

**RIPARIAN VEGETATIONAL DIVERSITY ALONG RIVER GANGA AT BHAGALPUR**

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**Received** : 15.07.2016; **Accepted** : 12.09.2016**ABSTRACT**

For the present study Ganga river bank near Prem Nagar, Sabour (Bhagalpur) was differentiated into two zones as site 'A' (Upper zone of the river bank) and site 'B' (Lower zone of the river bank). The species compositions, life form, biological spectrum, phenological and sociological characters of vegetation of two study sites were observed during pre-flowering stage. The 22 and 26 species were found at sites A and B respectively. In the biological spectrum therophytes and chamaephytes were dominant on both sites and called thero-chamaephytic flora. Phenological characters of the vegetation of two sites exhibited more annual species which completed life cycle within seven months. The quantitative analysis of the vegetation revealed that the greater area of both sites 'A' and 'B' were occupied by two dominant species *Mollugo hitra* and *Ammania baccifera* with 100% frequency and maximum important value index.

Figure : 00

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KEY WORDS : Biological spectrum, Ganga river, Life form, Phenology, Riparian vegetation.

**Introduction**

River bank vegetation is ecologically termed as riparian vegetation and is highly dynamic. Riparian areas are non-linear areas along rivers and stream that are occasionally flooded by these bodies of water, but may be dry for varying portion of the growing season<sup>6</sup>. Riparian vegetation grows along the sides of rivers. Riparian plant habitats and communities are characterised by hydrophilic plants. Plant communities in riparian lands are the main elements which are interacting with both aquatic and terrestrial ecosystem. Some workers<sup>3</sup> argued that these communities could be used as indicators of the conditions in both upland and aquatic communities. Riparian vegetation protects the stream bank from flood water and also

maintains biological diversity along rivers. Many workers<sup>1,2,4,7,8,10</sup> have studied the different aspects of riparian vegetation. The present paper deals with the phyto-sociological characters of riparian vegetation of river Ganga at Bhagalpur.

**Material and Methods**

The present study was carried out on the right bank of river Ganga at Prem Nagar, Sabour, Bhagalpur, Bihar. The river bank was differentiated into upper zone (Site-A) and lower zone (Site-B). The phenology of individual species was observed every month at study sites from November'2010 to June'2011. Vegetation analysis system<sup>9</sup> was followed. Inclusion of flora in different life forms showed climatic condition and biotic stresses. The phenological studies were grouped into following

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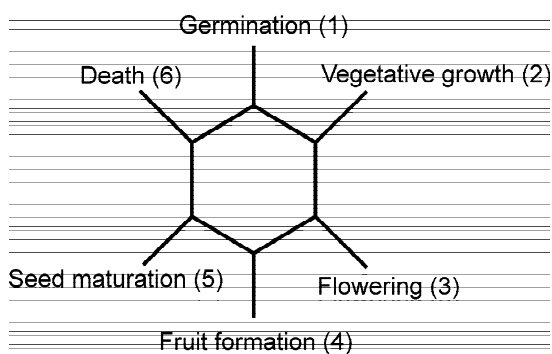
**TABLE-1: List of species occurring on the two sites and their life-forms**

<b>Plant species</b>	<b>Site A</b>	<b>Site B</b>	<b>Life-form</b>
<i>Achyranthes aspera</i>	P	A	Th
<i>Alternanthera sessilis</i>	P	P	Th
<i>Ammania baccifera</i>	P	P	Th
<i>Argemone Mexicana</i>	P	A	Th
<i>Boerhaavia diffusa</i>	P	P	Ch
<i>Brassica compestris</i>	P	A	Th
<i>Chrozophora rolleteri</i>	P	A	Th
<i>Commelina nudiflor</i>	A	P	Th
<i>Croton sparciflorus</i>	P	A	Th
<i>Cynodon dactylon</i>	P	P	Ch
<i>Cyperus kyllingia</i>	P	P	Cr
<i>Cyperus rotundus</i>	A	P	Cr
<i>Dicanthium annulatum</i>	A	P	Th
<i>Eclipta alba</i>	A	P	Th
<i>Euphorbia hirta</i>	P	P	Th
<i>Euphorbia microphylla</i>	P	A	Th
<i>Evolvulus nummularius</i>	A	P	He
<i>Gnaphalium indicum</i>	P	P	Th
<i>Gomphrena celosioides</i>	P	P	Th
<i>Heliotropium indicum</i>	A	P	Th
<i>Imperata cylindrical</i>	A	P	Ch
<i>Lippia nudiflora</i>	P	A	Th
<i>Ludwigia parviflora</i>	A	P	Th
<i>Malvastrum tricuspdatum</i>	P	A	Th
<i>Mollugo hitra</i>	P	P	Th
<i>Nicotiana plumbaginifolia</i>	A	P	Th
<i>Parthenium hysterophorus</i>	P	A	Th
<i>Polygonum barbatum</i>	P	P	He

