Variations in Herbaceous Composition of Dry Tropics Following Anthropogenic Disturbed Environment

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ABSTRACT

Present study was carried out at Bhoramdeo Wildlife Sanctuary of Chhattisgarh with the objective to assess the composition, structure and diversity of herb layer. Three circle of Kawardha forest division were selected, comprising of three disturbance gradients *i.e.*, heavily disturbed, moderately disturbed and lightly disturbed site, respectively in each circle. Stratified random sampling was opted to measure the herbaceous vegetation. A total of 39, 39 and 33 herbs species were recorded under Bhoramdeo circle, Jamunpani circle and Salehwara circle, respectively. The total density of herbs was varied from 67800-146900 individuals ha⁻¹ in Bhoramdeo circle, 70700-108700 individuals ha⁻¹ in Jamunpani circle and 72000-119200 individuals ha⁻¹ in Salehwara circle. The diversity indices showed that Shannon index value for herb layer in different forest circle along the disturbance gradient varied from 2.50 to 4.25, concentration of dominance (Cd) 0.06 to 0.37, species richness 1.35 to 2.19, equitability 0.76 to 1.34 and beta diversity 1.44 to 2.44. The experimental results clearly indicated that anthropogenic disturbances cause significant impact on ground flora in different circles.

Key words: Composition, Circle, Disturbances, Diversity indices, Herb.

INTRODUCTION

In many forest ecosystems, herbaceous vegetation is key strata and share to largest proportion of species diversity. The changes in herb layer occurred with topographic heterogeneity and biotic disturbances and harbor the majority of plant diversity in deciduous forests ecosystem^{1,2}. Any kind of disturbances resulted to degradation of habitats, especially herbaceous vegetation, which is essential for regulating nutrient cycling as well as ecological balance. The herbaceous species are capable to modify the site conditions to some extent. The composition and luxuriance of ground vegetation in degraded ecosystem are mainly depends upon the secondary site conditions³. The composition of herbaceous layer is varied continuously in space and time due to multiple factors such as fire4 land use change, grazing, anthropogenic disturbances⁵, local weather, rainfall, moisture and soil fertility⁶. Herbaceous vegetation is also affected by both natural and anthropogenic disturbances. Alteration in tree canopy due to tree falls, wildfire, harvesting, illicit felling are tends to moderate to large increases in resource availability^{7,8}. However, disturbances in low severity usually cause little damage to overstorey trees9 but affect ground vegetation directly by shifting the habitat available resources^{10,11}. The disturbances with high severity generate relatively homogeneous resource availability while low to moderate severity disturbances partially remove the canopy and generally result in greater resource heterogeneity¹². Anthropogenic disturbances in forests followed by livestock grazing and forest fire adversely affected the composition of herbaceous vegetation^{13,14}, it is therefore imperative to conserve the herbaceous vegetation of these sites. Hence, present study attempts to assess the composition and diversity of herbs following anthropogenic disturbance.

MATERIALS AND METHODS

The present experiment was executed in the Bhoramdeo Wildlife Sanctuary, located in Kabirdham district. It occupies a special position from biodiversity and tourism point of view. The natural forest of Kawardha (Chhattisgarh) adjacent to Kanha National Park (M.P.) is one of the important natural heritage sites of Central India. It is well known for its rich, complex and diverse flora and fauna¹⁵. The study site is located between 21°23'- 22°00' North latitude and 80°58'- 82°34' East longitudes. The topography is hilly which falls in the Maikal Range of the Satpura hills. The altitude ranges from 600 to 900 m from the sea level and climate is dry tropical with annual average rainfall of 1250-1380 mm. Different types of forest vegetation occur in the study area13. Northern and Eastern directions covered with luxuriant forests, whereas Teak plantations mainly occupy in Southern direction. The Western direction covered by degraded and mixed forest and also with bamboo brakes. The herbs widely found in this sanctuary are Achyranthus aspera inn., Apluda mutica Hack., Crotalaria calycina Schrank., Desmodium pulchellum (L) Benth., Eragrostis tenella Linn., Ischaemum pilosum Klein ex Willd., Paspalidium flavidum (Retz.) A.Camus, Tridax procumbens Linn. etc.¹⁵.

