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Floral diversity in sites deranged by opencast mining in Sonepur Bazari of Raniganj coalfield area, West Bengal

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ABSTRACT

Open cast coal mining has been leading to massive damage to landscape and biological communities sustained there in. Plant communities in the nearby areas also get perturbed. The associated landscape gets overburdened with large heaps of spoil. The plants themselves tend to revegetate the overburdened spoils and undertake their remediation. The present work reveals in all 69 species belonging to 57 genera of 25 families of angiosperms on the different age series (0, 4, 8, 12, 16 and 20 years) of overburden dumps in the Sonepur Bazari coal mines in Raniganj coal fields of West Bengal state in India. As many as 0, 11, 21, 46, 58 and 69 species were recorded form the OBDs- 0, -4, -8, -12, -16 and -20 respectively. Attributes like habit, life-form, selection-strategy and prevalence in OBDs were recorded and analyzed to reveal ongoing ecological succession. Nine plants were seen to be highly prevalent (83.4%) of which *Saccharum spontanium, Cynodon dactylon, Croton bonplandianum, Solanum sutattense* and *Desmodium trifolium* deserve mention. Herb: Shrub: Tree: Climber ratio was found to be 7.6: 1: 2.8: 2.6. Life-form analysis reveals the ratios of Mesophanerophyte: Microphanerophyte: Nanophanerophyte: Chamaephyte: Liana/ Scandent/ Climber as 1.1: 1: 1.8: 3.5: 1.5.Most of the species were herbaceous and r-Strategists. The grasses and some other tolerant species were observed as pioneers getting established under the prevailing high environmental adversity, while the tree species were seen get established in later stages of succession. The Generic Coefficient of the existing vegetation was found to be 82.61% which is indicative of floristic diversification likely to successfully revegetate and restore the deranged sites.

Key words : Over Burdened Dumps, Sonepur Bazari coal mines, Biological communities, Environmental adversity, Generic Coefficient

The surface mining methods produce a dramatic change in the landscape due to derangement from large scale excavation, removal of overlying vegetation cover, topsoil and its supportive life-forms[2]. Open cast coal mining hands over huge overburden dumps and huge voids in the sites[11]. The dumped overburden is called spoil[10] which is a mixture of disintegrated rocks and rocky soils with coal residues. This spoil is hostile to the growth of both plants and microbes because of impoverished organic matter content, unfavourable pH, draught arising from coarse texture or oxygen deficiency caused by compaction[1] reduced water holding capacity, inadequate nutrients and accelerated rate of soil erosion[9]. The nature tries to restore normalcy by operating plant succession on spoils. Characteristically the autophytic remediation of spoils often involves mycorrhizal association with the species struggling hard to establish on overburdens resulting from open cast coal mining[3].

Open cast coal mining, especially in the recent past, has been creating immense perturbations in the coal belts of West Bengal. The eventual land degradation and pollution have been damaging the vegetation as well as human health. In view of the role of plants in remediation of sites thus deranged, the task of taxonomic census of the vegetation tending to naturally develop a green cover on an age series of over burden dumps (OBDs) was taken up by the present authors which is a part of their research programme on autophytic remediation of the sites deteriorated by open cast coal mining in Sonepur Bazari area of Raniganj coal fields of India.in West Bengal state.

This study was carried out at Sonepur Bazari area which is covered by the Surface Coal Mine Project. It is located at 23^0 48" North Latitude and 87^0 47" East Longitude in the eastern part of Raniganj Coalfields of Burdwan (Barddhaman), West Bengal, India (Fig. 1). The topography of the area is slightly undulating and rolling marked by small ridges and valleys The climate is tropical monsoonal with very hot summer with an average temperature of 42^o C and a cold winter often experiencing temperature as low as 6^oC. The average rainfall amounts to 1450 mm/year. The mine has been kept operational during the last few decades and average strip ratio stands at 1:4.72 generating grade-B coal. Total land acquired for this project by ECL is 2404.85 Ha including the land for over burden dumps. Within this area, a series of 6 Over Burdened Dumps of different ages, henceforth referred to as age-series, was selected and named suffixing the respective age as OBD-0, OBD-4, OBD-8, OBD-12, OBD-16 and OBD-20. The average height of these dumps ranged from 0 to 50 m and quarry depth from 60 to 70 m. The naturally occurring plants on the selected overburden dumps were studied during November- December, 2011. Plant specimens were collected, dissected and described following standard taxonomic methods and identified with the help of pertinent literature[4,12] and authentic specimens preserved in the herbaria of the Botany Departments of B. B. College. The updated names of the plants were then arranged alphabetically with respective family. The habit, life-form and selection strategy of each plant was also recorded. Jacard Coefficient[8] for generic co-efficient, the following formula was used:

