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FLORAL SUCCESSION IN THE OPEN CAST MINING SITES OF RAMNAGORE COLLIERY, BURDWAN DISTRICT, WEST BENGAL

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ABSTRACT

The present work reveals the floristic assemblage vis-à-vis the physico- chemical characters of the over-burdens (OB) resulting from dumping of residues (spoil) from the opencast mining of coal at Ramnagore Colliery of Burdwan district, West Bengal. Analytical methods applied on spoil samples revealed similar values of pH. The organic carbon content of the spoils ranged from 0.84 (site C) to 12% (site A). The total nitrogen content was found to vary from 8 ppm to (site C) to 37 ppm (site E).The phosphate content was very low lying between 1.6 ppm (site D) to 13.6ppm (site B). The soils of these mining grounds is not suitable for plant growth, yet some tolerant species of Asteraceae and Fabaceae dominate the overburdens and show signs of remediation of the spoil to soil in the domain of ecological succession explainable with the help of tolerance model. In all, the present survey reveals from overburdens as many as 58 species of 52 genera belonging to 35 families of angiosperms covering 31 of dicots and 4 of monocots.

KEYWORDS : Over-burdens, Spoil, Remediation, Ecological Succession

Mining activities especially open cast coal mining; generate a variety of wastes differing from each other in their physical and chemical properties and toxicity. Large scale mining operations have the potential to destroy the flora and fauna, contaminate the soil, air and water in the mining region(Davcheva,1990). Mining operations lead to overburdening of large areas with spoiled soils or spoils. This has been a major environmental concern. Mined spoils present very rigorous conditions for soil microbes and plant growth because of their low organic matter content and unfavourable soil chemistry, poor structure-either coarse or compact and high isolation(Meyer,1973; Jha and Singh,1994). So far coal mining is concerned, the spoils have been seen to compose poor habitats for plant establishment, growth and survival. The nutrients and organic matter contents are not only very low but also the water holding capacity and pH are low (Vogel, 1982). Besides these, erosion and surface temperature are impediments for revegetation. Thus salinity, alkalinity, sodicity, acidity, poor water holding capacity and toxicity are major problems in revegetation process (Jha and Singh, 1993). The scientists have been trying very hard to optimize conditions for revegetation (Reddy and Reddy,2001) through suitable amendment since it is the green plants which can gradually convert spoils to good soils through an autogenic plant succession leading to a natural vegetation development, which however is a very slow process. Under scientifically and technically unaided conditions the nature heals itself by an autogenic ecological succession involving plants, animals and microbes in spite of all detriments and perturbations and such a natural process is referred to as phytoautoremediation since it always has its manifestations since inception mainly in form of green plants.

A taxonomic census of the existing natural colonizers or an in situ floristic study on overburdened spoils or simply OBs should be taken in to consideration since it is the index of the autophytoremediation in progress. It can help in understanding the direction of the ongoing plant succession when compared with the flora of the forest in the vicinity and guide augmentation of ecorestoration by environmental scientists. Moreover, if the taxonomic study is accompanied by assessment of the physicochemical properties of the underlying substratum, necessary amendments can also be made for optimizing the conditions for ecological restoration of the environmentally deterred mining sites.

In view of the foregoing, the present work was undertaken in the open cast coal mining areas of Ramnagore Colliery, in Burdwan district of West Bengal State. The primary objective of the present work is thus stocktaking of plant diversity on the over-burdens (OB) lying in the selected mining areas which are highly ecologically hostile

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and assessment of pH, specific conductance, contents of organic carbon, total nitrogen and phosphorus of the 'spoils' so that the findings may prove useful in formulating strategies for augmenting the process of revegetation and eventual ecorestoration.

STUDY SITE

The study site i.e Ramnagore colliery located within 23^{0}42'46" and 23^{0}44'0" N Latitude and from 86^{0}48'48" to 86^{0}50'20" E Longitude covers an area of 6.56 sq Km in the western part of the Raniganj coalfield and is about 18 Km west of Asansol in Burdwan district, West Bengal.