The study on herbaceous diversity along the disturbance gradient of tropical dry deciduous forest was done after the repeated reconnaissance survey of sanctuary area. Three circles viz., Bhoramdeo, Jamunpani and Salehwara were selected for the present study. In each of these circles, three disturbance gradients *i.e.*, heavily, moderately and lightly disturbed site were identified following Kumar and Ram¹⁶. The herbaceous vegetation was measured within 1m x 1m quadrat. The vegetational data were quantitatively analysed for frequency, density and abundance¹⁷. The importance value index was calculated followed Phillips¹⁸. Simpson index¹⁹ was used for concentration of dominance and Margalef index²⁰ for species richness. Diversity indices were calculated following Sagar and Singh²¹. A/F ratio (abundance to frequency) for different species was determined by eliciting the distribution pattern. The data was analysed in one-way analysis of variance. The significant differences between treatment means of all parameters were tested following Snedecor and Cochran²².

RESULTS AND DISCUSSION

Bhoramdeo circle

Herb density (Table 1) was maximum on heavily disturbed site and minimum on lightly disturbed site. The density of individual species were ranged from 200-86500 individuals ha-1 for heavily disturbed site, 600-40700 individuals ha-1 for moderately disturbed site and 400-22400 individuals ha⁻¹ for lightly disturbed site. Setaria spp. and *Xanthium Strumarium* showed highest frequency in highly disturbed site and Coriandrum sativum, Desmodium pulchellum, Lavandula bipinnata, Oscium gratissimum, Setaria spp. and Sida cordata in moderately disturbed site, whereas Coriandrum sativum, Imperata cylindrical, Ishaemum pilosum, Oscium gratissimum and Saccharum spontaneum in lightly disturbed site. Abundance to Frequency ratio (A/F) was ranged from 0.07 to 0.90 in highly disturbed site which indicated that most of the species were disturbed contagiously and randomly. In moderately disturbed site A/F value was 0.05 to 0.42 which revealed that most of the species performed contagious distribution pattern while a few species were distributed randomly. Under the lightly disturbed site A/F ratio varied from 0.01 to 1.60 and showed that Asparagus resimosus only disturbed regularly on the site and rest of the species randomly and contagiously. The IVI values in Bhoramdeo circle across the disturbance gradient were ranged from 2.12-103.78. The dominant species of herbs on heavily disturbed was Setaria spp. Dominant species on moderately disturbed site was Lavandula bipinnata and on lightly disturbed site Saccharum spontaneum was the dominant species. Analysis of variance indicated that the three sites differed significantly in the herb density (p<0.01). Along the disturbance gradient in Bhoramdeo circle the value of Shannon index ranged from 2.50-3.18, concentration of dominance from 0.16-0.37, species richness from 1.35-2.19, equitability value from 0.76-1.11 and beta diversity from 1.44-2.44, respectively (Table 4).

Jamunpani circle

Under Jamunpani circle herb density was maximum in heavily disturbed site and minimum in

