshwar Wildlife Sanctuary, situated in the southeastern part of Maharashtra. The sanctuary falls within the Deccan biogeographic zone and represents a typical tropical dry deciduous forest ecosystem (Champion & Seth, 1968). Geographically, it is located between 19°50′ to 20°10′ N latitude and 77°15′ to 77°30′ E longitude, covering an area of approximately 148 km².

The region experiences a tropical monsoon climate with distinct seasonal variations, including hot summers, a well-defined monsoon period and relatively mild winters. The average annual rainfall ranges between 900 and 1100 mm, with most precipitation occurring during the southwest monsoon. The terrain is undulating, consisting of low hills, valleys and seasonal streams, which contribute to habitat heterogeneity and influence vegetation distribution (Singh & Singh, 1992).

The vegetation of the sanctuary is predominantly tropical dry deciduous forest, characterized by species such as Tectona grandis, Anogeissus latifolia, Terminalia spp. and Madhuca longifolia, which are typical of central Indian forests (Champion & Seth, 1968 & Ramakrishnan, 1988). The study recorded a rich floristic diversity comprising 192 plant species and a total of 25,460 individuals across 10 quadrats drawn in 10 different beats of sanctuary, indicating substantial variation in species composition and abundance.

The area also supports a diverse assemblage of herbs, shrubs, climbers and grasses, reflecting variations in microhabitats and disturbance gradients. Anthropogenic pressures such as grazing and periodic forest fires influence vegetation structure in certain parts of the sanctuary, leading to spatial heterogeneity in plant diversity (Ganeshaiah et al., 1997).

Table -1 Estimation of biodiversity using Shannon and Simpson indices.

S. N.	Name of Species	Family	No. of Individuals(n)	No. of Quadrat in which species occurred (n)	Shannon-Wiener's Index			Simpson's Index
					n/N	ln(n/N)	H' = n/N*ln(n/N)	D = n/N Squared
1	*Abelmoschus manihot* (L.) Medik.	Malvaceae	25	5	0.0010	-6.9260	-0.0068	0.0000009642
2	*Abelmoschus tuberculatus* Pal & Har. B. Singh	Malvaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
3	*Abutilon theophrasti* Medik.	Malvaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
4	*Achyranthes aspera* L.	Amaranthacea e	44	3	0.0017	-6.3607	-0.0110	0.0000029867

http://doi.org/10.29369/ijrbat.2026.010.2.00002

5	*Adina cordifolia* (Roxb.) Brandis	Rubiaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
6	*Aegle marmelos* (L.) Correa	Rutaceae	10	2	0.0004	-7.8423	-0.0031	0.0000001543
7	*Aeschynomene indica* L.	Fabaceae	5	1	0.0002	-8.5354	-0.0017	0.0000000386
8	*Ageratum conyzoides* L.	Asteraceae	6	1	0.0002	-8.3531	-0.0020	0.0000000555
9	*Albizia lebbeck* (L.) Benth.	Fabaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
10	*Apluda mutica L.*	Poaceae	1800	7	0.0707	-2.6493	-0.1873	0.0049983678
11	*Alternanthera sessilis* (L.) R.Br. ex DC.	Amaranthaceae	407	6	0.0160	-4.1361	-0.0661	0.0002555477
12	*Alysicarpus glumaceus* (Vahl) DC.	Fabaceae	61	2	0.0024	-6.0340	-0.0145	0.0000057404
13	*Alysicarpus ovalifolius* (Schumach.) J. Léonard	Fabaceae	42	1	0.0016	-6.4072	-0.0106	0.0000027213
14	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	275	5	0.0108	-4.5281	-0.0489	0.0001166672
15	*Ampelocissus latifolia* (Roxb.) Planch.	Vitaceae	165	3	0.0065	-5.0389	-0.0327	0.0000420002
16	*Andrographis paniculata* (Burm. f.) Wall. ex Nees	Acanthaceae	104	2	0.0041	-5.5005	-0.0225	0.0000166859
17	*Andropogon pumilus* Roxb.	Poaceae	52	1	0.0020	-6.1936	-0.0126	0.0000041715
18	*Anogeissus latifolia* (DC.) Wall. ex Guill. & Perr.	Combretaceae	39	5	0.0015	-6.4813	-0.0099	0.0000023465
19	*Aristida funiculata* Trin. & Rupr.	Poaceae	85	2	0.0033	-5.7022	-0.0190	0.0000111461
20	*Azadirachta indica* A. Juss.	Meliaceae	7	2	0.0003	-8.1990	-0.0023	0.0000000756
21	*Baliospermum montanum* (Willd.) Müll. Arg.	Euphorbiaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
22	*Bambusa bambos* (L.) Voss	Poaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
23	*Bauhinia racemosa* Lam.	Fabaceae	14	3	0.0005	-7.5058	-0.0041	0.0000003024
24	*Biophytum sensitivum* (L.) DC.	Oxalidaceae	427	8	0.0168	-4.0881	-0.0686	0.0002812801
25	*Biophytum umbraculum* Welw.	Oxalidaceae	42	1	0.0016	-6.4072	-0.0106	0.0000027213
26	*Blumea axillaris* (Lam.) DC.	Asteraceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
27	*Boerhavia erecta* L.	Nyctaginaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247