The Ramnagore Colliery is well connected by rail and road. The National Highway No.2 (Grand Trunk Road) passes along the northern boundary of the colliery. A mettalled road branching from National Highway passes through the south western part of the colliery. The Grand chord line of Eastern Railway passes in the south of the colliery. The nearest railway station on this railway line, is located at a distance of four kilometers by road from the colliery office. The nearest airstrip is at Burnpur about 30 km away from site and owned by the Indian Iron and Steel Co. Ltd, a subsidiary of SAIL. Three sites within the jurisdiction of Ramnagore colliery were selected which were over burden of different ages. These sites were designated as site A (age 1 year), site B (9 years old), site C (age 14 years), site D (age 15 years) and site E (37years old). Two sites of similar age were selected to find the relative pace of remediation.

MATERIALS AND METHODS

The present work is in progress since March based on periodic visits to study sites in five overburden dumps resulting from open-cast coal mining in Ramnagore colliery, viz., A, B, C, D and E from each of which spoil samples were collected along with specimens of the plants composing the overlying vegetation. The collected plant specimens were identified with the help of standard literature (Prain, 1903) and processed for herbarium preservation for future reference.

Such soil/spoil characters as the pH, Specific conductance, and concentration of nitrogen, organic carbon, phosphate of the spoil were determined by analytical methods (Brady, 1920).

RESULTS AND DISCUSSION

The present survey reveals as many as 58 species of 52 genera belonging to 35 families of angiosperms covering 31 of dicots and 4 of monocots (Table, 1). Asteraceae dominates the floristic scenario with no less than six species, thus proving its wide ecological amplitude and its apomorphism with a variety of chemical weapons in form of their secondary metabolites to encounter various forms of environmental resistance. The next important family is Fabaceae, which is very encouraging since their existence in the area is certain to nutritionally enrich the substratum through sustenance of atmospheric nitrogen fixation in their root nodules. Among other families in the study sites Verbenaceae, a member of Asteridae, shares the same responsibility with Caesalpiniaceae of the sublass Rosidae in phytoremediation.

It is interesting to find that *Saccharum spontaneum*(Poaceae), *Dalbergia sissoo* (Fabaceae) and *Calotropis gigantea* (Asclepiadaceae) dominate the spoil-vegetation with a very high value of prevalence(80%) and such species as *Chromalaena odorata*, *Combretum roxburghii* and *Butea monosperma* are prevalent in 60% of over-burdens.

The species strength and age of the different overburdens (OB) were found to be in good agreement with a direct- proportional relationship with OB-E and OB-B deviating respectively with lower and higher number of species (Figure1) Vines which might have resulted from the uneven physicochemical constraints /support conveyed by the substrates (Table, 2) are in form of 12 species, nine of which are herbaceous i.e. climbers. Although the species number is low in OB-E, it has 15 woody species including the three species of woody vines or lianas..

The herbs being r-strategists dominate the overburden flora with 26 species (Figure, 2). Other habit-categories are more or less close in numerical representation. This is encouraging since the presence of plants of all sorts of habits reflects unbiased species preference on the part of the overburdens and the species are capable of withstanding all sorts of stress, adversity and