<i>Polygonum glabrum</i>	P	P	He
<i>Polygonum plebejum</i>	A	P	Ch
<i>Potentilla supine</i>	A	P	Th
<i>Ranunculus sceleratum</i>	A	P	Th
<i>Rumex dentatus</i>	A	P	Th
<i>Saccharum spontaneum</i>	P	A	Ch
<i>Scoparia dulcis</i>	A	P	Th
<i>Vernonia cinerea</i>	A	P	Th
<i>Xanthium strumarium</i>	P	A	Th

A=Absent, P=Present, Th=Therophytes, He=Hemicryptophyte, Ch=Chamaephyte, Cr=Cryptophyte

stages:-



The vegetation of study sites were analysed by 50cm X 50 cm sized quadrat. Phyto-sociological observations made during pre-flowering stage. Quadrats were laid along line of transect from various direction on each study site. The number of individuals of each species present in quadrats was counted and noted down. The basal area of the species was determined measuring the diameter at the point of emergence. The frequency, density, abundance, basal area, relative frequency, relative density and importance value index (IVI) were calculated<sup>5</sup>.

### Result and Discussion

Compact species of plant community is represented by floristic composition. A total number of 37 species were recorded from both the sites. 22 species were recorded from site 'A' and 26

species were recorded from site 'B'. Among them 11 species were common to both sites. The following species were present exclusively on site 'A' and were absent from site 'B' are:

Plant species	Life-form
<i>Achyranthes aspera</i>	Th
<i>Argemone Mexicana</i>	Th
<i>Brassica campestris</i>	Th
<i>Chrozophora rolleteri</i>	Th
<i>Croton sparciflorus</i>	Th
<i>Euphorbia microphylla</i>	Th
<i>Lippia nudiflora</i>	Th
<i>Malvastrum tricuspidatum</i>	Th
<i>Parthenium hysterophorus</i>	Th
<i>Saccharum spontaneum</i>	Ch
<i>Xanthium strumarium</i>	Th

Th- Therophytes, Ch- Chamaephyte

The following species were present exclusively on site 'B' and were absent from site 'A' are:

**TABLE-2: Number of species under different life-form classes**

Life-form classes	Site –A	Site -B	Total Flora
Chamaephyte	03	04	05
Hemicryptophyt	02	03	03
Cryptophyte	01	02	02
Therophyte	16	17	27
Total No. of species	22	26	37

<i>Commelina nudiflor</i>	Th
<i>Cyperus rotundus</i>	Cr
<i>Dicanthium annulatum</i>	Th
<i>Eclipta alba</i>	Th
<i>Evolvulus nummularius</i>	He
<i>Heliotropium indicum</i>	Th
<i>Imperata cylindrica</i>	Ch
<i>Ludwigia parviflora</i>	Th
<i>Nicotiana plumbaginifolia</i>	Th
<i>Polygonum plebejum</i>	Ch
<i>Potentilla supine</i>	Th
<i>Ranunculus sceleratum</i>	Th
<i>Rumex dentatus</i>	Th
<i>Scoparia dulcis</i>	Th
<i>Vernonia cinerea</i>	Th

The plant species which were common to both the sites are:

<i>Alternanthera sessilis</i>	Th
<i>Ammania baccifera</i>	Th

<i>Boerhaavia diffusa</i>	Ch
<i>Cynodon dactylon</i>	Ch
<i>Cyperus kyllingia</i>	Cr
<i>Euphorbia hirta</i>	Th
<i>Gnaphalium indicum</i>	Th
<i>Gomphrena celosioides</i>	Th
<i>Mollugo hitra</i>	Th
<i>Polygonum barbatum</i>	He
<i>Polygonum glabrum</i>	He

Th- Therophytes, He- Hemicryptophyte, Ch- Chamaephyte, Cr- Cryptophyte.

The life forms in both study sites showed the presence of Therophytes, Hemicryptophyte, Chamaephyte, Cryptophytes.

