

THE RELATIONSHIP OF SEED BANK TO VEGETATION IN A SALINE DESERT COMMUNITY

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ABSTRACT

Species of seed bank and those occurring in vegetation are compared for three desert halophytic shrub communities. Seed bank flora closely resembled with that of perennial halophytic vegetation. Some weed species were also found in the seed bank. Both above and below ground component of communities are dominated by halophytic species like *Suaeda fruticosa*, *Cressa cretica*, *Haloxylon recurvum* and *Salsola baryosma*. Soil analysis indicated the presence of high salinity in all three communities.

INTRODUCTION

The seed bank in the soil of most plant communities represents a vast pool of regenerative potential. Seed bank studies are of fundamental ecological interest and have been made in many habitats and vegetation types like tropical forest (Hopkins & Graham, 1983), coniferous forest (Granstrom, 1987), agricultural habitats (Angela et al., 1988) grassland (Coffin & Lauenroth, 1989), prairie glacial marshes (van der Valk & Davis, 1978), coastal and inland saline habitats (Hopkins & Parker, 1984; Philipupillai & Ungar, 1984; Smith & Kadlec, 1983; Ungar, 1984, 1988; Ungar & Riehl, 1980; Wertis & Ungar, 1986) and desert community (Henderson et al., 1988). This growing popularity of seed bank studies pertaining to the fact that it gives a clear picture of previous envi-

ronments, its ability to act as an evolutionary filter which determines the potential of the genotype to survive the selective pressure of the changing environment and its role in community regeneration after disturbance as the colonizing pattern is dependent on the recruitment of the species from buried seed pool along with the seed dispersal from the adjacent areas. The accumulated deposits in the seed bank bear limited resemblance to the overlying vegetation, even though the seed bank is derived from and in conjunction with vegetative regeneration, is ultimately the source for the plants represented at various stages in community development.

Diversity and relationship of seed bank with that of vegetation in arid and warm regions are not well documented

(Bullock, 1976; Henderson et al., 1988; Coffin & Lauenroth, 1989). Seed bank may play a very important role in maintaining plant species in the harsh environment. The purpose of the present study was to determine the relative abundance of the flora in seed bank and its relationship to the vegetation of three salt desert communities.

MATERIALS AND METHODS

(a) *Site Description* : The study area is located on the Karachi University Campus, 22 km north of the Arabian sea and about 8 km north of Karachi city (latitude 24°48'/N and longitude 66°55'/E). Karachi represents a sandy desert belt of Pakistan along the Arabian coast. The climate of Karachi is sub-tropical maritime desert (Chaudhry, 1961). Rainfall is seasonal, averaging 22 cm per year between June and September and very rare for the remainder of the year. Occasionally there are dry years too. The mean maximum temperature is 35°C in July and mean minimum temperature is 15°C in January. The temperature remains suitable for plant growth through the year. Strong coastal winds and dew formation are the characteristic features of Karachi.

The field studies were conducted at three saline plant communities having predominantly shrubby halophytic composition. Moderate grazing by cattle occurred throughout the sites.

(b) *Vegetation Sampling* : The plant communities were sampled using Point-centred Quarter method (Cottam & Curtis, 1956). The species composition of each site was evaluated by placing the grid randomly on 20 different points.

(c) *Seed Bank Sampling* : Forty soil seed bank samples were collected by using 9×9 cm metal soil core with a depth of 15 cm. The soil samples were placed in the plastic bags and transported to the laboratory. Twenty soil samples were spread in the aluminum trays and sufficient water was provided regularly for seed germination. Seedlings were identified, counted and then were removed. Every 15 day soil present in the tray was upturned to expose more seeds to the light. This process continued

for six weeks. The 20 remaining soil samples from each community were used to sort the seeds manually. Soil samples were examined under the binocular and the seeds were separated. Seed of various species were sorted into various groups and identified with the help of the seed collection from existing flora and specimens present in Karachi University Herbarium.

(d) *Soil Sampling and Analysis* : Twenty soil samples were collected at 0 - 15 cm depth using the metal soil core of 9×9 cm in diameter. Soil samples brought to the laboratory were dried, larger pebbles and plant parts removed and stored in a plastic bag for physico-chemical analysis. Soil texture determined by Bouyoucous hydrometer method (Bouyoucous, 1951) pH analyses were performed by using 10 g soil to 10 ml of distilled water and further dilution series 1:2, 1:3, 1:4, and 1:5 were made. pH was measured using a pH meter (Radiometer CD-83). Carbonate was determined by acid neutralization method.