Table 1: An Account of The Species Associated With The Overburdens (OBs) Studied

Sl. No	Name of the plant	Family	Habit	Attendance in overburdens					Prevalence (%)
				A	B	C	D	E	
1.	*Albizia lebbeck*	Mimosaceae	T	-	-	-	+	+	40
2.	*Alstonia scholaris*	Apocynacaae	T	-	-	+	-	+	40
3.	*Andrographis paniculata*	Acanthaceae	H	-	+	-	-	-	20
4.	*Annona squamosa*	Annonaceae	S	-	-	-	-	+	20
5.	*Azadirachta indica*	Meliaceae	T	-	-	+	-	+	40
6.	*Bauhinia purpurea*	Caesalpiniaceae	T	-	-	-	-	+	20
7.	*Boerhavia diffusa*	Nyctaginaceae	H	-	+	-	-	-	20
8.	*Bryonia laciniata*	Cucurbitaceae	Hv	-	+	-	-	-	20
9.	*Butea monosperma*	Fabaceae	T	-	-	+	+	+	60
10.	*Calotropis gigantea*	Asclepiadaceae	S	+	+	-	+	+	80
11.	*Cardiospermum helicacabum*	Sapindaceae	Hv	-	+	-	-	-	20
12.	*Cassia siamea*	Caesalpiniaceae	T	-	+	+	-	-	40
13.	*Cassia tora*	Caesalpiniaceae	S	-	+	-	-	-	20
14.	*Cayratia pedata*	Vitaceae	Hv	-	+	-	-	-	20
15.	*Cayratia reticulata*	Vitaceae	Hv	-	+	-	-	-	20
16.	*Centrantherum anthelminticum*	Asteraceae	H	-	-	+	-	-	20
17.	*Citrus limon*	Rutaceae	S	-	-	+	-	-	20
18.	*Cleodendrum viscosum*	Verbenaceae	S	-	-	+	-	-	20
19.	*Coccinia grandis*	Cucurbitaceae	Hv	-	-	+	-	-	20
20.	*Combretrum roxburghii*	Combretaceae	Wv	-	-	+	+	+	60
21.	*Commelina benghalensis*	Commellinaceae	H	-	-	+	-	-	20
22.	*Corchorus acutangulus*	Tiliaceae	H	-	+	-	-	-	20
23.	*Chromalaena odorata*	Asteraceae	H	-	+	-	+	+	60
24.	*Crotolaria pallida*	Fabaceae	H	+	+	-	-	-	40
25.	*Croton bonplandianum*	Euphorbiaceae	H	-	+	-	-	-	20
26.	*Dalbergia sissoo*	Fabaceae	T	-	+	+	+	+	80
27.	*Desmodium triflorum*	Fabaceae	H	+	+	-	-	-	40
28.	*Dioscorea alata*	Dioscoreaceae	Hv	-	+	-	-	-	20
29.	*Evolvulus nummularius*	Convolvulaceae	H	-	-	-	-	+	20
30.	*Ficus hispida*	Moraceae	T	-	-	-	-	+	20
31.	*Heliotropium indicum*	Boraginaceae	H	-	-	-	+	-	20
32.	*Heliotropium supinum*	Boraginaceae	H	-	-	-	+	-	20
33.	*Kyllinga monocephala*	Cyperaceae	H	-	+	-	-	-	20
34.	*Lantana camara*	Verbenaceae	S	+	+	-	-	-	40
35.	*Leucas aspera*	Lamiaceae	H	-	+	-	-	-	20
36.	*Mikania micrantha*	Asteraceae	Hv	-	-	-	+	-	20
37.	*Murraya koenigii*	Rutaceae	S	-	+	-	-	-	20
38.	*Olax scandens*	*Olacaceae*	Wv	-	-	-	-	+	20
39.	*Oplismenus compositus*	Poaceae	H	+	+	-	-	-	40
40.	*Parthenium hysterophorus*	Asteraceae	H	-	-	-	+	-	20
41.	*Phyla nodiflora*	Verbenaceae	H	-	-	-	+	-	20
42.	*Piper longum*	Piperceae	H	-	-	+	-	-	20
43.	*Polygonum barbatum*	Polygonaceae	H	-	-	-	+	-	20
44.	*Polygonum plebium*	Polygonaceae	H	-	-	-	+	-	20
45.	*Ruellia prostrata*	Acanthaceae	H	-	+	-	-	-	20
46.	*Saccharum spontaneum*	Poaceae	H	+	+	-	+	+	80
47.	*Sesbania grandiflora*	Fabaceae	T	-	-	-	+	-	20