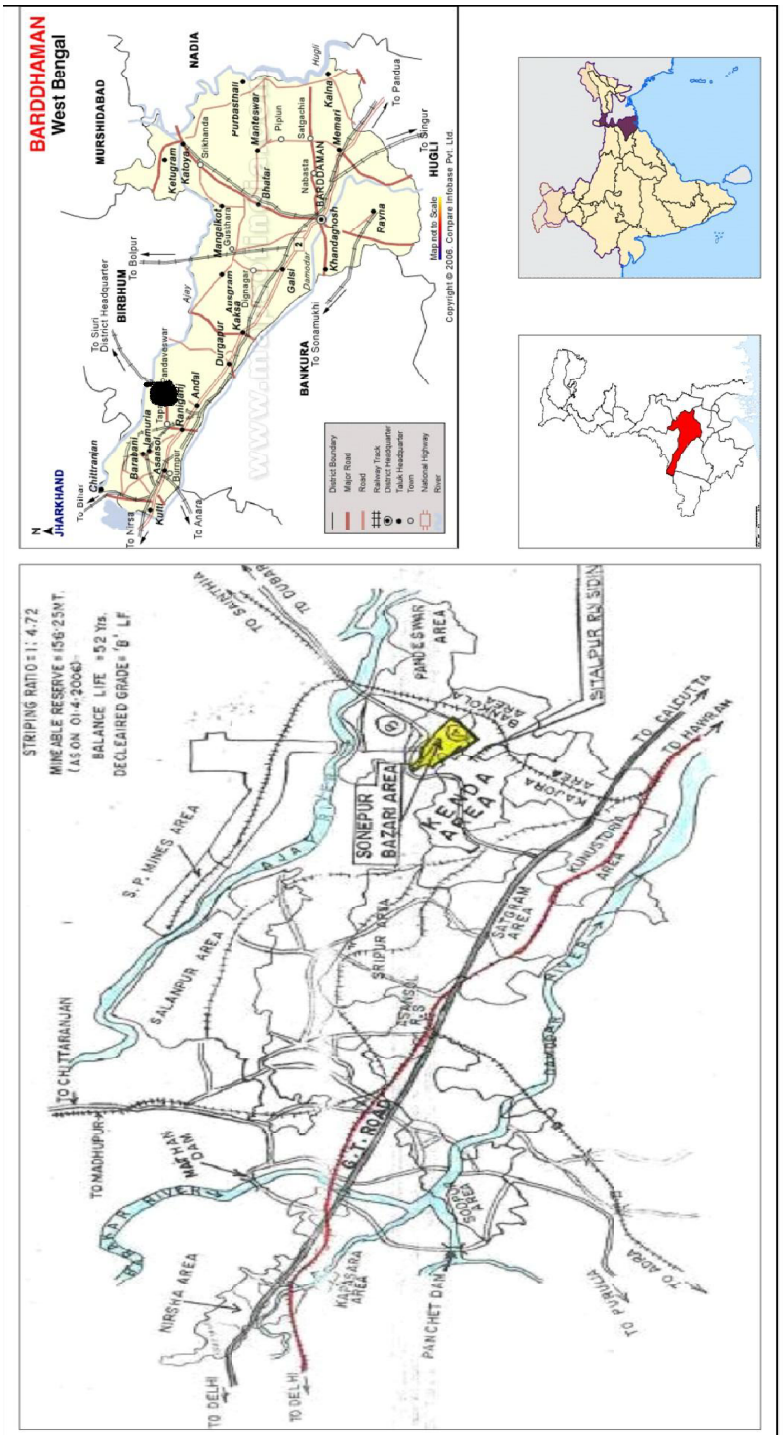

Fig. 1

Source: Mine area map : ECL. Burdwan district map taken from mapmyindia website

Map showing geographical location of study area.