Species		Heav	Heavily disturbed site	bed site			Mode	Moderately disturbed site	sturbed (site		Light	Lightly disturbed site	bed site	
	Ц	٥	A	A/F	≥	 Ц	٥	A	A/F	Σ	ш	٥	A	A/F	Σ
Achyranthus	10	600	6.00	09.0	3.90	50	1200	2.40	0.05	6.71	30	600	2.00	0.07	6.08
<i>aspra</i> L.															
Andrographis paniculata	30	600	2.00	0.07	4.86										
(Burm F.)Wallich															
Apluda mutica L.	10	800	8.00	0.80	4.79										
Asparagus resimosus .											60	400	0.67	0.01	8.13
Willd															
<i>Cassia absus</i> L.											10	1600	16.00	1.60	17.15
<i>Cassia tora</i> L.	30	6500	21.67	0.72	16.28										
Chrolophytum tuberosum	20	600	3.00	0.15	4.01										
(Roxb.) Baker															
Corchorus capsularis L.						80	7600	9.50	0.12	18.20	20	2400	12.00	0.60	16.08
Corchorus aquitans L.	10	600	6.00	0.60	3.90										
Coriandrum sativum L.	60	2900	4.83	0.08	11.20	100	10800	10.80	0.11	23.06	100	8400	8.40	0.08	31.17
Curculigo serratum	20	400	2.00	0.10	3.49						40	1200	3.00	0.08	8.98
Cynthocline purpurea	10	800	8.00	0.80	4.79										
Buch.Ham.															
Cyprus exaltatus Rottb.	10	200	2.00	0.20	2.12										
Desmodium macrophyllum					30	3800	12.67	0.42	12.88						
(Thumb)DC															
Desmodium	30	1500	5.00	0.17	6.61	100	6700	6.70	0.07	17.67	20	1600	8.00	0.40	11.50
pulchellum (L.)															
Dioscorea bulbifera L.											70	3200	4.57	0.07	16.75
Eragrostis japonica	20	400	2.00	0.10	3.49										
(Thunb.)Trin.															
Imperata cylindrica (L.)											100	4600	4.60	0.05	22.33
Ishaemum pilosum											100	4000	4.00	0.04	20.93
Hack.															
Knoxia sumatrensis	10	006	9.00	0.90	5.23										

Table 1: Species structure of herb layer along the disturbance gradient in Bhoramdeo circle of Bhoramdeo Wildlife Sanctuary

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Table 1. Continues (Retz.)DC.															
Lavandula bipinnata (Roth)						100	40700	40.70	0.41	62.41					
Limnophila sessilifora (Vahl.)Blume.						30	1200	4.00	0.13	5.88					
Malvestrum	70	13000	18.57	0.27	24.48	20	600	3.00	0.15	3.97					
coromandelicum (L.)															
Mimosa pudica L.	40	2300	5.75	0.14	8.67										
Oscium gratissimum L.	40	8200	20.50	0.51	18.24	100	29900	29.90	0.30	48.20	100	12800	12.80	0.13	41.41
Paspalidium flavidum	20	1500	20	0.38	6.31										
(Retz)A. Camus															
Perotis hordeiformis	10	600	6.00	0.60	3.90										
<i>Phyllanthus</i> urinaria L.	40	3200	8.00	0.20	10.13	70	3400	4.86	0.07	11.53	20	2200	11.00	0.55	14.94
Polygala furcata Royle	20	400	2.00	0.10	3.49	50	1400	2.80	0.06	7.09	30	1200	4.00	0.13	8.66
Rumex dentatus	10	400	4.00	0.40	3.01										
auct.non L.															
Saccharum .											100	22400	22.40	0.22	63.74
spontaneum L															
Setaria spp.	100	86500	86.50	0.87	103.78	100	13600	13.60	0.14	26.75					
Sida cordata (Burm.f.)	20	1200	6.00	0.30	5.54	100	8200	8.20	0.08	19.64	30	600	2.00	0.07	6.08
Borss.															
Tacca leontopetaloides	20	1200	6.00	0.30	5.54										
(L.) Kuntze															
Toningia cucullata	20	600	3.00	0.15	4.01	40	1400	3.50	0.09	6.62					
Kuntze.															
Tridex procumben L.						50	1800	3.60	0.07	7.85					
Uraria lagopus DC.						50	1800	3.60	0.07	7.85					
<i>Vigna pilosa</i> Willd.	30	600	2.00	0.07	4.86	20	600	3.00	0.15	3.97					
Xanthium strumarium	100	10400	10.40	0.10	23.34	40	2800	7.00	0.18	9.70	90	600	2.00	0.07	6.08
Boiss.															
Total	810	146900	265.72	9.67	300	1130	137500	169.82	2.65	300	860	67800	117.44	4.16	300
F, D, A, A/F and IVI respectively, are frequency	, are freq		ercentage	, density	in percentage, density (individuals ha"i), abundance, abundance/frequency and Importance Value Index	s ha"¹), al	bundance,	abundan	ce/freque	ncy and Ir	nportanc	e Value In	dex.		