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28	*Bombax ceiba* L.	Malvaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
29	*Bonnaya ciliata* (Colsm.) Spreng.	Linderniaceae	98	2	0.0038	-5.5599	-0.0214	0.0000148161
30	*Boswellia serrata* Roxb.	Burseraceae	18	4	0.0007	-7.2545	-0.0051	0.0000004998
31	*Bothriochloa pertusa* (L.) A. Camus	Poaceae	62	1	0.0024	-6.0177	-0.0147	0.0000059302
32	*Butea monosperma* (Lam.) Taub.	Fabaceae	145	8	0.0057	-5.1681	-0.0294	0.0000324354
33	*Cajanus scarabaeoides* (L.) Thouars	Fabaceae	8	1	0.0003	-8.0654	-0.0025	0.0000000987
34	*Canscora alata* (Roth) Wall.	Gentianaceae	10	1	0.0004	-7.8423	-0.0031	0.0000001543
35	*Canthium coromandelicum* (Burm. f.) Alston	Rubiaceae	1	1	0.0000	-10.1449	-0.0004	0.0000000015
36	*Capparis sepiaria* L.	Capparaceae	2	6	0.0001	-9.4517	-0.0007	0.0000000062
37	*Cassia fistula* L.	Fabaceae	45	6	0.0018	-6.3382	-0.0112	0.0000031240
38	*Catunaregam spinosa* (Thunb.) Tirveng.	Rubiaceae	19	1	0.0007	-7.2004	-0.0054	0.0000005569
39	*Cayratia trifolia* (L.) Domin	Vitaceae	14	3	0.0005	-7.5058	-0.0041	0.0000003024
40	*Celosia argentea* L.	Amaranthaceae	138	4	0.0054	-5.2176	-0.0283	0.0000293793
41	*Chamaecrista mimosoides* (L.) Greene	Fabaceae	6	1	0.0002	-8.3531	-0.0020	0.0000000555
42	*Chamaecrista nictitans* (L.) Moench	Fabaceae	64	5	0.0025	-5.9860	-0.0150	0.0000063189
43	*Chloroxylon swietenia* (Roxb.) DC.	Rutaceae	34	7	0.0013	-6.6185	-0.0088	0.0000017834
44	*Chromolaena odorata* (L.) R.M. King & H. Rob.	Asteraceae	9	1	0.0004	-7.9476	-0.0028	0.0000001250
45	*Chrysopogon polyphyllus* (Steud.) Veldkamp	Poaceae	118	2	0.0046	-5.3742	-0.0249	0.0000214806
46	*Cissampelos pareira* L.	Menispermaceae	2	2	0.0001	-9.4517	-0.0007	0.0000000062
47	*Coccinia grandis* (L.) Voigt	Cucurbitaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
48	*Cocculus hirsutus* (L.) W. Theob.	Menispermaceae	62	6	0.0024	-6.0177	-0.0147	0.0000059302
49	*Commelina benghalensis* L.	Commelinaceae	82	2	0.0032	-5.7381	-0.0185	0.0000103732
50	*Commelina diffusa* Burm. f.	Commelinaceae	15	1	0.0006	-7.4368	-0.0044	0.0000003471