48.	*Solanum indicum*	Solanaceae	H	-	+	-	+	-	40
49.	*Solanum sysimbrifolium*	Solanaceae	S	-	-	-	+	-	20
50.	*Spermacocci hispida*	Rubiaceae	H	-	+	-	-	-	20
51.	*Stephania japonica*	Menispermaceae	Hv	-	-	+	-	-	20
52.	*Syzygium cumini*	Myrtaceae	T	-	-	+	-	-	20
53.	*Tamarindus indica*	Fabaceae	T	-	-	-	+	-	20
54.	*Trichosanthes cucumererina*	Cucurbitaceae	Hv	-	+	+	-	-	40
55.	*Tridax procumbens*	Asteraceae	H	+	+	-	-	-	40
56.	*Xanthium indicum*	Asteraceae	H	+	-	-	+	-	40
57.	*Ziziphus mauritiana*	Rhamnaceae	T	-	-	-	-	+	20
58.	*Ziziphus oenoplea*	Rhamnaceae	S	-	+	-	-	-	20

Table 2: Physico-chemical Analysis of Spoils Collected From Overburdens (OB) By Using Laboratory Methods of Soil Analysis

Parameter	Overburdens					Trends
	A	B	C	D	E	
pH	8.5	8.5	7.5	7.0	8.5	E=B=E>C>D
Specific conductance (m mho/cm)	21.70	27.62	0.80	0.91	0.86	A < B > C <D > E
Organic Carbon (%)	12	9.86	0.84	1.2	1.92	A >B > C < D > E
Nitrogen (mg/ml)	12	10	8	26	37	A< B > C>D>E
Phosphate (mg/ml)	6.8	13.6	2.4	1.6	3.6	A>B>C> D < E

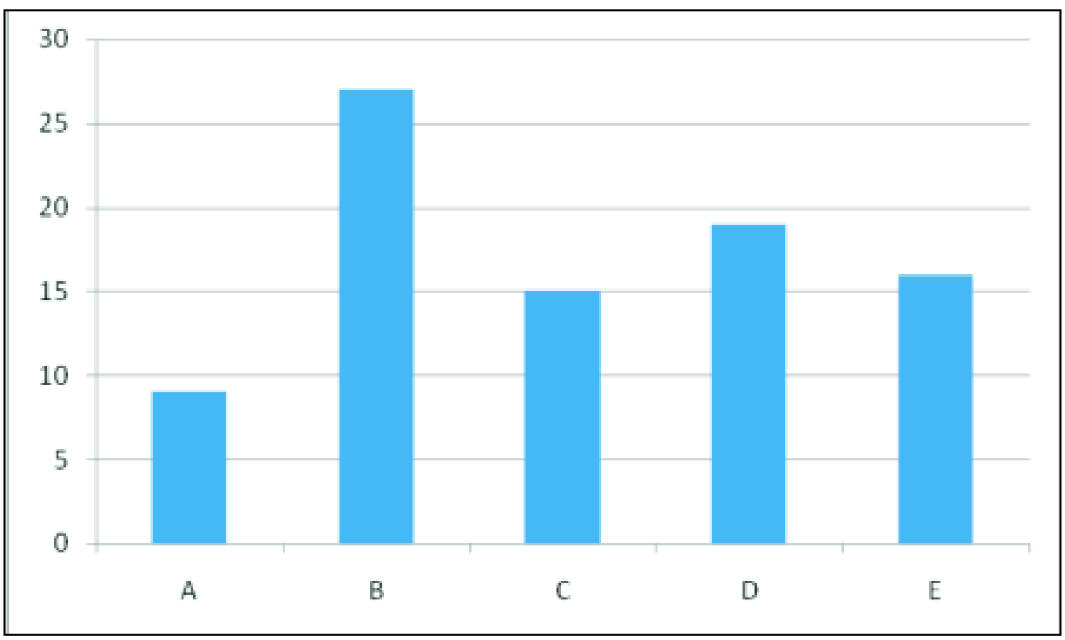

Figure 1 : Number of Species In Different Overburdens (A-E)

