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PHYTOSOCIOLOGICAL STUDIES AROUND THE POLLUTED DISPOSAL CHANNELS OF INDUSTRIAL AREAS OF KARACHI

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Quantitative phytosocilogical studies of 13 stands were carried out alongwith soil analysis on the disturbed and polluted industrial areas of Sind Industrial Trading Estates (SITE) and Manghopir. Four associations were recognized on the basis of floristic composition, physiognomic similarity, importance value index and soil characteristics.

INTRODUCTION

A lot of work has been done in ordinating the tropical, temperate, deciduous, desert and calcareous types of vegetation, whereas little work has been reported from disturbed vegetation. The study area comprised about 10 square miles in the Sind Industrial Trading Estates and Manghopir localities in Karachi city. Disturbance was caused mainly by industrialization which was advancing with a tremendous speed, spreading different types of chemical compounds in the air, soil and water. The effect of industrial pollutants on plants depends upon many factors such as nature of the chemicals, toxicity, time of exposure and temperature. Plants absorb ions of toxic nature by the root system and also by the aerial parts (Lagerwerff and Specht, Page *et al.*, Haghiri, Rolfe Buchauer [5,10,12,14,16]. Suspended matter and colour of the effluents may also affect the vegetation. The discharge of many effluents which differ nutritionally from that of the receiving water will thus affect the vegetation types. The degree to which the vegetation is affected, may depend both on the quantitative and qualitative change in the water.

MATERIALS AND METHODS

Sampling of the vegetation was done adjacent to the waste disposal outlets by quadrat method. At some places the vegetation was sampled by the random pairs method of Cottom and Curtis [7]. Relative cover, relative frequency and relative density were calculated. An importance value index (I. V. I.) was obtained by the addition of the above community attributes, the community was named according to dominant species which had the highest I. V. I.

Statistical Methods. On the basis of phytosociological studies all the stands of the Sind Industrial Trading Estates and Manghopir were ordinated using the technique of Lucks [13] and the index of similarity of Czekanowski [8]. The positions of the stands were plotted on the basis of Beal's [2] procedure.

Soil Analysis: 1. Mechanical analysis of the soils were carried out by the pipette method of USDA [19].

2. Organic matter was determined by Walkely and Black method described by Jackson, [11].

3. Inorganic phosphorus was determined by Fogg and Wilkinson [9] method.

4. pH was determined by E.I.L. direct reading pH meter.

5. Calcium carbonate was determined by a method of acid neutralization, which was described by Qadir *et al.* [15].

6. Sodium and potassium were determined by the flame photometer.

7. Maximum water holding capacity was claculated by the following formula.

$$\text{MWHC } (\%) = \frac{\text{loss in weight}}{\text{oven dried weight of the soil}} \times 100$$

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RESULTS

Phytosociological data are summarized in Table 1. Two types of vegetation were found outside the waste disposal drains– a disturbed type and an halophytic herbaceous type. Ten of the forty recorded species *(Cressa cretica, Prosopis glandulosa, P. juliflora, Salsola foetida, Cassia holosericea, Desmostachya bipinnata, Suaeda fruticosa, S. monoica, Withania somnifera* and *Calotropis procera* were leading dominants in various stands. *Datura alba, Abutilon indicum, Heliotropium tuberculosum, Launaea nudiculis* and *Aeluropus insignis* were next in importance.

On the basis of habitat conditions, floristic composition and the importance value index, four major types of communities were recognised in the study area.

Table 1. Summary of phytosociological data.

