

SEED BANKS OF COASTAL SHRUB COMMUNITIES

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ABSTRACT

Seed banks of six coastal communities around the coast of Arabian sea near Karachi were studied. All these communities have loamy sand with alkaline pH. Level of soil salinity vary greatly. Seed bank size was small with only *Arthrocnemum indicum* (Willd.) Moq. and *Halosarcia indica* (Willd.) Wilson having more than 100 seeds/m². There was a strong relationship between the vegetation and seed bank. Species diversity in general was low with the exception of communities III and IV.

Key words: Coastal shrub vegetation, seed bank, seed density, relative frequency, soil properties.

INTRODUCTION

There are few reports on the seed bank of coastal and inland saline habitats (Hopkins & Parker 1984, Philipupillai & Ungar 1984, Smith & Kadlec 1983, Ungar 1984, 1988, Ungar & Riehl 1980, Wertis & Ungar 1986, Zaman & Khan 1992) and on the coastal desert environment (Aziz & Khan 1993).

Perennial salt marsh species either did not produce a persistent seed bank or maintain a relatively small number of buried seeds in the soil (Hopkins & Parker 1984). In hypersaline environment, the vegetation is strongly represented in the seed bank (Hopkins & Parker 1984, Philipupillai & Ungar 1984, Ungar & Riehl 1980). Coastal salt marsh communities have been reported to possess seed densities ranging from a low number of 380 seeds/m² (Hopkins and Parker 1984) to as high as 140,000 seeds/m² (Jerling 1984). It has been suggested that seed numbers are limited by nutrient availability (Lamont *et al.* 1985, Cowling *et al.* 1986, Stock *et al.* 1989). Distinctly segregated species patterns were found to be related to soil salinity in an inland salt marsh in Ohio (Ungar & Riehl 1980).

The seed bank of coastal desert environment is poorly understood. Most of the recruitment takes place through vegetative propagation. The aim of this paper was to study the seed bank of communities around the coast of Arabian sea near Karachi.

MATERIAL AND METHODS

The study sites are situated along the coast of Arabian sea near Karachi, Pakistan (Latitude 24° 48' N, Longitude 65° 55' E). Annual rainfall is less than 220 mm during the monsoon usually between June and September but occasionally there may be years without rain. Average temperature ranges from 35°C in July to 15°C in January.

Six stands were selected along the coastal areas of Karachi. Study sites I, II and III were located at Clifton, IV and V at Sandspit and VI at Gidani. All six study sites were dominated by perennial halophytic species. Point centered quarter methods (Cottam & Curtis 1956) was used to sample the vegetation over 20 random points and relative frequencies were calculated for each species in all communities.

Seed bank analysis was carried out by taking 20 random samples from each stand with a soil corer 2.5 cm in diameter and 15 cm in length. The samples were stored in plastic bags for subsequent laboratory analysis. Soil samples were air dried and seeds of each species were sorted manually and counted with the help of a binocular microscope. Seeds which appeared intact and viable were included in the count and identified by comparing with seed samples.

The intra-group heterogeneity of seed was determined by calculating diversity in terms of species richness, diversity (H) (Shanon & Weaver 1949) and evenness (J) (Pielou 1966) with the computer package SPDIVERS (Ludwig & Reynolds 1988). Cluster analysis of seed bank of six communities was performed using the Relative Euclidian Distance index and Group Average strategy with the computer package CLUSTER (Ludwig & Reynolds 1988).

Ten soil samples were randomly collected from each study site using a soil auger, 5 cm in diameter from a depth of 15 cm, and stored in plastic bags. Each soil sample was air dried and texture was determined using Boyoucouos methods (Boyoucouos 1951). Ten gram sieved soil was mixed with 50 ml distilled water and after 60 min the pH (Radiometer Ion 85, Ion Analyzer) and soil conductivity (Radiometer CD-83, conductivity meter) was measured. Concentrations of Na^+ and K^+ were determined with the help of Flame Photometer using Ammonium acetate for extraction. Three gram of sieved soil was weighed for the estimation of alkaline earth carbonates (CaCO_3) by acid neutralization technique (USDA 1951).

Statistical analysis was performed using SPSS/PC⁺ statistical package (Nie *et al.* 1975) on an IBM-286 computer.

RESULTS

Soil texture in all six communities was loamy sand. Based on the level of soil moisture, the soil type was classified as wet (communities I and VI), moist (communities II and V) and dry (communities III and IV) (Table 1). Communities I, II, III and VI showed a neutral pH, whereas in communities IV and V pH was alkaline. Community VI showed high salinity ($\text{EC} = 29.8 \text{ mS cm}^{-1}$), followed by communities I and II with moderate, while communities III, IV and V had mild salinities (Table 1). Sodium ion was high in community VI, lower in communities I and II and very low in communities III, IV and V. Potassium ion was high in community VI, low in communities I, II, and III and much lower in communities IV and V. Alkaline earth carbonate (CaCO_3) was low in communities I and II while it was slightly higher in communities III, IV, V and VI (Table 1).