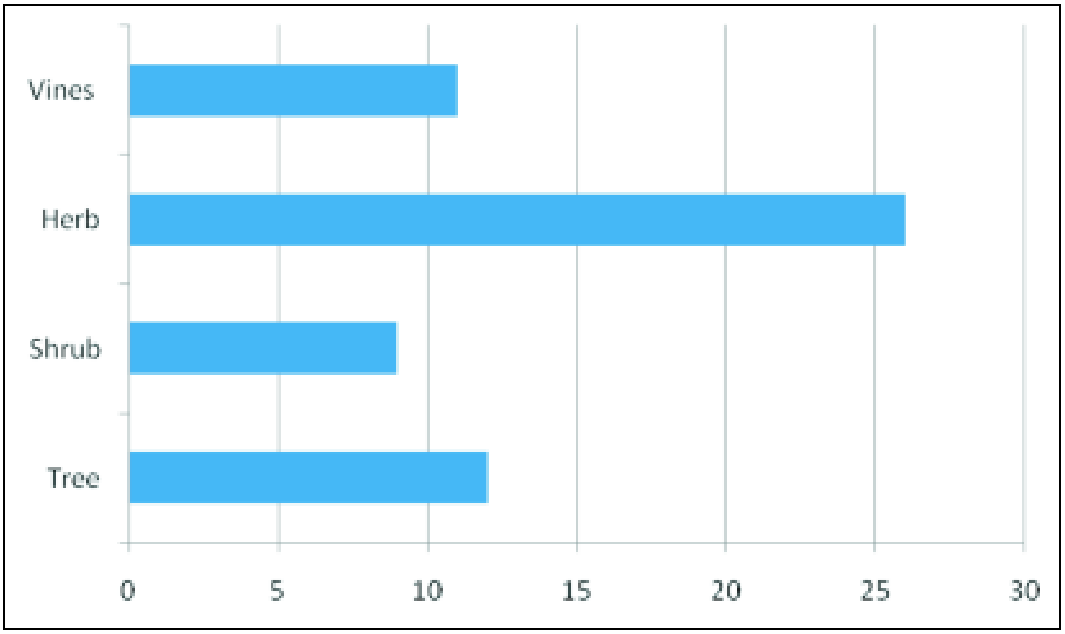

Figure 2 : Habit Analysis of Plants Recorded From Different Overburdens

resource limitations. Analysis of habits of plants reveals the ratios of Trees: Shrubs: Herbs: Vines to be 1: 0.75: 2.2: 0.92. Thus the herbaceous plants have the highest share in form-composition of the sites. However the ligneous species i.e. trees + shrubs + woody vines or lianas have surpassed the herbs by virtue of their adaptability to the existing dehydrating stress, physicochemical constraints and impoverished nutrients. This is indicative of secondary succession in vogue on deranged and spoiled matrices. The succession processes which were visualized in the study sites do not fit in the conventional facilitation model of ecosystem development. The events when correlated with the data of the physic-chemical properties of the substratum things were found well to match with the Tolerance model of ecosystem development which is conventionally referred to as ecological succession. The trees showing their excellence in this particular aspect include the names of *Albizzia lebbeck, Alstonea scholaris, Butea monosperma, Dalbergia sissoo* and *Azadirachta indica*. The woody scandants like *Combretum roxburghii* and *Olax scandens* are also highly stress-tolerant. The latex secreting *Calotropis gigantea* and the C4 grass *Saccharum spontaneum* also deserve special mention as excellent optimizers.

Physico-chemical properties of the spoil-samples collected from different overburdens revealed (Table, 2) values of pH close to neutrality in case of OBs C and D and alkalinity(8.5) in case of OBs A, B and E. The total nitrogen content was found to vary from 8 ppm to (site C) to 37 ppm (site E). The trend was more or less towards an increase in nitrogen status of the spoils with age of OBs, the status being A< B > C>D>E. The organic carbon content was more or less along an increasing gradient, the trend being A >B > C < D > E and the values ranged from 0.84 (site C) to 12% (site A). The phosphate content was very low lying between 1.6 ppm (site D) to 13.6ppm (site B). The trend (A>B>C> D < E) does not reflect any improvement in phosphate content with ageing of overburdens.

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