http://doi.org/10.29369/ijrbat.2026.010.2.00002

51	*Commelina hasskarlii* C.B. Clarke	Commelinacea e	6	1	0.0002	-8.3531	-0.0020	0.0000000555
52	*Corchorus aestuans* L.		8	2	0.0003	-8.0654	-0.0025	0.0000000987
53	*Corchorus olitorius* L.	Malvaceae	27	2	0.0011	-6.8490	-0.0073	0.0000011246
54	*Corchorus trilocularis* L.	Malvaceae	9	1	0.0004	-7.9476	-0.0028	0.0000001250
55	*Cordia dichotoma* G. Forst.	Boraginaceae	9	4	0.0004	-7.9476	-0.0028	0.0000001250
56	*Crotalaria hebecarpa* (DC.) Rudd	Fabaceae	15	1	0.0006	-7.4368	-0.0044	0.0000003471
57	*Crotalaria juncea* L.	Fabaceae	36	2	0.0014	-6.5613	-0.0093	0.0000019993
58	*Cryptomitrium tenerum* (Hook.) Austin ex Underw.	Aytoniaceae	52	1	0.0020	-6.1936	-0.0126	0.0000041715
59	*Cucumis melo* L.	Cucurbitaceae	2	2	0.0001	-9.4517	-0.0007	0.0000000062
60	*Cuscuta reflexa* Roxb.	Cuscutaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
61	*Cyanthillium cinereum* (L.) H. Rob.	Asteraceae	103	3	0.0040	-5.5101	-0.0223	0.0000163666
62	*Cymbopogon martinii* (Roxb.) J.F. Watson	Poaceae	53	1	0.0021	-6.1746	-0.0129	0.0000043335
63	*Cynodon dactylon* (L.) Pers.	Poaceae	2203	3	0.0865	-2.4473	-0.2118	0.0074870752
64	*Cyperus esculentus* L.	Cyperaceae	22	1	0.0009	-7.0538	-0.0061	0.0000007467
65	*Cyperus richardii* Steud.	Cyperaceae	26	1	0.0010	-6.8868	-0.0070	0.0000010429
66	*Cyperus squarrosus* L.	Cyperaceae	15	1	0.0006	-7.4368	-0.0044	0.0000003471
67	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	25	1	0.0010	-6.9260	-0.0068	0.0000009642
68	*Dalbergia lanceolaria* L. f.	Fabaceae	17	1	0.0007	-7.3117	-0.0049	0.0000004458
69	*Dalbergia latifolia* Roxb.	Fabaceae	2	4	0.0001	-9.4517	-0.0007	0.0000000062
70	*Dalbergia sissoo* DC.	Fabaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
71	*Dendrocalamus strictus* (Roxb.) Nees	Poaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
72	*Desmodium dichotomum* (Willd.) DC.	Fabaceae	5	1	0.0002	-8.5354	-0.0017	0.0000000386
73	*Desmodium procumbens* (Mill.) Hitchc.	Fabaceae	1	1	0.0000	-10.1449	-0.0004	0.0000000015

