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STUDIES IN SILTARA AREA, RAIPUR, CHHATTISGARH II: GRASS AND SEDGE VEGETATION

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ABSTRACT
Industries are now being located in defined areas, so that the pollution remains restricted to the defined area. Siltara is such a defined area to locate the industries near to Raipur, the capital city of Chhattisgarh. A large variety and sizes of industries are located in the area, most of which release gaseous pollutants with dust. In this dust polluted area grass and sedge vegetation were studied for their phytosociological parameters and diversity. *Typha angustata* and *Eragrostis tenella* were found to be the most dominant species. The Simpson indices as well as the rank-abundance plot for the recorded species of the grasses and sedges indicated that evenness of the vegetation is poor while the rarefaction plot indicated that sampling intensity has been satisfactory.

KEYWORDS: Siltara, Grass and sedge, Phyto-sociology, Diversity indices, Rank-abundance plot, Rarefaction plot.

INTRODUCTION

Environment is the sum total of all surroundings of a living organism, including natural forces and other living things, which provide conditions for development and growth as well as danger and damage. Environment of earth has changed continuously and slowly but at times very drastically. However, the earlier changes have been all due to natural phenomenon. Since the beginning of industrialization in 18th century the environment is changing rapidly, mainly due to human activities. It is becoming difficult for the organisms to adapt to the rapid changes in the environment. To restrict the effects of rapidly increasing industries on the environment, industries are now located in defined areas, away from human settlement. Siltara is a similar area located near Raipur city, the capital city of Chhattisgarh state, at about 15 km away from the Raipur city on Raipur-Bilaspur Road. Industries from small to relatively large are located within the area; most of them are sponge iron factories. Most prominent of the area is the air pollution, including the gases and dust. Present studies were made therefore to analyze the impact of air pollution on the grass and sedge vegetation within the Siltara industrial area, with respect to their diversity and phyto-sociological characters. The industrial area has large open area to allow growth of vegetation. The land area has some planted species with wild vegetation of trees, shrubs, herbs, grasses and climbers. Some of the low lying areas have developed as wet lands supporting the growth of hydrophytes together with the hydrophytes developing along the waste water channels.

A rank abundance curve or Whittaker plot is a chart used by ecologists to display relative species abundance, a component of biodiversity. It can also be used to visualize species richness and species evenness. It overcomes the shortcomings of biodiversity indices that cannot display the relative role different variables played in their calculation (Magurran, 2004). In ecology, rarefaction is a technique to assess species richness from the results of sampling. Rarefaction allows the calculation of species richness for a given number of individual samples, based on the construction of so-called rarefaction curves. This curve is a plot of the number of species as a function of the number of samples. On the left, the steep slope indicates that a large fraction of the species diversity remains to be discovered. If the curve becomes flatter to the right, a reasonable number of individual samples have been taken: more intensive sampling is likely to yield only few additional species. The rarefaction method was proposed by Sanders (1968) , and corrected by Hurlbert (1971) and Simberloff (1972).

MATERIAL AND METHODS

A rank abundance curve or Whittaker plot is a chart used by ecologists to display relative species abundance, a component of biodiversity. It can also be used to visualize species richness and species evenness. It overcomes the shortcomings of biodiversity indices that cannot display the relative role different variables played in their calculation (Magurran, 2004). In ecology, rarefaction is a technique to assess species richness from the results of sampling. Rarefaction allows the calculation of species richness for a given number of individual samples, based on the

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1. Phytosociology of grasses and sedges:

Grass vegetation of the area was studied for three seasons viz: winter, summer and after rains. Survey was made in the months of January (winter), June (summer) and October (after rains), 2014 with 25 quadrats during each survey, totaling 75 quadrats during one year period. The data was analysed for importance value index with following procedure:

$$\text{Frequency (\%)} = \frac{\text{No. of sampling plots in which the species is present}}{\text{Total No. of plots sampled}} \times 100$$

$$\text{Density (Ha}^{-1}\text{)} = \frac{\text{No. of individuals of the species}}{\text{Total area sampled (ha)}}$$

$$\text{Abundance} = \frac{\text{No. of individuals of the species}}{\text{No. of sampling units in which the species is present}}$$

$$\text{Relative frequency} = \frac{\text{Frequency of the species}}{\text{Frequency of all the species}} \times 100$$

$$\text{Relative Density} = \frac{\text{Density of the species}}{\text{Density of all the species}} \times 100$$

$$\text{Relative abundance} = \frac{\text{Abundance of the species}}{\text{Abundance of all the species}} \times 100$$