Table1. An account of the species associated with the over burden dumps (OBDs) studied

Name of the plant (Family)	Habit	Life-form category	Strategy (r/K)	Attendance in different OBDs						Prevalence (%)
				0	4	8	12	16	20	
Acacia nilotica Willd. (Mimosaceae)	T	MiP	K	-	-	-	-	+	+	33.2
Achyranthes aspera L. (Amaranthaceae)	H	CP	R	-	+	+	+	+	+	83.4
Alstonia scholaris R. Br. (Apocynaceae)	T	MiP	K	-	-	-	-	-	+	16.6
Alternanthera paronycheoides A. St.-Hilaire (Amaranthaceae)	H	CP	R	-	-	-	+	+	+	50
Alternenthera sessilis R. Br. (Amaranthaceae)	Hv	CP	R	-	-	-	+	+	+	50
Amaranthes viridis L. (Amaranthaceae)	H	CP	R	-	-	-	+	+	+	50
Ammannia baccifera L. (Lythraceae)	Hv	CP	R	-	-	-	+	+	+	50
Andropogon asciculatus Retz. (Poaceae)	H	CP	R	-	-	+	+	+	+	66.4
Anisomalis ovata R. Br. (Lamiaceae)	H	CP	R	-	-	+	+	+	+	66.4
Argemone mexicana L. (Papaveraceae)	H	NP	R	-	-	-	+	+	+	50
Azadirachta indica L. (Meliaceae)	T	MsP	K	-	-	-	-	+	+	33.2
Boerhavia repens L. (Nyctaginaceae)	Hv	LSC	R	-	-	-	+	+	+	50
Butea monosperma Taub. (Fabaceae)	T	MiP	K	-	-	-	+	+	+	50
Cajanus scarabioides L. (Fabaceae)	Hv	LSC	R	-	-	+	+	+	+	66.4
Calotropis gigantea R.Br. (Asclepediaceae)	S	MiP	K	-	-	+	+	+	+	66.4

Cassia fistula L. (Caesalpiniaceae)	T	MiP	K	-	-	-	-	+	+	33.2
Cassia siamia L. (Caesalpiniaceae)	T	MsP	K	-	-	-	+	-	+	33.2
Cassia tora L. (Caesalpiniaceae)	H	CP	R	-	-	+	+	+	+	66.4
Chromolaena odorata (L) King & H.E.Robins. (Asteraceae)	H	NP	R	-	-	+	+	+	+	66.4
Cleome viscosa L. (Capparidaceae)	H	CP	R	-	-	+	-	+	+	50
Clerodendrum viscosum Vent. (Verbenaceae)	H	NP	R	-	-	-	-	-	+	16.6
Convolvulus prostratus Forssk. (Convolvulaceae)	Hv	LSC	R	-	-	-	+	+	+	50
Croton bonplandianum Baill.(Euphorbiaceae)	H	CP	R	-	+	+	+	+	+	83.4
Cynodon dactylon L. (Pers) (Poaceae)	Hv	LSC	R	-	+	+	+	+	+	83.4
Cyperus rotundus L. (Cyperaceae)	H	CP	R	-	+	+	+	+	+	83.4
Dactyloctenium aegyptium.(L.)Willd. (Poaceae)	H	CP	R	-	-	+	+	+	+	66.4
Dalbergia sissoo Roxb. (Fabaceae)	T	MsP	K	-	-	-	+	+	+	50
Datura metel L. (Solanaceae)	H	NP	R	-	-	-	-	-	+	16.6
Desmodium triflorum DC. (Fabaceae)	Hv	CP	R	-	+	+	+	+	+	83.4
Eclipta alba Hessk. (Asteraceae)	H	CP	R	-	-	-	+	+	+	50
Euphorbia heyneana Spreng.(Euphorbiaceae)	Hv	LSC	R	-	+	+	+	+	+	83.4
Euphorbia hirta (Euphorbiaceae)	H	CP	R	-	-	+	+	+	+	66.4