In both the sites the percentage was maximum and of cryptophytes minimum. The percentage of hemicryptophytes stood next to therophytes. The percentage of therophytes and chamaephyte were higher on both sites as compared normal spectrum<sup>9</sup>. The high value of therophyte was due to influence of human beings and animals in site B as well as reduction in tree and shrub flora. Therophytes became dominant life-forms on the riparian sites only due to periodic physical and biotic stresses of which the flooding and overgrazing were

**TABLE- 3: Biological spectra for the study sites and Raunkiaer's Normal Spectrum (Percentage of total species)**

	Chamaephyte	Hemicryptophyt	Cryptophyte	Therophyte
Site -A	13.636	9.810	4.545	72.72
Site -B	15.384	11.538	7.692	65.384
Total flora of the species	13.51	8.10	5.40	72.97
Raunkiaer's Normal spectrum	9.000	26.000	6.000	13.000

**TABLE- 4: Phenological characters of the species (Nov. 2010 –June 2011)**

Plant species	Nov.10	Dec.10	Jan.11	Feb.	Mar.	Apr	May	Jun
<i>Achyranthes aspera</i>	2,3	2,3,4	2,3,4,5	4,5	4,5	5	6	-
<i>Alternanthera sessilis</i>	3,4	3,4	3,4,5	5,6	-	-	-	-
<i>Ammania baccifera</i>	2	2,3	2,3,4	3,4,5	3,4,5,6	2	2	1,2
<i>Argemone Mexicana</i>	1	1,2	2	2,3	3,4	5,6	5,6,1	5,6,2
<i>Boerhaavia diffusa</i>	1,2	2,3	3,4	3,4	4,5	5,6	-	-
<i>Brassica compestris</i>	1,2	2,3	3,4	3,4	4,5	5,6	-	-
<i>Chrozophora rolleteri</i>	2	2,3	2,3	2,3,4	3,4	3,4,5	3,4,5	4,5,6
<i>Commelina nudiflora</i>	2,3	3,4	4,5	5,6	-	-	-	-
<i>Croton sparciflorus</i>	2	2,3	2,3	2,3,4	3,4	3,4,5	4,5	4,5
<i>Cynodon dactylon</i>	2,3	2,3	2,3,4	2,3,4	3,4	4,5	4,5,6	1,2
<i>Cyperus kyllingia</i>	2,3	2,3,4	2,3,4	3,4,5	4,5	4,5	5,6	-
<i>Cyperus rotundus</i>	3,4	3,4	1,2	2,3,4	4,5	1,2	1,2	1
<i>Dicanthium annulatum</i>	2,3	3,4	4,5	4,5	4,5,6	5,6	-	-
<i>Eclipta alba</i>	2	2	2,3	2,3,4	3,4	4,5	5	-
<i>Euphorbia hirta</i>	1,2	2	2,3	3,4	3,4	4,5	1,2	1,2
<i>Euphorbia microphylla</i>	3,4	3,4,5	3,4,5	4,5	4,5	4,5	4	3,5
<i>Evolvulus nummularius</i>	1	1,2	2,3	3,4	3,4,5	5	3,4	5
<i>Gnaphalium indicum</i>	1	1,2	2	2,3	3,4	3,4	4,5	5,6

<i>Gomphrena celosioides</i>	2	2,3	2,3,4	3,4	3,4,5	4,5	6	-
<i>Heliotropium indicum</i>	2	2,3	2,3	2,3,4	2,3,4	4,5	5	6
<i>Imperata cylindrical</i>	2,3	3,4	3,4	3,4,5	4,5	5,6	5,6	6
<i>Lippia nudiflora</i>	2,3	2,3	2,3,4	3,4,5	4,5	4,5	4,5,6	-
<i>Ludwigia parviflora</i>	2,3	2,3	2,3,4	3,4	4,5	4,5	5,6	-
<i>Malvastrum tricuspidatum</i>	2,3	3,4	3,4,5	3,4,5	4,5	-	-	-
<i>Mollugo hitra</i>	1	1,2	2,3	2,3	3,4	4,5	5	6
<i>Nicotiana plumbaginifolia</i>	2,3	2,3	2,3,4	3,4	3,4,5	3,4,5	3,5	3,5
<i>Parthenium hysterophorus</i>	2	2,3	2,3,4	2,3,4	3,4	3,4,5	4,5,6	5,6
<i>Polygonum barbatum</i>	2	2,3	2,3	2,3,4	3,4	3,4,5	3,4,5	5,6
<i>Polygonum glabrum</i>	1,2	2	2,3	2,3,4	3,4	3,4	3,4,5	4,5
<i>Polygonum plebejum</i>	2,3	2,3,4	2,3,4	3,4	3,4,5	3,4,5	4,5	4,5
<i>Potentilla supine</i>	1	1,2	2	2,3	3,4,5	3,4,5	5	-
<i>Ranunculus sceleratum</i>	1,2	2	2,3	2,3,4	3,4	3,4	3,4,5	4,5,6
<i>Rumex dentatus</i>	2	2,3	2,3	3,4	3,4,5	3,4,5	4,5	6
<i>Saccharum spontaneum</i>	2,3	2,3	3,4	3,4	4,6	6	2	-
<i>Scoparia dulcis</i>	3,4	2,3	2,3	2,3,4	3,4,5	4,5	4,5	-
<i>Vernonia cinerea</i>	2	2,3	3,4	3,4	3,4,5	4,5	1,2	2,3
<i>Xanthium strumarium</i>	2	2,3	3,4	4,5,6	6,1	2,3	2,3	3,4