http://doi.org/10.29369/ijrbat.2026.010.2.00002

74	*Dichanthium annulatum* (Forssk.) Stapf	Poaceae	677	4	0.0266	-3.6272	-0.0964	0.0007070670
75	*Dichanthium caricosum* (L.) A. Camus	Poaceae	318	3	0.0125	-4.3828	-0.0547	0.0001560046
76	*Dichrostachys cinerea* (L.) Wight & Arn.	Fabaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
77	*Digitaria nuda* Schumach.	Poaceae	6	1	0.0002	-8.3531	-0.0020	0.0000000555
78	*Dioscorea alata* L.	Dioscoreaceae	1	1	0.0000	-10.1449	-0.0004	0.0000000015
79	*Diospyros melanoxylon* Roxb.	Ebenaceae	71	6	0.0028	-5.8822	-0.0164	0.0000077768
80	*Dolichandrone falcata* (Wall. ex DC.) Seem.	Bignoniaceae	10	1	0.0004	-7.8423	-0.0031	0.0000001543
81	*Dregea volubilis* (L. f.) Benth. ex Hook. f.	Apocynaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
82	*Eclipta prostrata* (L.) L.	Asteraceae	7	3	0.0003	-8.1990	-0.0023	0.0000000756
83	*Ehretia laevis* Roxb.	Boraginaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
84	*Eragrostis cilianensis* (All.) Vignolo ex Janchen	Poaceae	32	1	0.0013	-6.6791	-0.0084	0.0000015797
85	*Eragrostis unioloides* (Retz.) Nees ex Steud.	Poaceae	467	4	0.0183	-3.9985	-0.0733	0.0003364472
86	*Euphorbia heterophylla* L.	Euphorbiaceae	10	2	0.0004	-7.8423	-0.0031	0.0000001543
87	*Euphorbia hirta* L.	Euphorbiaceae	185	7	0.0073	-4.9245	-0.0358	0.0000527991
88	*Evolvulus alsinoides* (L.) L.	Convolvulaceae	77	4	0.0030	-5.8011	-0.0175	0.0000091467
89	*Evolvulus nummularius* (L.) L.	Convolvulaceae	15	1	0.0006	-7.4368	-0.0044	0.0000003471
90	*Ficus racemosa* L.	Moraceae	1	1	0.0000	-10.1449	-0.0004	0.0000000015
91	*Ficus virens* Aiton	Moraceae	1	1	0.0000	-10.1449	-0.0004	0.0000000015
92	*Fimbristylis dichotoma* (L.) Vahl	Cyperaceae	75	2	0.0029	-5.8274	-0.0172	0.0000086777
93	*Fimbristylis littoralis* Gaudich.	Cyperaceae	25	1	0.0010	-6.9260	-0.0068	0.0000009642
94	*Fimbristylis miliacea* (L.) Vahl	Cyperaceae	25	1	0.0010	-6.9260	-0.0068	0.0000009642
95	*Gardenia latifolia* Aiton	Rubiaceae	12	3	0.0005	-7.6600	-0.0036	0.0000002221
96	*Gomphrena serrata* L.	Amaranthaceae	28	1	0.0011	-6.8127	-0.0075	0.0000012095

http://doi.org/10.29369/ijrbat.2026.010.2.00002

97	*Grewia abutilifolia* Vent. ex Juss.		4	1	0.0002	-8.7586	-0.0014	0.0000000247
98	*Grona triflora* (L.) H. Ohashi & K. Ohashi	Fabaceae	1201	4	0.0472	-3.0540	-0.1441	0.0022252008
99	*Hemidesmus indicus* (L.) R. Br. ex Schult.	Asclepiadaceae	47	6	0.0018	-6.2947	-0.0116	0.0000034078
100	*Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult.	Poaceae	2216	3	0.0870	-2.4414	-0.2125	0.0075756990
101	*Hibiscus lobatus* (Murray) Kuntze	Malvaceae	73	6	0.0029	-5.8544	-0.0168	0.0000082211
102	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	7	2	0.0003	-8.1990	-0.0023	0.0000000756
103	*Indigofera cordifolia* Heyne ex Roth	Fabaceae	25	2	0.0010	-6.9260	-0.0068	0.0000009642
104	*Indigofera glandulosa* J.C. Wendl.	Fabaceae	114	1	0.0045	-5.4087	-0.0242	0.0000200490
105	*Ipomoea pes-tigridis* L.	Convolvulaceae	24	6	0.0009	-6.9668	-0.0066	0.0000008886
106	*Ipomoea triloba* L.	Convolvulaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
107	*Ischaemum rugosum* Salisb.	Poaceae	30	1	0.0012	-6.7437	-0.0079	0.0000013884
108	*Iseilema laxum* Hack.	Poaceae	15	1	0.0006	-7.4368	-0.0044	0.0000003471
109	*Ixora brachiata* Roxb.	Rubiaceae	6	1	0.0002	-8.3531	-0.0020	0.0000000555
110	*Justicia quinqueangularis* Koenig ex Roxb.	Acanthaceae	32	1	0.0013	-6.6791	-0.0084	0.0000015797
111	*Kydia calycina* Roxb.	Malvaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
112	*Lagascea mollis* Cav.	Asteraceae	55	2	0.0022	-6.1375	-0.0133	0.0000046667
113	*Lagerstroemia parviflora* Roxb.	Lythraceae	22	1	0.0009	-7.0538	-0.0061	0.0000007467
114	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	11	1	0.0004	-7.7470	-0.0033	0.0000001867
115	*Lantana camara* L.	Verbenaceae	69	7	0.0027	-5.9108	-0.0160	0.0000073448
116	*Leucaena leucocephala* (Lam.) de Wit	Mimosaceae	6	1	0.0002	-8.3531	-0.0020	0.0000000555
117	*Ludwigia octovalvis* (Jacq.) P.H. Raven	Onagraceae	76	3	0.0030	-5.8141	-0.0174	0.0000089107
118	*Mangifera indica* L.	Anacardiaceae	5	2	0.0002	-8.5354	-0.0017	0.0000000386
119	*Maytenus senegalensis* (Lam.) Exell	Celastraceae	25	6	0.0010	-6.9260	-0.0068	0.0000009642