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ellum (L.) orea glabra 3.33 0.11	oulchellum (L.) Dioscorea glabra		40		5.25	0.13	10.52	50	2800	5.60	0.11	12.15	
orea glabra 3.0 1000 3.33 0.11	Dioscorea glabra												
			30		3.33	0.11	6.66						

Table 2: Species structure of herb layer along the disturbance gradient in Jamunpani circle of Bhoramdeo Wildlife Sanctuary

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Echinochloa colonum (L.) Link Euphorbia 50 2400 4.80 0.1 heterophylla L 50 1800 3.60 0.0 hypericifolia L. 40 1800 4.50 0.1 nummularius L.	0.10 0.07 0.11	8.78 7.67 7.22						00	2300	3.83	0.0	12.11
a 70 6600 9.00 a 70 6600 9.43 a 10 1500 15.00	0.23 0.13 1.50	10.96 16.53 9.20			4.00	0.10	8.96					
Malvestrum 70 4600 6.57 0.0 coromandelicum (L.) 40 2800 7.00 0.1 Mimosa pudica L. 40 2800 7.00 0.1 Oscium gratissimum L. 80 10200 12.75 0.1 Parthenium 20 1000 5.00 0.2	0.09 0.18 0.16 0.25	13.36 9.30 22.25 4.98	40 40 40 40 40 40 40 40 40 40 40 40 40 4	1400 (1400 (1400 (1400) (14000) (14000) (14000) (14000) (1400) (1	3.50 3.50 23.33	0.09 0.09 0.39	8.33 8.33 41.68	80	5600	7.00	0.09	19.23
<i>ria</i> L. 30 800 2.67	0.09	4.58	50 2	2000	4.00	0.08	10.51	60 50	2600 1600	4.33 3.20	0.07 0.06	11.92 8.99
. 70 8600 12.29 a (Burm.f.) 40 4300 10.75 ina maxima	0.18 0.27	19.69 12.41	30 11	800 2	22.00 2.67	0.28 0.09	47.84 5.92	80 50 40	41100 1300 1200	51.38 2.60 3.00	0.64 0.05 0.08	92.83 8.19 7.43
2500 5.00	010	90 00 00	20	4000 2	20.00	1.00	21.30	30 30	900	3.33	0.10	6.14 6.50
lasne 20 1200 6.00 um. 60 5700 9.50	0.30	5.62 14.86	20 20 20	200 200	2.00 2.00 4.00	0.10 0.07 0.08	3.91 5.19 10.51	90 90	1600 6200	3.20 6.89	0.06	8.99 20.78
Total 1150 108700 215.84 5.80 300 1010 70700 146.39 3.78 300 1050 88600 132.33 2 F, D, A, AF and IVI respectively, are frequency in percentage, density (individuals ha?1), abundance, abundance/frequency and Importance Value Index	5.80 centage, d	300 1 ensity (indiv	1010 70 viduals ha?	70700 14 a?1), abuno	146.39 ndance, at	3.78 oundance	300 //frequency	1050 y and Im	88600 portance \	132.33 /alue Inde	2.17 ex	300