S.No.	Name of species	No of stands in which the species occurred.	Total I.V.I.	Average I.V.I	Maximum I.V.I	Minimum I.V.I.	No. of stands 1st. dominant	No. of stands 2nd. dominant	No. of stands 3rd. dominant
1.	*Cressa cretica* L.	8	870.45	108,81	300.00	5.582	4	2	–
2.	*Prosopis glandulosa* Torr.	7	492.45	70.35	121.04	13.12	1	2	1
3.	*Prosopis juliflora* DC.	7	379.80	54.25	155.70	8.19	1	3	2
4.	*Salsola foetida* Willd.	5	367.22	73.44	142.41	13.59	1	2	1
5.	*Cassia holosericea* Fres.	5	317.84	63.57	207.00	4.596	2	–	–
6.	*Desmostachya bipinnata* (L.) Stapf	2	242.43	121.21	233.37	9.10	1	–	–
7.	*Suaeda fruticosa* L. forsk.	2	219.35	109.67	142.13	77.22	2	–	–
8.	*Suaeda monoica* Forsk. ex. Gmel.	3	124.31	41.43	50.67	36.35	–	–	3
9.	*Withania somnifera* (L.) Dunal.	5	117.59	29.39	88.31	4.75	1	–	–
10.	*Calotropis procera* (Willd.) R. Br.	6	101.64	16.94	45.83	3.07	–	1	–
11.	*Datura alba* Nees.	2	69.66	34.83	12.18	11.04	–	–	1
12.	*Abutilon indicum* (L.) Sweet.	2	55.42	27.71	36.69	18.73	–	1	–
13	*Heliotropium tuberculosum* Boiss.	3	52.37	17.45	28.12	5.60	–	–	–
14.	*Launaea nudicaulis* (L.) Hooker	4	50.03	12.75	17.87	9.22	–	–	–
15.	*Aeluropus insignis* L.	2	47.71	23.85	40.10	7.61	–	1	–
16.	*Cynodon dactylon* (L.) Pers.	3	39.06	13.02	25.18	5.67	–	1	–

(continued . . . .)

(Table 1, continued . . . .)

17. *Haloxylon recurvum* (Moq.) Bunge.	2	38.62	19.13	26.88	11.75	–	–	–
18. *Zizyphus nummularia* (Burm., f.) Wt. & Arn.	2	33.92	16.96	20.82	13.10	–	–	–
19. *Solanum albicaule* Kotschy	1	32.90	32.90	32.90	32.90	–	–	1
20. *Atriplex stocksii* (Wight.) Boiss.	1	25.69	25.69	25.69	25.69	–	–	–
21. *Juncellus laevigatus* (L.) Clarke.	2	24.90	12.45	13.76	11.14	–	–	1
22. *Cyperus rotundus* L.	1	24.63	24.63	24.63	24.63	–	–	–
23. *Sporoblus pallidus* (Nees.) Boiss.	1	23.94	23.94	23.94	23.94	–	–	1
24. *Corchorus depressus* (L.) Stocks	3	23.74	7.97	13.23	4.60	–	–	–
25. *Indigofera oblongifolia* Forsk.	1	21.55	21.55	21.55	21.55	–	–	–
26. *Sida grewioides* Guill.	1	20.47	20.47	20.47	20.47	–	–	1
27. *Aerva javanica* (Burm.f.) Juss.	1	19.72	19.72	19.72	19.72	–	–	–
28. *Heliotropium ophioglossum* Stocks.	2	17.92	8.96	10.08	7.84	–	–	–
29. *Solanum surattense* Burm.	1	15.86	15.86	15.86	15.86	–	–	–
30. *Triathema pentandra* L.	1	10.09	10.09	10.09	10.09	–	–	–
31. *Mollugo hirta* Thumb.	1	9.45	9.45	9.45	9.45	–	–	–
32. *Alhaji pseudalhagi* (M. Bieb.) Desv.	1	8.09	8.09	8.09	8.09	–	–	–
33. *Prosopis cineraria* (L.) Druce.	1	6.35	6.35	6.35	6.35	–	–	–
34. *Eclipta prostrata* (L.),L. Mantiss.	1	5.22	5.22	5.22	5.22	–	–	–
35. *Aristolochia bracteata* Retz.	1	4.86	4.86	4.86	4.86	–	–	–
36. *Amaranthus viridis* L.	1	3.74	3.74	3.74	3.74	–	–	–
37. *Acacia nilotica* (Linn.) Delile	1	2.86	2.86	2.86	2.86	–	–	–
38. *Convolvolus arvensis* L.	1	2.56	2.56	2.56	2.56	–	–	–
39. *Cenchrus biflorus* Roxb.	1	2.55	2.55	2.55	2.55	–	–	–
40. *Gossypium stocksii* Mast.	1	2.51	2.51	2.51	2.51	–	–	–