Evolvulus alsinoides Wall. (Convolvulaceae)	Hv	LSC	R	-	-	-	+	+	+	50
Evolvulus nummularius L. (Convolvulaceae)	Hv	LSC	R	-	+	-	+	+	+	66.4
Ficus benghalensis L. (Moraceae)	T	MsP	K	-	-	-	-	-	+	16.6
Ficus cunea L. (Moraceae)	S	MiP	R	-	-	-	-	-	+	16.6
Hygrophila schulii M.R. Almeida et S.M.Almeida (Acanthaceae)	H	CP	R	-	-	-	+	+	+	50
Hyptis suaveolens L. (Lamiaceae)	H	NP	R	-	-	-	+	+	+	50
Ipomoea fistula L. (Convolvulaceae)	S	MiP	K	-	-	-	-	-	+	16.6
Lagerstoemia lanceolata Wall. (Lythraceae)	T	MsP	K	-	-	-	-	+	+	33.2
Lantana camara L. (Verbenaceae)	S	NP	R	-	-	+	+	+	+	66.4
Leonotis nepetifolia R. Br. (Lamiaceae)	H	NP	R	-	-	-	+	-	+	33.2
Leucaena leucocephala Dwit. (Caesalpiniaceae)	T	MsP	K	-	-	-	+	+	+	50
Leucas aspera Spreng (Lamiaceae)	H	CP	R	-	-	-	-	+	+	33.2
Melia azadirachta L. (Meliaceae)	T	MsP	K	-	-	-	-	-	+	16.6
Mikania micrantha Kunth.(Asteraceae)	Hv	LSC	R	-	-	+	+	+	+	66.4
Ocimum americannum L. (Lamiaceae)	H	CP	R	-	-	-	-	+	+	33.2
Ocimum basilicum L. (Lamiaceae)	H	CP	R	-	-	-	-	+	+	33.2
Oldenlandia corymbosa L. (Rubiaceae)	H	LSC	R	-	-	-	+	+	+	50
Parthenium hysterophorus L. (Asteraceae)	H	NP	R	-	+	+	+	+	+	83.4

Pennisetum pedicellatum Trin. (Poaceae)	H	NP	R	-	-	-	-	+	+	33.2
Phoenix sylvestris L. (Arecaceae)	T	MsP	K	-	-	-	-	-	+	16.6
Phyla nodiflora Green. (Verbenaceae)	H	LSC	R	-	-	-	-	+	+	33.2
Phyllanthus fraternus Webster (Euphorbiaceae)	H	CP	R	-	-	-	+	+	+	50
Phyllanthus virgatus Forst.f. (Euphorbiaceae)	H	CP	R	-	-	-	-	+	+	33.2
Phyllanthus urinaria L. (Euphorbiaceae)	H	CP	R	-	-	-	-	+	+	33.2
Saccharum spontaneum L. (Poaceae)	S	NP	R	-	+	+	+	+	+	83.4
Saraca indica L. (Caesalpiniaceae)	T	MsP	K	-	-	-	-	-	+	16.6
Sida acuta Burm (Malvaceae)	H	CP	R	-	-	-	+	+	+	50
Sida rhombifolia L. (Malvaceae)	H	CP	R	-	-	-	+	+	+	50
Solanum sisymbrifolium Lamk . (Solanaceae)	H	NP	R	-	-	-	+	+	+	50
Solanum surattense Schrad. (Solanaceae)	H	NP	R	-	-	-	-	+	+	33.2
Solanum surratense L. (Solanaceae)	Hv	LSC	R	-	+	+	+	+	+	83.4
Tephrosia perpurea Pers. (Fabaceae)	H	CP	R	-	-	+	+	+	+	66.4
Tribulus terrestris L. (Zygophylaceae)	H	LSC	R	-	-	-	-	+	+	33.2
Tridax procumbens L. (Asteraceae)	Hv	CP	R	-	+	-	+	+	+	66.4
Urena lobata L. (Malvaceae)	H	CP	R	-	-	-	+	+	+	50
Vernonia cinerea Less. (Asteraceae)	H	NP	R	-	-	-	+	+	+	50
Zizyphus jujuba Lamk (Rhamnaceae)	T	MiP	K	-	-	-	+	+	+	50