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species		Heavily		disturbed site			Mod	erately di	Moderately disturbed site	site		Ligh	Lightly disturbed site	bed site	
	ц	٩	A	A/F	Σ	ш	٥	A	A/F	Σ	LL	٩	A	A/F	Σ
Achyranthus	60	4600	7.67	0.13	15.08	30	1200	4.00	0.13	7.45					
aspra L.															
Ageratum	60	3600	6.00	0.10	13.19	50	4100	8.20	0.16	16.33					
conyzoides L.															
Apluda mutica L.											50	4200	8.40	0.17	18.26
Asparagus						20	400	2.00	0.10	3.96	30	400	1.33	0.04	4.83
resimosus Willd.															
Cassia tora L.	100	17400	17.40	0.17	36.21	50	9600	19.50	0.38	31.54					
Cenchrus						40	2200	5.50	0.14	10.86	60	3000	5.00	0.08	14.71
setigerus Vahl.															
Clerodendrum	20	300	1.50	0.08	3.33										
serratum (L.)Moon															
Conyza stricta Willd.											40	1600	4.00	0.10	9.83
Coriandrum sativum L.											70	3300	4.71	0.07	15.93
Crotalaria albida											60	2600	4.33	0.07	13.59
Heyne ex .Roth															
Curculigo serratum	50	2000	4.00	0.08	9.52	30	500	1.67	0.06	4.86					
Curcuma aromatica Salihs						20	400	2.00	0.10	3.96					
Cvnrus procerous						60	3400	5.67	0.09	14.59					
Rottb						0) -)								
Desmodium	50	4900	9.80	0.20	15.61	50	1400	2.80	0.06	8.87					
macrophyllum /Thumb)DC															
Desmodium	60	4800	8.00	0.13	15.46	50	1600	3.20	0.06	9.42					
pulchellum (L.)	}														
Echnochloa colonnm	20	0001	8 A0	1	~ ~ ~ ~										

Table 3. Continues															
Eragrostis atrovirens (Deef) Trin ev Steud						50	6400	12.80	0.26	22.69	50	2300	4.60	0.09	12.36
Evolvulus						60	3200	5.33	0.09	14.09					
nummularius (L.) Fimbristvlis dichotoma											60	5200	8.67	0.14	20.92
auct.non Vahl.											8				
Imperata						30	1200	4.00	0.13	7.45	80	3000	3.75	0.05	15.72
cylindrica (L.)															
Iphigenia indica											80	5000	6.25	0.08	20.65
(L.)A.gray															
Malvestrum	50	2100	4.20	0.08	9.73	80	4500	5.63	0.07	18.04					
coromandelicum (L.)															
Mimosa pudica L.	40	1000	2.50	0.06	6.67	60	2000	3.33	0.06	11.05					
Oscium gratissimum L.	60	3900	6.50	0.11	13.75	50	3000	6.00	0.12	13.29	60	1800	3.00	0.05	11.33
Paspalidium flavidum										60	9800	16.33	0.27	33.90	
(Retz)A. Camus															
Perotis hordeiformis											50	2000	4.00	0.08	11.42
Phyllanthus urinaria L.	30	500	1.67	0.06	4.66	40	1000	2.50	0.06	7.12	40	1400	3.50	0.09	9.12
Rumex dentatus	50	1200	2.40	0.05	7.84	30	800	2.67	0.09	5.97					
auct.non L.															
Setaria glauca	60	9200	15.33	0.26	23.77	60	3600	6.00	0.10	15.10	70	3100	4.43	0.06	15.40
(L.)P.Beauv.															
Setaria spp.	100	55800	55.80	0.56	92.64	20	18300	26.14	0.37	50.15	70	22900	32.71	0.47	67.21
Sida cordata	50	1400	2.80	0.06	8.26										
(Burm.f.) Borss.															
Toningia cucullata						20	200	1.00	0.05	2.98	30	400	1.33	0.04	4.83
Kuntze.															
Xanthium strumarium	50	2300	4.60	0.09	10.15	50	5500	11.00	0.22	20.20					
Boiss.															
Total	940	119200	158.57	2.37	300	1000	74500	140.63	2.91	300	960	72000	116.36	1.96	300
F, D, A, A/F and IVI respectively, are frequency in percentage, density (individuals ha?1), abundance, abundance/frequency and Importance Value Index	ctively, ar	e frequen	cy in perce	∋ntage, d€	∋nsity (indi	ividuals h	ia?1), abui	ndance, a.	bundance	e/frequency	y and Im	portance ¹	/alue Inde	×	