Seed bank size was generally small. *Arthrocnemum indicum* and *Halosarcia indica* were the only species with 100 seeds/m² or more (Table 2). A total of 11 species were found in the seed bank. In all communities seed bank was dominated by the most abundant species in the above ground vegetation.

All communities studied were dominated by perennial shrubs. Community I and II were dominated by *Arthrocnemum indicum*, community III by *Halopyrum mucronatum* (L.) Stapf, community IV by *Calotropis procera* (Willd.) R. Br., community V by *Cressa cretica* L. and community VI by *Halosarcia indica*. Relative frequencies of plant species are given in Fig. 1. A species presence list including the names of all those plants not encountered during sampling is given in Table 4.

Numbers of viable seeds between communities I and VI and communities III and IV were not different from each other. Communities I and VI had wet, while communities III and IV had dry soil types (Table 1).

Communities I and II were early clustered into a group than communities III and IV (Fig. 2). Both the former communities were adjacent to each

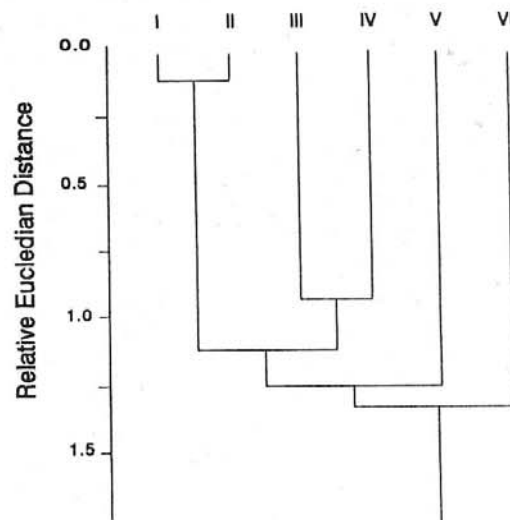


Fig. 1. Dendrogram for the cluster analysis of six communities using Relative Euclidian Distance Index and Group Average strategy.

other with *Arthrocnemum indicum* as the common seed bank species. Communities III and IV were clustered in a group although they had no species in common but both had similar species richness (Table 3) and seed density (Table 2). Communities V and VI were not clustered into any group whatsoever.

Species diversity (H') and evenness (J') were high in communities III and IV (Table 3) although total seed density was low as compared to communities V and VI. This may be due to low species evenness in communities III and IV. Communities V and VI had intermediate values of diversity (H') and evenness (J').

Table 1. Results of physical and chemical soil analyses of the different communities.

Soil Parameter	Plant Community					
	I	II	III	IV	V	VI
Soil type	Wet	Moist	Dry	Dry	Moist	Wet
Texture	LS	LS	LS	LS	LS	LS
pH	7.49 ^b	7.34 ^{bd}	7.52 ^b	8.11 ^c	7.91 ^a	7.16 ^d
EC (mS cm ⁻¹)	7.42 ^a	7.15 ^a	2.24 ^a	1.17 ^b	1.95 ^b	29.75 ^c
Na ⁺ (ppm)	1660 ^a	1873 ^a	620 ^b	395 ^b	588 ^b	3535 ^c
K ⁺ (ppm)	158.33 ^{ae}	183.00 ^a	111.67 ^{de}	50.00 ^b	48.33 ^b	568.33 ^c
CaCO ₃ (%)	13.38 ^a	13.33 ^a	16.75 ^b	17.09 ^b	17.10 ^b	16.75 ^b

Values in row for each community having the same letter are not significantly different at 1% level by Duncan's Multiple Range test. LS= Loamy Sand.

Table 2. . Seed density (seeds m⁻²) at the six communities.

Species	Plant Community					
	I	II	III	IV	V	VI
<i>Suaeda fruticosa</i>	-	2.6	1.5	-	-	-
<i>Cressa cretica</i>	-	-	-	-	16.8	2.0
<i>Halopyrum mucronatum</i>	-	-	0.8	-	0.3	-
<i>Halosarcia indica</i>	-	-	-	-	-	100.5
<i>Calotropis procera</i>	-	-	-	0.5	-	-
<i>Arthrocnemum indicum</i>	110.2	33.7	-	-	-	-
<i>Aerua pseudotomentosa</i>	-	-	-	-	-	0.5
<i>Atriplex griffithii</i>	-	-	-	2.3	-	0.5
<i>Haloxylon recurvum</i>	-	-	-	1.8	-	-
<i>Cenchrus pennisetiformis</i>	-	-	1.5	-	-	-
<i>Amaranthus graecizans</i>	-	-	-	-	0.3	-

Table 3. Diversities shown as species richness, species diversity and evenness of seed bank at each site.