Generic Co-efficient=(No. of genera/No. of species)x100.

In all, from the six study sites no less than 69 species could be recorded which belong to 57 genera of 25 species. After thorough survey no vegetation cover could be observed on OBD-0 as it was comparatively a fresh mine with unfavorable environmental conditions like salinity, acidity, drought arising from coarse texture or oxygen deficiency likely to be due to compaction[1]. Vegetation starts to grow from the 4th year after dumping[3]. No less than 0, 11, 21, 46, 58 and 69 species were recorded form the OBDs- 0, -4, -8, -12, -16 and -20 respectively (Table 1). The dicots were seen to dominate the flora in all dumps the values being 1: 0.37, 1: 0.32, 1: 0.12, 1: 0.12, 1: 0.11 in OBDs-4, -8, -12, -16 and -20 1:00.9On respectively.OBD-4 Euphorbiaceae and Poaceae were seen to dominate the site with two species each. In OBD-8 Poaceae established as the largest family with 4 species. In OBD-12 Asteraceae and Fabaceae were dominant by establishing 6 and 5 species respectively. On OBD-16, Fabaceae and Euphorbiaceae had the largest share holding families as they were represented by 5 and 6 species respectively. Finally on OBD-20, Asteraceae, Euphorbiaceae and Lamiaceae dominated the floristic scenario with 6 species each. Highest prevalence was shown by seven species, viz. *Achyranthes aspera, Parthenium hysterophorus, Euphorbia microphylla, Croton bonplandianum, Desmodium trifolium, Solanum surratense, Cyperous rotundus, Cynodon dactylon* and *Saccharum spontaneum.*

The Generic Coefficient, which serves as an index of diversification, was found to be 82.61%. Thus it indicates an appreciable floristic diversification although the flora is of recent origin on over burdened dumps which are more or less and highly disturbed. Under the existing conditions where more than one species share single genus is likely to be reduced to 1 in course of time. Since the gap between observed (82.61%) and expected (100%) values of generic coefficients is not very wide there is a possibility of successful revegetation and restoration. Habit analysis of the vegetation shows Herb: Shrub: Tree: Climber ratio to be 7.6: 1: 2.8 : 2.6. Similarly life-form analysis shows that Mesophanerophyte: Microphanerophyte: Nanophanerophyte: Chamaephyte: Liana/ Scandent/ Climber ratio are 1.1: 1: 1.8: 3.5: 1.5. Finally it is also observed that most of the species, mainly the herbs and climbers are *r-strategists* utilizing most of their earnings, i.e. their primary production towards reproduction. This is indicative of a strong colonizing ability of grass members under very adverse conditions like drought, low soil nutrients and climatic stresses[3]. In the pioneer stages of succession the grasses, particularly the C4 species offer a superior virtue for tolerance of drought, low soil nutrients and other adverse soil condition prevailing in coal mine spoils which was also reviewed by [5,13&14]. According to Helm[7] as well as Skeel and Gibson[15], grasses can also contribute substantially to the success in vegetating mine spoil. During the later stages, the contribution of non-grass herbaceous species and trees become evident for being the dominant contributors to the flora of the area. This has also been reported earlier[6], according to which the shrubs and tree species happen to dominate the vegetation of older spoils. This clearly demonstrates the strategic importance of

grass and non-grass herbs and trees with respect to the stages of successional colonization of the adverse habitats like that of coalmine spoil.

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