Circles	Shannon index (H')	Simpson's index (Cd)	Species richness (d)	Equitability (e)	Beta diversity
		Не	avily Disturbed S	Site	
Bhoramdeo	2.50	0.37	2.19	0.76	1.44
Jamunpani	4.25	0.06	1.98	1.34	1.67
Salehwara	2.81	0.26	1.37	0.99	1.94
		Mod	erately Disturbed	I Site	
Bhoramdeo	3.18	0.16	1.44	1.10	2.17
Jamunpani	3.71	0.12	2.06	1.17	1.67
Salehwara	3.75	0.23	1.87	1.21	1.50
		Lig	ghtly Disturbed S	lite	
Bhoramdeo	3.08	0.17	1.35	1.11	2.44
Jamunpani	3.08	0.24	1.58	1.05	2.11
Salehwara	3.40	0.15	1.43	1.20	1.94

Table 4: Diversity pattern of herb layers along the disturbance gradient in forest circle of Bhoramdeo Wildlife Sanctuary

moderately disturbed site (Table 2). The density of individual species in highly disturbed site was 800-12700 individuals ha-1, 200-17600 individuals ha-1 in moderately disturbed site and 800-41100 individuals ha-1 in lightly disturbed site. The maximum frequency value was represented by Coriandrum sativum in highly disturbed site, by Setaria spp. in moderately disturbed site and Xanthium strumarium in lightly disturbed site. A/F value and IVI value in this circle across the disturbance gradient were ranged from 0.03 to 1.50 and 3.91 to 92.83, respectively. The dominant species of herbs on heavily disturbed was Coriandrum sativum, Oscium gratissimum and Achyranthus aspra. Dominant species on moderately disturbed site was Setaria spp. and Oscium gratissimum. On lightly disturbed site Setaria spp. was the dominant species. Analysis of variance indicated that the three sites differed significantly (p<0.05) in the herb density. The diversity indices in Jamunpani circle (Table 4) along the disturbance gradient shows that the value of Shannon index varied from 3.08-4.25, concentration of dominance 0.06-0.24, species richness 1.58-2.06, equitability 1.05-1.34 and beta diversity values from 1.67-2.11.

Salehwara circle

In this circle the density of herb (Table 3) was maximum in heavily disturbed site and minimum in lightly disturbed site showing same trend as in

Bhoramdeo circle. The density of individual species were ranged from 300-55800 individuals ha-1 on heavily disturbed site, 200-18300 individuals ha-1 on moderately disturbed site and 400-22900 individuals ha-1 on lightly disturbed site. The highest frequency value is achieved by Cassia tora and Setaria spp. under highly disturbed site, Malvestrum coromandelicum under moderately disturbed site whereas in lightly disturbed site by Imperata cylindrica and Iphigenia indica, respectively. The value of A/F ratio and IVI were ranged from 0.04 to 0.56 and 2.98 to 92.64, respectively in this circle across the disturbance gradient. The dominant species of herbs on heavily disturbed was Setaria spp. and Cassia tora. Dominant species on moderately disturbed site was Setaria spp., Cassia tora and Eragrotis atrovirens. On lightly disturbed site Setaria spp., Paspalidium flavidum and Fimbrystylis dichotoma was the dominant species. Analysis of variance indicated that three sites differed significantly in herb density (p<0.01). In Salehwara circle the value of Shannon index were ranged from 2.81-3.75, concentration of dominance from 0.15-0.26, richness from 1.37-1.87, equitability from 0.99-1.21 and value of beta diversity from 1.50-1.94, respectively along the disturbance gradient (Table 4).