Salinity measurements were made using conductivity meter (Radiometer, CD-83). Ten gram of air-dried soil in 50 ml of water was agitated for 2 h with mechanical shaker and then filtered with Buchner funnel using vacuum extraction. Ammonium acetate extraction procedure was used to estimate Na and K concentrations in the soil using flame photometer.

RESULTS

(a) *Vegetation* : Table 1 represented the data on relative frequency, relative density and relative cover of the vegetation in three halophytic communities. All three communities are dominated by perennial halophytic shrubs. The species diversity is very low and only few species, viz *Suaeda fruticosa*, *Salsola baryosma*, *Haloxyylon recurvum* and *Cressa cretica* represented the vegetation of all the communities. However, their relative frequency and relative density value varied appreciably. Community 1 was dominated by *Cressa cretica* and community 2 and 3 by *Suaeda fruticosa*.

(b) *Soil Analysis* : The data of physical

Table 1 : Species composition of three saline desert communities, showing relative density (RD), relative frequency (RF) and relative cover (RC) for each species in all communities

Species	Plant community								
	I			II			III		
	RD	RF	RC	RD	RF	RC	RD	RF	RC
<i>Suaeda fruticosa</i>	22	27	35	53	53	47	69	11	39
<i>Cressa cretica</i>	75	67	39	3	3	4	—	—	—
<i>Salsola baryosma</i>	3	6	26	17	17	17	5	22	19
<i>Haloxylon recurvum</i>	—	—	—	10	10	8	18	56	25
<i>Prosopis juliflora</i>	—	—	—	17	17	24	—	—	—

and chemical analyses of the soil of three communities are presented in Table 2. Results indicate that the soil of all three communities studied are sandy clay loam with high salinity and carbonate content. All the communities show an alkaline pH.

Table 2 : Physical and chemical analyses of soils collected from three communities

Soil parameters	Plant community		
	I	II	III
Texture	Sandy clay loam	Sandy clay loam	Sandy clay loam
pH	8.6	8.5	8.3
Conductivity (ms/cm)	25.6 ±3.9	34.0 ±11.2	22.6 ±5.0
Na ⁺ (%)	0.44 ±0.18	0.35 ±0.11	0.34 ±0.10
K ⁺ (%)	0.065 ±0.002	0.001 ±0.001	0.007 ±0.002
CO ₃ (%)	17.4 ±3.9	13.8 ±2.5	11.0 ±1.8

(c) *Seed Bank* : Species that were present in the seed bank of three halophytic communities studied are reported in Table 3. In all 12 species are present in the seed bank of community I. When soil cores collected from community I were irrigated with distilled water only few seeds of *Suaeda fruticosa* germinated. While other seeds

present in the seed bank remained dormant. Community 2 consisted of 14 species in the seed bank. Germination studies resulted in the germination of only 8 relatively salt tolerant species. Nineteen species comprised of the seed bank of community 3. However, only 4 species germinated in the laboratory. Vegetation is represented by only perennial halophytes but flora present in seed reserve have lot of annual weeds e.g. *Leucas urticaefolia*, *Aristida mutabilis*, *Ipomoea sindica*, *Gleome viscosa*, *Tephrosia strigosa*, etc.

DISCUSSION

There is little information available regarding the significance of the seed bank in regulating the plant populations occurring in coastal and saline habitats (Hopkins & Parker, 1984; Philipupillai & Ungar, 1984, Smith & Kadlec, 1983; Ungar, 1984, 1987 a, b; Ungar & Reihl, 1980; Wertis & Ungar, 1986). The present study of the desert halophytic communities allowed us to assess the relationship of soil seed flora with that of existing vegetation. All the three halophytic communities show low diversity. Very few perennial halophytes, viz. *Suaeda fruticosa*, *Cressa cretica*, *Salsola baryosma*, *Haloxylon recurvum*, and *Prosopis juliflora* were present in the community with different levels of dominance in various communities. However, soil reserve flora show the presence of many annual and perennial fugitive species. Low diversity of the

Table 3 : Seed bank/m² and seedling/m² composition at the salt desert communities