1-Germination, 2- Vegetative, 3-Flowering, 4-Fruiting, 5- Mature seeds, 6- Death of plant

the most common factor. But the exposure, silting, run-off and soil erosion also caused elimination of shrubs and facilitate dominance of therophytes.

Climatic conditions were distinct and have major role in the phenological events of plant species. A large number of herbaceous plant species showed germination by seeds or appeared from the perennating structures after first shower of monsoon. Few plants showed periodicity in germination. Most of the species were annual. The seeding of *Mollugo hitra* emerge during November when temperature is low while it

was found that *Ammania baccifera* started their germination in the month of June and after rainy season vegetative stage reported from month of November. Flowering started in the month of February and continued upto March. The flowering was closely followed by fruit setting and seed formation. After the first shower of rain in the month of June, the *Mollugo hitra* totally disappeared and *Ammania baccifera* completed their life cycle till the month of March but vegetative and reproductive growth continued simultaneously. The earlier formed seeds took longer time for maturation, but

TABLE-5: Frequency, density, abundance, basal cover and their relative per square meter and Importance value index (IVI) of species on study site -A

Name of species	Fre- qu (%)	Rel. fre- quency	Abu- nd.	Den- sit	Rel. den- sit	Basal cover (mm <sup>2</sup> )	Rel. domin.	IVI
<i>Achyranthes aspera</i>	60	8.36	4.84	3.31	4.84	40.08	5.34	18.54
<i>Alternanthera sessilis</i>	30	4.82	6.25	6.31	3.34	26.78	2.74	10.90
<i>Ammania baccifera</i>	100	6.50	48.45	48.45	4.65	40.35	9.25	20.40
<i>Argemone Mexicana</i>	30	2.06	8.00	2.40	0.58	33.24	1.79	4.43
<i>Boerhaavia diffusa</i>	15	1.03	4.00	0.60	0.14	8.28	0.44	1.61
<i>Brassica compestris</i>	43	5.82	5.95	2.56	0.57	50.09	2.36	8.75
<i>Chrozophora rolleteri</i>	18	0.94	8.00	0.64	0.24	60.11	1.54	2.72
<i>Croton sparciflorus</i>	10	1.72	4.25	2.00	0.41	20.05	1.07	3.20
<i>Cynodon dactylon</i>	60	3.13	83.33	50.00	10.18	160.70	6.32	19.63
<i>Cyperus kyllingia</i>	10	0.28	26.00	0.25	0.11	20.05	1.27	1.66
<i>Euphorbia hirta</i>	10	0.68	16.00	1.60	0.38	14.31	0.77	1.83
<i>Euphorbia microphylla</i>	15	0.87	6.50	0.52	0.05	10.25	0.15	1.07
<i>Gnaphalium indicum</i>	50	3.44	21.60	10.80	2.63	11.12	0.60	6.67
<i>Gomphrena celosioides</i>	10	0.98	28.25	1.45	0.28	30.15	1.55	2.73
<i>Lippia nudiflora</i>	65	4.48	11.38	7.40	1.80	42.18	2.27	8.55
<i>Malvastrum tricuspdatum</i>	12	0.27	1.50	0.03	0.01	3.25	0.80	1.08
<i>Mollugo hitra</i>	100	6.89	55.80	55.80	13.60	231.01	12.47	32.96
<i>Parthenium hysterophors</i>	16	0.69	14.00	0.84	0.09	10.15	1.30	2.08
<i>Polygonum barbatum</i>	15	1.04	22.15	1.145	0.35	43.18	1.58	2.97
<i>Polygonum glabrum</i>	13	0.34	27.33	0.82	0.08	14.35	2.23	2.65
<i>Saccharum spontaneum</i>	20	4.55	30.28	3.15	1.25	25.65	2.45	8.25
<i>Xanthium strumarium</i>	30	2.06	10.66	3.22	0.78	26.37	1.42	4.26