The floral and faunal communities in the ecosystems is largely influenced by the disturbances frequently occurring either by naturally or manmade^{23,24,25}. In many of these systems, disturbances may alter the overall community structure²⁶ which in turn affects the community and population dynamics. Herb layer composition is often interrelated with regional climate and site conditions²⁷. Plants may assist other species directly by ameliorating severe environmental circumstances, changing substrate characteristics, or increasing the availability of a resource²⁸. In the present study general structure of herbaceous species in all sites illustrated an increasing fashion as the disturbance rise. The reason for their maximum occurrence due to the availability of resources like space, light, moisture, nutrient and other environmental factors. Comparable to these Alhassan et al.29 reported similar aspects which are responsible for the variation in species recovery and diversity. The disturbed site supports more herbs as compared to least disturbed site due to reduction in competition for space and resources. The herb increases immediately due to the anthropogenic disturbance due to general reduction in tree cover that eventually supportive to growth and development of herbaceous vegetation due to availability of resources^{5,13,14,30,31}.

In the present study the total herb density was varied from 67800-146900 individuals ha-1 on Bhoramdeo circle, 70700-108700 individuals ha-1 on Jamunpani circle and 72000-119200 individuals ha-1 on Salehwara circle. These figures are well within the range of herb density measured by Jhariya et al.13 (112000 to 668000 individuals ha-1 during pre-fire season whereas, 230000 to 510000 after fire season) and Jhariya et al.5 (502000 to 724000 individuals ha⁻¹). Pande³² studied the ecological status of vegetation in Satpura plateau (M.P.) and reported the total density of herb layer was 15905 to 102078 stems ha-1. Negi and Nautiyal³³ have found the 20-23 species of herbs in study area. Rastogi and Rastogi³⁴ reported that the density of herbs varied between 168000-497800 per ha, which resemble with present estimated value.

Species diversity is known to be one of the key parameters typically describing the ecosystems and ecosystem functioning³⁵. Worldwide, biodiversity is fluctuating at an unprecedented degree as a compound response to numerous biotic changes³⁶. Species diversity tends to be low in physically controlled communities and high in biologically

control communities3. The present estimated values of diversity indices were comparable with various studies. Rastogi and Rastogi³⁴ found the diversity index between 0.918-0.967, while the similarity index was between 33-80%. Negi and Nautiyal33 reported the concentration of dominance (cd) was 0.1 to 0.13, diversity index varied from 2.41 to 2.69. Beta diversity between two sites of forests was 3.8 and 1.2 for herbs³⁷. Pande³⁸ showed the range of diversity index (Shannon Wiener index) as 0.64-2.34 and also described that diversity index was invariably higher for herbs and it was minimum for least disturbed sites. The species diversity ranged from 1.80 to 3.03 was also reported by Shameem et al.39 which are found to be similar with present study. Kittur et al.14 specified the diversity parameters of herb layer showed that Shannon index in different fire zones varied from 2.21 to 2.57, equitability from 1.02 to 1.24, species richness from 0.34 to 0.67, concentration of dominance from 0.21 to 0.31 and beta diversity from 1.81 to 3.33 which are closer to similar with present outcomes. These parameters were also supported by the findings made by Jhariya et al.^{5,13}. Analysis of variance calculated by Jhariya and Oraon² indicated that the dissimilarity in density among site were found significant at p<0.05 in both the fire season and the number of species was found significant in post-fire season (p<0.05) which are line agreement with the present investigation.

A/F ratio in present research indicated that most of the species showed contiguous and random distribution pattern while regular distribution found virtually insignificant on the Bhoramdeo Wildlife Sanctuary. Likewise, Jhariya *et al.*^{5,13}; Jhariya and Oraon² and Kittur *et al.*¹⁴ described that most of the species documented in the investigated area follow the contagious and random distribution pattern whereas the regular distribution was negligible.

CONCLUSION

The improvement in vegetation cover is possible through systematic monitoring of livestock grazing and anthropogenic disturbance in these forest areas. Human disturbances have influenced the floristic composition at countless magnitude. Moreover, new sites need to be explored for seasonal grazing as substitute followed by protection for few years that certainly will allow the vegetation to regenerate which is constantly under threat due to various factors. However, increasing biotic interference at few sites need serious consideration and the human activities for fuel, fodder collection, harvesting of NTFPs, collecting medicinal plants or herbs, burning of the ground vegetation and uncontrolled livestock grazing requires sustainable management aspects or measures.

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