Species	Plant community					
	I		II		III	
	Seed density	Seedling density	Seed density	Seedling density	Seed density	Seedling density
<i>Suaeda fruticosa</i>	981±91	10±2.1	332±110	4±1.2	233±35.9	4±1.2
<i>S. nudiflora</i>	6±4	—	3±0.8	1	1	—
<i>Salsola baryosma</i>	4±2	—	±1.8	1	2.0±0.8	1
<i>Haloxylon recurvum</i>	1	—	5±1.4	—	1	—
<i>Cressa cretica</i>	1	—	2±0	—	1	—
<i>Atriplex griffithii</i>	1	—	1	—	—	—
<i>Amaranthus viridis</i>	—	—	1	—	1	—
<i>Leucas urticaefolia</i>	—	—	1	—	14±4.5	—
<i>Salvia santolinifolia</i>	—	—	1	—	—	—
<i>Zygophyllum simplex</i>	2±1.2	—	19±2.0	2.4±1.1	10±2.6	2±0.8
<i>Blepharis indica</i>	—	—	6±1.8	1	4±1.6	—
<i>Commicarpus boissieri</i>	—	—	9±2.4	1	5±2.0	—
<i>Aristida mutabilis</i>	6±2.5	—	15±3.8	1	25±2.8	3±1.5
<i>Cyperus rotundus</i>	5±1.8	—	12±5.4	1	—	—
<i>Ipomoea indica</i>	—	—	—	—	—	—
<i>Eragrostis ciliaris</i>	—	—	—	—	10±2.6	—
<i>Tragus biflorus</i>	—	—	—	—	6±3.1	—
<i>Clome viscosa</i>	2±1.5	—	—	—	2±1.1	—
<i>Digera muricata</i>	1	—	—	—	1±0.2	—
<i>Tephrosia strigosa</i>	—	—	—	—	1	—
<i>Convolvulus glomeratus</i>	1	—	—	—	1	—
<i>Eragrostis pilosa</i>	—	—	—	—	1	—
<i>Heliotropium ophioglossum</i>	—	—	—	—	1	—

community could be attributed to the high salinity. Only those plants which can tolerate high level salinity could be represented in existing vegetation.

Soil seed bank was dominated by *Suaeda fruticosa* in all the three communities even in the community I where *Cressa cretica* dominated the vegetation. Little representation of *Cressa cretica* in soil reserve is significant. In addition other halophytic species also have very poor representation in the seed bank. Comprehensive information on the characteristics of a particular species seed pool, particularly in a desert region is sparse. Therefore, only theoretical considerations can be made. *Suaeda nudiflora* seeds present in the reserve of all three communities and its virtual absence from the above ground flora.

This pattern could be due to the unsuitable conditions, e.g. high salinity or competition with *Suaeda fruticosa* for its germination and establishment in all three communities studied. It also indicates that it may be a relict of the past vegetation.

The presence of rare species like *Amaranthus viridis*, *Ipomoea indica* and *Salvia santolinifolia* in the seed bank can be related to the propensity of resources. The seed bank data also show that a transient pattern occurs for the *Cressa cretica* species. Seed predation might create the differences between transient and persistent seed pools (Louda, 1989) so the loss of the seeds from the seed bank due to predation may be another reason for the paucity of *Cressa cretica* seeds.

Similar results were also shown by Hopkins & Parker (1984) for perennial salt marsh species. Numerically the seed bank of all three saline sites are dominated by relatively few species. The presence and prevalence of *Suaeda fruticosa* in all the communities suggest the strategy in which a few seeds germinate and most of them go to seed bank, thus forming a persistent seed bank.

The relationship between qualitative and quantitative characteristics of the soil seed reserve and existing plant populations have been reported to be poor (Keddy & Reznicek, 1982; Roach, 1983; Ungar, 1987 a). On the contrary Leck & Graveline (1979) and Parker & Leck (1985) found a good relationship between seed pool and floral composition of marshes.

There is very little information available concerning the nature of seed reserves and its effect on population dynamics. Milton (1939) reported considerable variability between the soil seed reserves and actual species composition of halophytic communities. Ungar

(1987a) reported that a persistent seed bank of small seeds of *Salicornia europaea* plays a significant role in maintaining plant populations in highly stressful salt marsh habitat. Wertis & Ungar (1986) reported the same response for *Atriplex triangularis* seed bank. The estimated number of seed bank reported in these saline desert communities are far more smaller than reported for wetland communities (Hopkins & Parker, 1984; Ungar, 1987b; Wertis & Ungar, 1986) and similar to that reported to desert communities (Coffin & Laurenroth, 1989). However, the relative density of seeds vary significantly in the present saline desert communities. Some species have maintained a large seed bank while others very small.

Suaeda fruticosa is the only species that represents a persistent seed bank while all other species a more or less transient seed bank. Further attempt will be made to understand the seasonal dynamics of the seed bank and their regulatory role in maintaining the vegetation.