**TABLE-6: Frequency, density, abundance, basal cover and their relative per square meter and Importance value index (IVI) of sps. on study site -B**

Name of species	Frequ (%)	Rel. frequency	Abund.	Densit	Rel. densit	Basal cover (mm <sup>2</sup> )	Rel. domin.	IVI
<i>Alternanthera sessilis</i>	25	3.55	25.33	7.63	2.69	32.83	2.63	8.89
<i>Ammania baccifera</i>	100	6.45	38.40	24.15	5.66	44.72	18.24	30.55
<i>Boerhaavia diffusa</i>	05	0.59	12.00	0.62	0.21	8.41	0.68	1.48
<i>Commelina nudiflora</i>	25	1.72	6.66	5.00	1.21	24.15	1.30	4.23
<i>Cynodon dactylon</i>	32	3.77	20.00	6.40	2.45	22.65	2.03	8.25
<i>Cyperus kyllingia</i>	30	2.06	45.33	13.60	3.31	76.84	4.15	9.52
<i>Cyperus rotundus</i>	15	1.77	29.33	4.44	1.56	24.86	2.01	5.34
<i>Dicanthium annulatum</i>	45	4.96	25.30	12.05	6.45	30.25	1.93	13.34
<i>Eclipta alba</i>	40	2.75	28.50	11.40	2.77	28.63	1.54	7.06
<i>Euphorbia hirta</i>	10	0.94	4.00	0.32	0.12	2.31	0.20	1.26
<i>Evolvulus nummularius</i>	45	5.32	28.88	13.02	4.59	40.91	3.30	13.21
<i>Gnaphalium indicum.</i>	40	4.73	42.50	17.04	6.01	17.68	1.43	12.17
<i>Gomphrena celosioides</i>	05	0.96	27.20	1.36	0.22	30.02	1.05	2.23
<i>Heliotropium indicum</i>	40	4.73	30.00	12.08	4.26	84.48	6086	15.85
<i>Imperata cylindrical</i>	17	0.92	65.46	12.08	2.24	60.15	8.45	11.61
<i>Ludwigia parviflora</i>	25	1.72	12.00	3.00	0.73	1.15	0.49	2.49
<i>Mollugo hitra</i>	100	8.21	65.83	65.83	13.08	282.56	18.30	39.59
<i>Nicotiana plumbaginifolia</i>	14	0.57	14.00	0.56	0.07	30.05	1.04	1.68
<i>Polygonum barbatum</i>	10	0.88	15.18	0.75	0.15	10.18	0.56	1.59
<i>Polygonum glabrum</i>	14	0.54	28.25	0.90	0.10	12.43	2.45	3.09
<i>Polygonum plebejum</i>	16	0.81	14.00	0.84	0.19	40.25	1.05	2.05
<i>Potentilla supine</i>	15	0.96	19.20	0.96	0.15	10.15	1.25	2.36
<i>Ranunculus sceleratum</i>	16	0.66	19.20	0.96	0.15	10.15	1.25	2.36
<i>Rumex dentatus</i>	65	4.48	8.92	5.81	1.41	54.63	2.95	8.84
<i>Scoparia dulcis</i>	05	0.59	8.00	0.48	0.16	2.32	0.18	0.93
<i>Vernonia cinerea</i>	15	1.71	13.87	2.08	0.20	10.22	1.14	3.05



on the onset of spring the process was enhanced and fruit were formed in the winter season. The life cycle of the river side vegetation includes longer duration of flowering and fruiting as compared to vegetative phase. The species survived in hottest season when most of the surrounding vegetation dried off. Thus, the vegetation possesses a wide range of tolerance of high atmospheric temperature and drought.

Seasonal study of both sites revealed that the total number of species during winter season showed higher values as compared to summer season. Most of the species showed decreased in

frequency percentage from winter season to summer season due to dry conditions.

The quantitative analysis of vegetation of both sites showed that site 'A' and site 'B' were occupied by two dominant species *Mollugo hitra* and *Ammania baccifera*. These two species showed 100% frequency on both sites. Their relative dominance and Importance value Index (IVI) were also found highest than other species on both sites. The density, relative dominance and IVI of *Mollugo hitra* were higher than *Ammania baccifera* on both sites.

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