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120	*Melinis repens* (Willd.) Zizka	Poaceae	5	1	0.0002	-8.5354	-0.0017	0.0000000386
121	*Melochia corchorifolia* L.	Malvaceae	5	1	0.0002	-8.5354	-0.0017	0.0000000386
122	*Merremia gangetica* (L.) Cufod.	Convolvulaceae	10	2	0.0004	-7.8423	-0.0031	0.0000001543
123	*Mesosphaerum suaveolens* (L.) Kuntze	Lamiaceae	898	9	0.0353	-3.3447	-0.1180	0.0012440444
124	*Mimosa hamata* Willd.	Fabaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
125	*Mitracarpus hirtus* (L.) DC.	Rubiaceae	35	1	0.0014	-6.5895	-0.0091	0.0000018898
126	*Mitragyna parvifolia* (Roxb.) Korth.	Rubiaceae	33	1	0.0013	-6.6484	-0.0086	0.0000016800
127	*Morinda tinctoria* Roxb.	Rubiaceae	3	1	0.0001	-9.0463	-0.0011	0.0000000139
128	*Murdannia nudiflora* (L.) Brenan	Commelinaceae	72	1	0.0028	-5.8682	-0.0166	0.0000079974
129	*Ocimum americanum* L.	Lamiaceae	28	2	0.0011	-6.8127	-0.0075	0.0000012095
130	*Oldenlandia corymbosa* L.	Rubiaceae	78	2	0.0031	-5.7882	-0.0177	0.0000093858
131	*Oplismenus burmannii* (Retz.) P. Beauv.	Poaceae	7205	7	0.2830	-1.2623	-0.3572	0.0800849985
132	*Oplismenus hirtellus* (L.) P. Beauv.	Poaceae	210	1	0.0082	-4.7978	-0.0396	0.0000680333
133	*Parthenium hysterophorus* L.	Asteraceae	12	1	0.0005	-7.6600	-0.0036	0.0000002221
134	*Pennisetum pedicellatum* Trin.	Poaceae	134	2	0.0053	-5.2470	-0.0276	0.0000277008
135	*Pergularia daemia* (Forssk.) Chiov.	Apocynaceae / Asclepiadaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
136	*Phyllanthus amarus* Schumach. & Thonn.	Phyllanthaceae	32	1	0.0013	-6.6791	-0.0084	0.0000015797
137	*Phyllanthus emblica* L.	Phyllanthaceae	5	2	0.0002	-8.5354	-0.0017	0.0000000386
138	*Phyllanthus tenellus* Roxb.	Phyllanthaceae	112	3	0.0044	-5.4264	-0.0239	0.0000193517
139	*Phyllanthus urinaria* L.	Phyllanthaceae	82	6	0.0032	-5.7381	-0.0185	0.0000103732
140	*Phyllanthus virgatus* G. Forst.	Phyllanthaceae	66	4	0.0026	-5.9552	-0.0154	0.0000067200
141	*Physalis angulata* L.	Solanaceae	18	3	0.0007	-7.2545	-0.0051	0.0000004998
142	*Physalis minima* L.	Solanaceae	6	1	0.0002	-8.3531	-0.0020	0.0000000555