REFERENCES

- Angela, E.D., Facelli, J.M. and Jacoba, E. 1988. The role of seed bank in early stages of a post agricultural succession in the inland Pampa, Argentina. *Vegetatio* **74** : 39-45.
- Boyocous, G.J. 1951. A recalibration of the hydrometer method for making mechanical analysis of soils. *Agron J.*, **43** : 434-438.
- Bullock, S.H. 1976. Comparison of the distribution of seed and present-plant populations. *Southwestern Naturalist* **21** : 383-389.
- Chaudhry, I I. 1961. The vegetation of Karachi. *Vegetatio* **10** : 229-246.
- Coffin, D.P. and Lauenroth, W.K. 1989. Spatial and temporal variation in the seed bank of a semiarid grassland. *Amer. J. Bot.*, **76** : 53-58.
- Cottam, G. and Curtis, J.T. 1956. The use of distance measure in phytosociology sampling. *Ecology* **37** : 451-460.
- Granstrom, A. 1987. Seed viability of fourteen species during five years of storage in a forest soil. *J. Ecol.*, **75** : 321-331.
- Henderson, C.B., Petersen, K.E. and Redak, R.A. 1988. Spatial and temporal patterns in the seed bank and vegetation of a desert grassland community. *Ibid*, **76** : 717-728.
- Hopkins, M.S. and Graham, A.W. 1983. The species composition of soil seed banks beneath lowland tropical rain forest in North Queensland, Australia. *Biotropica* **15** : 90-99.
- Hopkins, D.R. and Parker, V.T. 1984. A study of a seed bank of a salt marsh in northern San Francisco Bay. *Amer. J. Bot.*, **71** : 348-355.
- Keddy, P.A. and Reznicek, A.A. 1982. The role of seed banks in the persistence of Ontario's coastal plain flora. *Ibid.*, **69** : 13-22.
- Leck, M.A. and Graveline, K. J. 1979. The seed bank of a fresh water tidal marshes. *Ibid*, **66** : 1006-1015.
- Louda, S. 1989. Predation in the dynamics of seed bank regeneration. In : *The Ecology of Seed Bank*, (eds.) V.T. Parker, M.A. Leck & R.L. Simpson, Academic Press.

- Milton, W.E.J. 1939. The occurrence of buried viable seeds in soils at different elevation and on a salt marsh. *J. Ecol.*, **27** : 149-159.
- Parker, V.T. and Leck, M.A. 1985. Relationship of seed banks to plant distribution pattern in a fresh water tidal wetland. *Amer. J. Bot.*, **72** : 161-174.
- Philipupillai, J. and Ungar, I.A. 1984. The effect of seed dimorphism on the germination and survival of *Salicornia europaea* L. populations. *Ibid.*, **71** : 542-549.
- Roach, D.A. 1983. Buried seed and standing vegetation in two adjacent tundra habitats in northern Alaska. *Oecologia* **60** : 359-364.
- Smith, L.M. and Kadlec, J.A. 1983. Seed banks and their role during drawdown of a North American marsh. *J. Appl. Ecol.*, **20** : 673-684.
- Ungar, I.A. 1984. Autecological studies with *Atriplex triangularis*. In : *Symposium on the Biology of Atriplex and Related Chenopods*, (eds.) Tiedmann, A.R., McArthur, E.D., Stutz, H.C., Stevens, K.R. & Johnson, K.L. General Technical Report INT-172, USDA Forest Service, Provo, Utah. pp. 309.
- Ungar, I.A. 1987a. Population ecology of halophyte seeds. *Bot. Rev.*, **53** : 301-334.
- Ungar, I.A. 1987b. Population characteristics, growth, and survival of halophyte *Salicornia europaea*. *Ecology* **68** : 569-575.
- Ungar, I.A. 1988. A significant seed bank for *Spergularia marina* (Caryophyllaceae). *Ohio. J. Sci.*, **88** : 200-202.
- Ungar, I.A. and Reihl, T.E. 1980. The effect of seed reserves on species composition in zonal halophytic communities. *Bot. Gaz.*, **141** : 447-452.
- van der Valk, A.G. and Davis, C.B. 1978. The role of seed banks in vegetation dynamics of prairie glacial marshes. *Ecology* **59** : 322-335.
- Wertis, B.A. and Ungar, I.A. 1986. Seed demography and seedling survival in a population of *Atriplex triangularis* Willd. *Amer. Middl. Naturalist* **116** : 153-162.