IVI = Relative frequency + Relative density + Relative abundance

2. Shannon index of diversity: Shanon index of diversity has also been named as Shannon Weaver index, Shannon Weiner index bur it is only Shanon index as has been given originally by Shanon (1947). Ignorant about this paper of Shannon, some people name it as Shanon Weaver index, on the basis of the paper published in co-authorship in 1948 (Spellerberg and Fedor, 2003).

Shannon index (H) = $-\sum pi \ln pi$

Where:

Pi = importance value of ith species

ln = Natural logarithm

3. Simpson' index: Simpson' index has been calculated following Simpson (1949) using the formula:

Simpson's index of dominance (D) = $\sum pi^2$

Where: pi = value for ith species

4. Gini Simpson index of diversity: Gini Simpson index of diversity was calculated following Jost (2006)

Gini–Simpson index = 1-D

5. Simpson's reciprocal index = 1/D

5. K dominance plot, rank abundance plot and rarefaction plots: K dominance plot, rank abundance plot and rarefaction plots have been plotted using Biodiversity Professional version 2, software.

A large number of articles, papers and books are available on different types of diversity indices, their calculation and interpretations. Some of them are: Allen, et al. (2009), Chao (1984), (2005), Chao *et al*. (2014), Chao and Jost (2012), Chiarucci *et al*., (2008), Coleman *et al*. (1982), Colwell (2009), Colwell *et al*. (2012), Colwell and Coddington (1994), Gotelli and Colwell (2011), Hill (1973), Jost (2006, 2007), Krebs (1999), MacArthur and Wilson (1967), Magurran (2004), Pielou (1975), Tipper (1979) and Whittaker (1965). Paper on the herbs of Siltara area has been published by Shrivastava *et al*. (2015).

RESULTS AND DISCUSSION

The IVI values of the grass and sedge species, recorded from the study area, are given in table 1 and fig. 1:

Table 1: Grass species in siltara industrial area with their IVI values.