http://doi.org/10.29369/ijrbat.2026.010.2.00002

143	*Pleurolobus gangeticus* (L.) J. St.-Hil. ex H. Ohashi & K. Ohashi	Fabaceae	130	6	0.0051	-5.2773	-0.0269	0.0000260717
144	*Poa trivialis* L.	Poaceae	60	1	0.0024	-6.0505	-0.0143	0.0000055537
145	*Pombalia parviflora* (L. f.) Paula-Souza	Violaceae	10	1	0.0004	-7.8423	-0.0031	0.0000001543
146	*Pongamia pinnata* (L.) Pierre	Fabaceae	6	1	0.0002	-8.3531	-0.0020	0.0000000555
147	*Porana racemosa* Roxb.	Convolvulaceae	1	1	0.0000	-10.1449	-0.0004	0.0000000015
148	*Psoralea corylifolia* L.	Fabaceae	6	1	0.0002	-8.3531	-0.0020	0.0000000555
149	*Rhynchosia minima* (L.) DC.	Fabaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
150	*Ruellia prostrata* Poir.	Acanthaceae	51	1	0.0020	-6.2130	-0.0124	0.0000040126
151	*Rungia pectinata* (L.) Nees	Acanthaceae	100	2	0.0039	-5.5397	-0.0218	0.0000154271
152	*Rungia repens* (L.) Nees	Acanthaceae	50	2	0.0020	-6.2328	-0.0122	0.0000038568
153	*Scleria parvula* Steud.	Cyperaceae	26	2	0.0010	-6.8868	-0.0070	0.0000010429
154	*Securinega virosa* (Roxb. ex Willd.) Baill.	Phyllanthaceae	8	1	0.0003	-8.0654	-0.0025	0.0000000987
155	*Sehima nervosum* (Rottler) Stapf	Poaceae	12	1	0.0005	-7.6600	-0.0036	0.0000002221
156	*Senegalia catechu* (L. f.) P.J.H. Hurter & Mabb.	Fabaceae	36	4	0.0014	-6.5613	-0.0093	0.0000019993
157	*Senna tora* (L.) Roxb.	Caesalpinaceae	261	9	0.0103	-4.5803	-0.0470	0.0001050907
158	*Sesamum alatum* Thonn.	Pedaliaceae	30	1	0.0012	-6.7437	-0.0079	0.0000013884
159	*Sesbania bispinosa* (Jacq.) W. Wight	Fabaceae	11	1	0.0004	-7.7470	-0.0033	0.0000001867
160	*Setaria italica* (L.) P. Beauv.	Poaceae	27	2	0.0011	-6.8490	-0.0073	0.0000011246
161	*Setaria pumila* (Poir.) Roem. & Schult.	Poaceae	35	3	0.0014	-6.5895	-0.0091	0.0000018898
162	*Sida cordata* (Burm. f.) Borss. Waalk.	Malvaceae	147	7	0.0058	-5.1544	-0.0298	0.0000333363
163	*Sida cordifolia* L.	Malvaceae	126	3	0.0049	-5.3086	-0.0263	0.0000244920
164	*Solidago gigantea* Aiton	Asteraceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
165	*Soymida febrifuga* (Roxb.) A. Juss.	Meliaceae	10	1	0.0004	-7.8423	-0.0031	0.0000001543