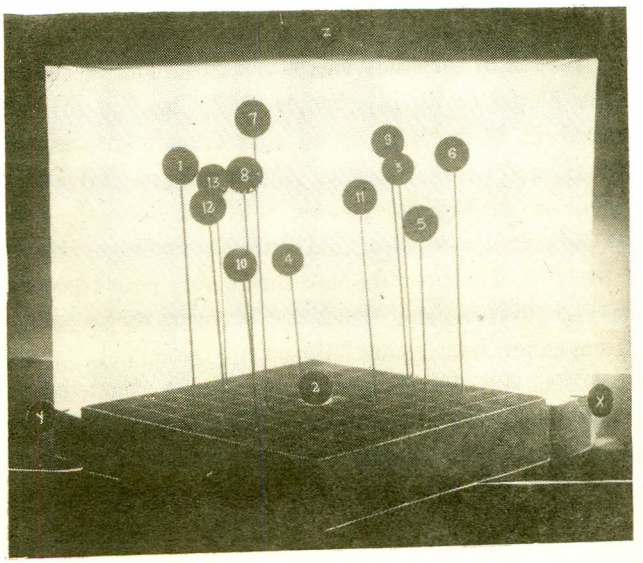
1. *Suaeda fruticosa– Aeluropus insignis– S. monoica* Community: All the dominants were halophytic herbs which formed an open community, located near Valika Chemical Industries and Jasmin Silk and Cotton Mills. Other characteristic members of this community were *C. cretica, D. bipinnata, Haloxylon recurvum* and *H. ophioglossum* The dominant species of this community indicate high salinity.

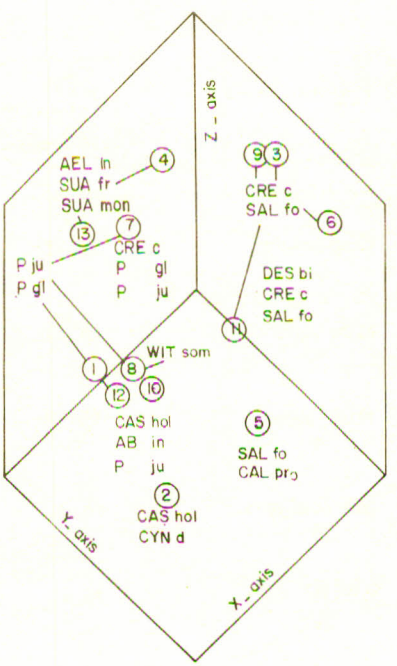
2. *Cressa– Desmostachya– Salsola* Community: This community was located near Bawany Textile Mills, Darbar Soap Works, Abid Textile Mills and Valika Chemical Industries. Most of the species were halophytic herbs. Other less abundant associates were *S. monoica A. javanica* and *Alhagi pseudalhagi.* This community also indicates saline soil.

3. *Cassia– Salsola– Calotropis* Community: This community was found near Simplex Rubber Mfg . Co. and Darbar Soap Works. *Datura alba, P. glandulosa, Zizyphus nummularia,* Heliotropium *tuberculosum, Cynodon dactylon, P. juliflora* and *Trianthema pentandra* were also found in this community The presence of *Calotropis procera* showed that this community was approaching the sub-climax stage of disturbance Ahmed & Qadir [1].

4. *Prosopis glandulosa– P. juliflora– Withania somnifera* Community: This closed community was situated near Carbon and Ribbon Mfg. Co., Cotton Godown, Eastern Pharmaceutical Laboratory, Dada Bhoy Ceramic Industries, and Ghani Textile Mills. The first two dominants are large shrubs with scattered spiny branches, indicating the sub-climax stage of succession (Ahmed & Qadir) [1]. At some localities *Cassia holosericea, Solanum albicaule, Cyperus rotundus, Withania somnifera, Amaranthus viridis* and *Launaea nudicaulis* formed a second stratum under *P. glandulosa* and *P. juliflora.* Other important species of this community were *Abutilon indicum, Cressa cretica, Calotropis procera, Salsola foetida* and *Aerva javanica.*