SN	SPECIES	FRE	DEN	ABU	RF	RD	RA	IVI
1.	*Alloteropsis cimicina*, Stapf.	4	0.09	1.75	0.72	0.15	0.49	1.37
2.	*Aristida adscencionis*, L.	5.33	0.6	11.25	0.96	1.01	3.17	5.14
3.	*Bothriochloa pertusa*, (L.) A. Camus.	22.67	0.53	2.35	4.10	0.89	0.66	5.65
4.	*Brachiaria distachia*,	21.33	0.71	3.31	3.86	1.19	0.93	5.98
5.	*Chloris barbata*, Sw.	10.67	4.33	40.63	1.93	7.26	11.44	20.63
6.	*Chrysopogon aciculatus*, (Retz.) Trin.	21.33	7.2	33.75	3.86	12.07	9.50	25.43
7.	*Chrysopogon fulvus*, (Sprengel.} Chiov.	8	0.72	9	1.45	1.21	2.53	5.19
8.	*Cynodon dactylon*, Pers.	37.33	6.13	16.43	6.75	10.27	4.63	21.65
9.	*Cyperus castaneus*, Willd.	9.33	0.49	5.14	1.69	0.82	1.45	3.96
10.	*Cyperus exaltatus*, Retz.	2.67	0.04	2.5	0.48	0.07	0.70	1.25
11.	*Cyperus iria*, L.	6.67	0.28	4.25	1.21	0.47	1.20	2.87
12.	*Cyperus rotundus*, L.	22.67	1.4	6.18	4.10	2.35	1.74	8.19
13.	*Dactyctenium aegyptium*, (desf.) Beauv.	8	0.17	2.17	1.45	0.28	0.61	2.34
14.	*Dichanthium annulatum*, Stapf.	5.33	0.32	6.24	0.96	0.54	1.76	3.26
15.	*Digitaria royleana*, Prain.	46.67	4.07	8.71	8.44	6.82	2.45	17.72
16.	*Digitaria sanguinalis*, Scop.	14.67	0.33	2.27	2.65	0.55	0.64	3.85
17.	*Echinochloa colona*, Link.	9.33	0.36	3.86	1.69	0.60	1.09	3.38
18.	*Eleusine indica*, Gaertn.	8	0.17	2.17	1.45	0.28	0.61	2.34
19.	*Eragrostis stenophylla*, Hochst.	20	0.63	3.13	3.62	1.06	0.88	5.56
20.	*Eragrostis tenella*, Roem & Sch.	53.33	8.13	15.25	9.65	13.62	4.29	27.57
21.	*Eragrostis unioloides*, (Retz.) Nees ex Steudel.	6.67	0.28	4.25	1.21	0.47	1.20	2.87
22.	*Eragrostis viscosa* Trin.	48.67	6.8	14.57	8.81	11.40	4.10	24.30
23.	*Fimbristylis bisumbellata*, (Forsskal) Bubani.	18.67	0.77	4.14	3.38	1.29	1.17	5.83
24.	*Fimbristylis podocarpa*, Nees.	16	0.67	4.17	2.89	1.12	1.17	5.19
25.	*Finbristylis aestivalis*, (Retz.) M. Vahl.	9.33	0.33	3.57	1.69	0.55	1.01	3.25
26.	*Heteropogon contortus*, Roem.	10.67	0.37	3.5	1.93	0.62	0.99	3.54
27.	*Iseilema laxum*, Hack.	38.67	2.13	5.52	7.00	3.57	1.55	12.12
28.	*Kyllinga triceps*, Rottb.	5.33	0.12	2.25	0.96	0.20	0.63	1.80
29.	*Panicum psilopodium*, Trin.	6.67	0.43	6.4	1.21	0.72	1.80	3.73
30.	*Pennisetum pedicillatum*, Trin.	2.67	0.68	25.5	0.48	1.14	7.18	8.80
31.	*Saccharum spontaneum*, L.	2.67	0.93	35	0.48	1.56	9.85	11.89
32.	*Setaria glauca*, Beauv.	6.67	0.13	2	1.21	0.22	0.56	1.99
33.	*Sporobolus diander*, Beauv.	20	0.8	4	3.62	1.34	1.13	6.09
34.	*Themeda quadrivalvis*, O. Kuntze.	2.67	0.53	20	0.48	0.89	5.63	7.00
35.	*Typha angustata*, Chaub.	20	8	40	3.62	13.41	11.26	28.29
Total		**552.69**	**59.67**	**355.21**	**100.00**	**100.00**	**100.00**	**300.00**

Abbreviations:

FRE = Frequency, DEN = Density, ABU = Abundance, RF = Relative frequency, RD = Relative density, RA = Relative abundance, IVI = Importance value index.

Grasses and sedges cover most of the area in the industrial area. On the basis of IVI two most dominant grasses of the area, with almost similar IVI values, were *Typha angustata* (IVI - 28.29) and *Eragrostis tenella* (IVI - 27.57) while

Chrysopogon fulvus (IVI - 25.43) and *Eragrostis viscosa*, (IVI 24.30) closely followed the above two species. *Typha angustata* is a gregarious species, out growing any other species in its vicinity. It grows in wetlands but survives even after the water, above the soil surface gets dried. *Eragrostis tenella* is an invasive, exotic. It has invaded the area not very long ago. The species is replacing the local species from most of the grasslands particularly from moist places. All the grass vegetation has been observed to be covered with the black dust, coming from the industries, but very little impact is observed in their growth.