http://doi.org/10.29369/ijrbat.2026.010.2.00002

166	*Spermacoce hispida* L.	Rubiaceae	25	1	0.0010	-6.9260	-0.0068	0.0000009642
167	*Sporobolus indicus* (L.) R. Br.	Poaceae	128	2	0.0050	-5.2928	-0.0266	0.0000252757
168	*Striga angustifolia* (D. Don) C.J. Saldanha	Orobanchaceae	25	1	0.0010	-6.9260	-0.0068	0.0000009642
169	*Strophostyles helvola* (L.) Elliott	Fabaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
170	*Synedrella nodiflora* (L.) Gaertn.	Asteraceae	30	2	0.0012	-6.7437	-0.0079	0.0000013884
171	*Tamarindus indica* L.	Fabaceae	8	2	0.0003	-8.0654	-0.0025	0.0000000987
172	*Tectona grandis* L. f.	Lamiaceae	379	10	0.0149	-4.2073	-0.0626	0.0002215958
173	*Tephrosia purpurea* (L.) Pers.	Fabaceae	6	1	0.0002	-8.3531	-0.0020	0.0000000555
174	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	8	3	0.0003	-8.0654	-0.0025	0.0000000987
175	*Terminalia elliptica* Willd.	Combretaceae	36	1	0.0014	-6.5613	-0.0093	0.0000019993
176	*Themeda quadrivalvis* (L.) Kuntze	Poaceae	915	3	0.0359	-3.3259	-0.1195	0.0012915921
177	*Tinospora cordifolia* (Willd.) Hook. f. & Thomson	Menispermaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
178	*Trichodesma zeylanicum* (Burm. f.) R. Br.	Boraginaceae	22	3	0.0009	-7.0538	-0.0061	0.0000007467
179	*Tridax procumbens* L.	Asteraceae	111	6	0.0044	-5.4353	-0.0237	0.0000190077
180	*Triumfetta rhomboidea* Jacq.	Malvaceae /	61	5	0.0024	-6.0340	-0.0145	0.0000057404
181	*Vachellia leucophloea* (Roxb.) Maslin, Seigler & Ebinger	Fabaceae	48	7	0.0019	-6.2737	-0.0118	0.0000035544
182	*Vachellia nilotica* (L.) P.J.H. Hurter & Mabb.	Fabaceae	8	3	0.0003	-8.0654	-0.0025	0.0000000987
183	*Ventilago denticulata* Willd.	Rhamnaceae	11	3	0.0004	-7.7470	-0.0033	0.0000001867
184	*Vicia bithynica* (L.) L.	Fabaceae	2	1	0.0001	-9.4517	-0.0007	0.0000000062
185	*Vicia tetrasperma* (L.) Schreb.	Fabaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
186	*Vicoa indica* (L.) DC.	Asteraceae	4	2	0.0002	-8.7586	-0.0014	0.0000000247
187	*Vigna radiata* (L.) R. Wilczek	Fabaceae	6	3	0.0002	-8.3531	-0.0020	0.0000000555
188	*Zinnia elegans* Jacq.	Asteraceae	16	1	0.0006	-7.3723	-0.0046	0.0000003949

http://doi.org/10.29369/ijrbat.2026.010.2.00002

189	*Ziziphus jujuba* Mill.	Rhamnaceae	9	4	0.0004	-7.9476	-0.0028	0.0000001250
190	*Ziziphus mauritiana* Lam.	Rhamnaceae	4	1	0.0002	-8.7586	-0.0014	0.0000000247
191	*Ziziphus oenopolia* (L.) Mill.	Rhamnaceae	17	5	0.0007	-7.3117	-0.0049	0.0000004458
192	*Ziziphus xylopyrus* (Retz.) Willd.	Rhamnaceae	9	2	0.0004	-7.9476	-0.0028	0.0000001250
		N =	25460				-3.2467	0.1078287892
					Sum of all n/N*ln(n/N)= -3.2467			**Sum of n/N Squared for all = 0.1078287**
					Take negative of it! H' = 3.2467			**= 1-Sum of n/N Squared for all (D)= 0.8921713**

Table -2 Overview of key diversity measures showing species composition and distribution in the sampled quadrats.