Phytosociological Ordination: The stands were distributed in four distinct groups (Fig. 1). Stands 3,6,9, and 11 in which *C. cretica, S. foetida* and *D. bipinnata* were abundant occupied the upper right side of the model. This group of stands occurred on highly saline soil. The second group, dominated by *S. fruticosa, A. insignis,* and *S. monoica* also occurred on saline soil, was located toward the upper left side of the model opposite to the first group. Stands 1,7,8,10 and 12 which were dominated by *P. glandulosa, P. juliflora, W. somnifera* and *C. holosericea,* occupied the central left portion of the model, while stands 2 and 5 which were dominated by *C. holosericea, S. foetida* and *C. procera* occupied the lower right hand side of the model.





CRE c	*CRESSA CRETICA*
SAL fo	*SALSOLA FOETIDA*
DES bi	*DESMOSTACHYA BIPINNATA*
CAL pro	*CALOTROPIS PROCERA*
CAS hol	*CASSIA HOLOSERICEA*
SUA mon	*SUAEDA MONOICA*
SUA fr	*SUAEDA FRUTICOSA*
P ju	*PROSOPIS JULIFLORA*
P gl	*P. GLANDULOSA*
WIT som	*WITHANIA SOMNIFERA*
AB in	*ABUTILON INDICUM*
CYN d	*CYNODON DACTYLON*
AEL in	*AELUROPUS INSIGNIS*

Fig. 1. Standard positions in the 3-dimentional ordination showing dominant species.

DISCUSSION AND CONCLUSIONS

The soil of the study area is calcareous and of marine origin. Blatter *et. al.* [3], Sabnis [17], Chaudhri [6] and Shaukat & Qadir [18] found that *Commiphora mukul* (HK. f. ex. Stocks) Engler, *Acacia senegal* (L.) Willd, *Euphorbia caducifolia* Haines, *Pulicaria hookeri* Jafri and *Barleria acanthoides* Vahl were the dominant species of the area. These species have shown very poor regeneration and cover in many stands due to recent anthropological and animal interference (Ahmed and Qadir) [1]. Natural vegetation was being replaced by species characteristic of disturbed sites i.e. *A. javanica, Fagonia cretica, C. procera* and *P. glandulosa.* The well developed industries of the study area release toxic substances which modify the nature. structure and composition of vegetation and soil. At some places where the drains were uncemented and poor, the waste products created waterlogging and salinity. In these areas halophytes completely replaced the natural vegetation. The *Suaeda fruticosa-Aeluropus–S. monica* community occurred where the salinity was highest (Table 2). In those stands where the amount of sodium and the maximum water holding capacity was slightly less than the above community, the *Cressa–Desmostachva–Salsola* community was found. The *Cassia-Salsola-Calotropis* community was found outside the waste disposal drains where disturbance was mainly due to grazing and cutting of the original vegetation. The presence of *C. procera* indicates the sub-climax

Table 2. Soil characteristics.

	Environmental data averaged for communities			
	1st Community (Stands 4&13)	2nd Community (Stands 3,6,9&11)	3rd Community (Stands 2&5)	4th Community (Stands 1,7,8,10&12)
Coarse sand %	32.46	49.74	64.61	58.04
Fine sand %	17.27	14.55	11.07	15.04
Total sand %	49.73	64.29	75.68	73.08
Silt & clay %	46.48	28.49	29.97	23.35
MWHC %	34.44	29.74	25.24	32.78
CaCO3 %	30.99	30.49	34.54	23.38
Organic matter %	1.36	1.10	0.40	1.21
pH	8.1	7.9	8.5	7.8
Phosphorus %	0.0025	0.0057	0.0658	0.0050
Sodium (ppm)	2750.00	2465.00	1845.00	1250.00
Potassium (ppm)	385.00	150.00	125.00	496.00

stage of succession on disturbed areas. Whereas the *Prosopis glandulosa-P. juliflora-Withania somnifera* community occurred on the most disturbed sites because of the vigorous growth form.

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