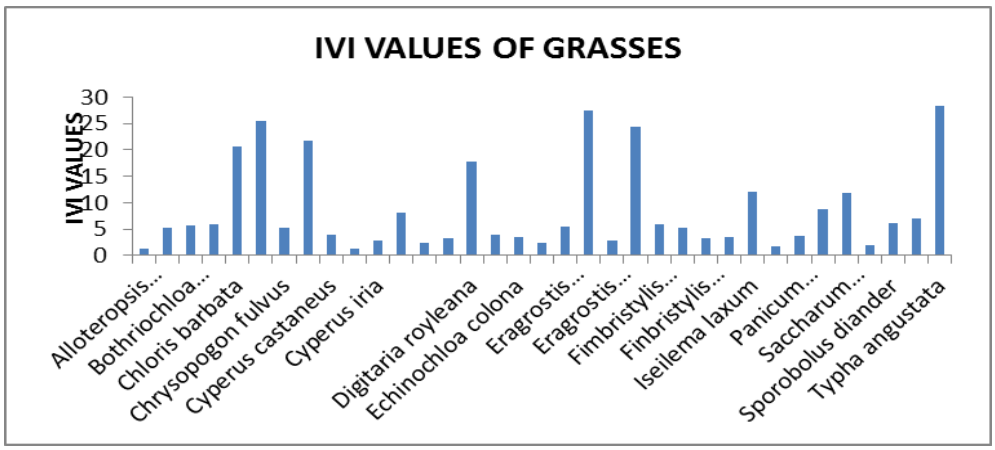


Fig. 1: IVI values of grasses in the study area.

Shanon index = 3.180
Simpson index = 0.054
Gini Simpson Index = 0.946
Simpson reciprocal index - 18.52

The values for Simpson index being very low, Gini Simpson Index and Simpson reciprocal indices being very high as well as the pattern of rank-abundance plot, all indicate poor evenness of the grass and sedge species which consequently indicates concentration of dominance on a very few species. The rank abundance plot (Fig. 2) indicates that the abundance is concentrated only on few of the species, confirming the values obtained with Simpson indices. The rarefaction curve has become almost flat approaching the asymptote. The plot indicates that sapling has been satisfactory with respect to recording the number of species in the study area.

FIG. 2: RANK ABUNDANCE PLOT FOR GRASSES AND SEDGES

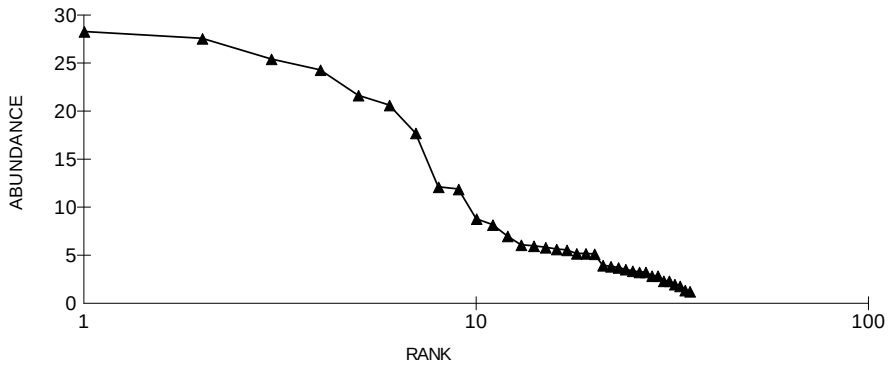
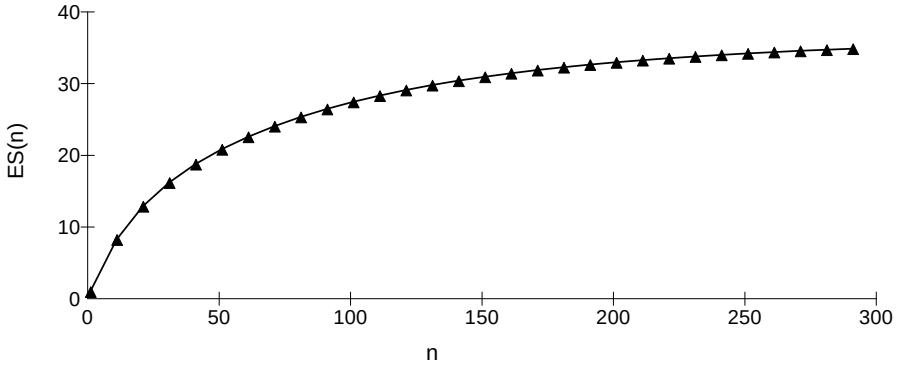


FIG. 3: RAREFACTION PLOT FOR GRASSES AND SEDGES



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