Sr. No.	Parameter / Index	Symbol / Formula	Value
1	Total number of quadrats studied	Q	10
2	Total number of species	S	192
3	Total number of individuals	N	25,460
4	Sum of proportions	$\sum (n/N)$	1.0000
5	Sum of (n/N × ln n/N)	$\sum p_i \ln p_i$	-3.2467
6	Shannon–Wiener Index	$H' = -\sum p_i \ln p_i$	3.2467
7	Sum of squared proportions	$\sum (n/N)^2$	0.1078
8	Simpson's Index (Dominance)	$D = \sum (n/N)^2$	0.1078
9	Simpson's Diversity Index	1 – D	0.8922

RESULTS AND DISCUSSION:

Given its ecological importance and variability in environmental conditions, Tipeshwar Wildlife Sanctuary provides an ideal setting for studying plant diversity patterns. The application of Shannon and Simpson diversity indices in this region offers valuable insights into community structure and helps in understanding ecological dynamics for effective conservation and management planning (Magurran, 2004 & Morris et al., 2014).

Field observations from Tipeshwar Wildlife Sanctuary revealed noticeable differences among trees, shrubs and herbs in terms of their presence, distribution and ecological roles. The dataset comprised 192 plant species with a total count of 25,460 individuals recorded from 10 quadrats, indicating that the area supports a fairly rich and varied plant community. Even though all three life forms contribute to overall diversity, their relative importance varies across the vegetation layers.

http://doi.org/10.29369/ijrbat.2026.010.2.00002

At ground level, herbaceous species were clearly the most prominent, both in number of species and total individuals. Grasses and other herb forms, especially from Poaceae and Asteraceae, were widely distributed, often occupying open patches and disturbed sites. Their dominance appears to be closely linked with factors such as light availability, seasonal moisture and recurring disturbances like grazing. This strong herb presence is reflected in the relatively high Shannon value (H′ = 3.2467), suggesting that species are not only numerous but also fairly evenly represented. In contrast, shrubs occurred less uniformly. They were scattered and often restricted to certain patches, particularly in areas where partial shade or specific soil conditions prevailed. Their intermediate position in the vegetation profile seems to be influenced by both the overstory trees and the dense herb layer beneath, which together regulate space and resources (Ramakrishnan, 1988).

Tree species, although fewer in number compared to herbs, were more consistent in their occurrence and formed the main structural component of the forest. Species such as *Tectona grandis*, *Anogeissus latifolia* and *Terminalia* spp. were commonly observed and are typical of dry deciduous forests in central India (Champion & Seth, 1968). Unlike herbs, which tend to respond quickly to short-term environmental changes, trees reflect longer-term ecological conditions and stability (Singh & Singh, 1992). Their distribution across the study sites suggests that the forest retains characteristics of a relatively stable system despite visible human influence in some areas.

When all three life forms are considered together, a clear pattern emerges: herbs dominate in terms of abundance and rapid response to environmental conditions, shrubs occupy a transitional role with moderate presence and trees provide long-term structure and continuity. The Simpson index value (1–D = 0.8921) further indicates that no single species overwhelmingly dominates the community, pointing to a fairly balanced ecosystem. Such a distribution pattern suggests that different plant groups coexist without strong competitive exclusion.

Overall, the vegetation structure observed in the sanctuary reflects a combination of natural ecological processes and localized disturbances. Comparable patterns have been noted in other Indian forest regions, where herb layers expand under open or disturbed conditions, shrubs occupy intermediate niches and trees represent the more stable component of the ecosystem (Misra, 1968; Morris et al., 2014). Looking at these layers together provides a clearer understanding of how plant diversity is organized and maintained in this landscape.

Acknowledgement

The authors express their sincere gratitude to the Principal of their institution for continuous support and encouragement throughout the course of this work. The academic environment provided by the institution greatly contributed to the successful completion of the study. The authors are also thankful to the officials of the Maharashtra Forest Department for granting permission to conduct field investigations in Tipeshwar Wildlife Sanctuary. The cooperation and assistance extended by the field staff during data collection are deeply appreciated. The authors further acknowledge the support and help received from colleagues and well-wishers during the course of this study.

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