Community	Richness	Diversity (H)	Evenness (J)
I	1	0.00	1.70
II	2	0.24	0.36
III	3	1.06	0.96
IV	3	0.96	0.87
V	3	0.15	0.14
VI	4	0.16	0.12

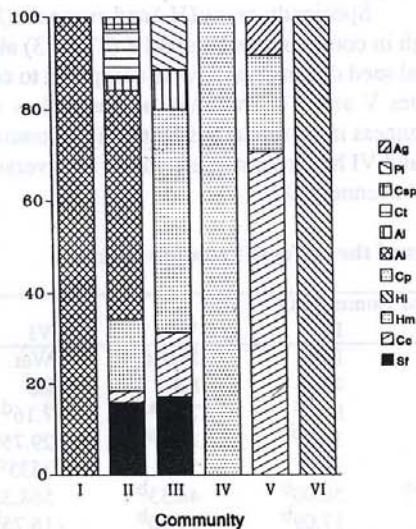


Fig. 2. Histogram showing Relative Frequencies of species of above ground vegetation in different communities. Ag = *Atriplex griffithii*; Pl = *Pluchea lanceolata*; Csp = *Cenchrus penisetiformis*; Ct = *Cistanche tubulosa*; Al = *Aeluropus lagopoides*; Ai = *Arthrocnemum indicum*; Cp = *Calotropis procera*; Hi = *Halosarcia indica*; Hm = *Halopyrum mucronatum*; Cc = *Cressa cretica*; Sf = *Suaeda fruticosa*

Table 4. Species presence list in six communities studied.

Community I
<i>Arthrocnemum indicum</i> (Willd.) Moq.
<i>Avicennia marina</i> (Forsk.) Vierh.
<i>Cistanche tubulosa</i> (Schenk) Wight.
Community II
<i>Arthrocnemum indicum</i> (Willd.) Moq.
<i>Halopyrum mucronatum</i> (L.) Stapf
<i>Suaeda fruticosa</i> Forsk. ex Gmelin
<i>Cistanche tubulosa</i> (Schenk) Wight
<i>Aeluropus lagopoides</i> (L.) Trin. ex Thw.
<i>Cenchrus penisetiformis</i> Hochst. & Steud.
<i>Cressa cretica</i> L.
Community III
<i>Halopyrum mucronatum</i> (L.) Stapf
<i>Suaeda fruticosa</i> Forsk. ex Gmelin
<i>Cressa cretica</i> L.
<i>Pluchea lanceolata</i> Oliv. & Hiern
<i>Aeluropus lagopoides</i> (L.) Trin. ex Thw.

Ipomoea pes-caprae (L.) Swt.
Cenchrus penisetiformis. Hochst. & Steud.
Community IV
Cressa cretica L.
Atriplex griffithii Moq. var. *stocksii* Boiss.
Halopyrum mucronatum (L.) Stapf
Community V
Calotropis procera (Willd.) R. Br.
Halopyrum mucronatum (L.) Stapf
Cressa cretica L.
Community VI
Halosarcia indica (Willd.) P.G.) Wilson
Arthrocnemum indicum (Willd.) Moq.

DISCUSSION

Coastal areas around Karachi are primarily dominated by perennial shrubby halophytes with few perennial bunch grasses. Some of the populations studied were present in Manora creek while others directly facing the open sea. The primary mode of recruitment in most of the coastal population is through vegetative propagation. Rhizomes and stolons are the predominant way of introducing a new individual. However, all the halophytic shrubs appear to produce a large number of seeds. The present study shows that coastal halophytic shrub communities do maintain a seed bank (usually less than 100 seeds / m²) which is quite small as compared to the size of the seed bank reported from the moist cool salt marshes of North America (Ungar & Riehl 1980, Jefferies *et al.* 1981, 1983, Keddy & Reznicek 1982, 1986, Smith & Kadlec 1983, Hopkins & Parker 1984, Ungar 1984, 1988, 1990).

Khan (1990) in his studies on the seed bank of inland saline desert communities observed that seed bank flora resembled more closely with perennial halophytic vegetation. There was a poor relationship between the seed bank and existing vegetation. *Suaeda fruticosa* showed a persistent seed bank while other halophytes showed a transient nature. Khan (1993) reported a similar pattern of the seed reserve where the seed bank from two different communities showed that except for *Suaeda fruticosa* all other species had a sizeable seed bank immediately after dispersal and rapidly declined thereafter.

Aziz & Khan (1993) in studies on the seed bank of a coastal desert community dominated by *Cressa cretica* found that perennial halophytic population has considerable relationship in the seed bank

but the seed bank flora is more diverse than existing vegetation. Hopkins & Parker (1984) reported that in highly saline areas the existing vegetation is usually well represented in the seed bank. Hartman (1984) studied the degree of similarity between the vegetation and seed bank and found that a number of species well represented in the seed bank were sparse in the vegetation. Marked difference in buried seed reserves and vegetation of halophytic communities were noted (Oosting & Humphreys 1940, Olmsted & Curtis 1947, Major & Pyott 1966, Livingston and Allesio 1968, Roach 1983 and Parker & Leck 1985).

Zaman & Khan (1992) studied an inland community of *Cressa cretica* a halophytic shrub and found a transient nature of the seed bank. The presence of a transient seed bank was also reported in the communities of *Impatiens capensis* (Thompson & Grime 1979) and *Cirsium vulgare* (De Jong & Klinkhamer 1988).

The present survey of the seed bank of coastal communities showed strong relationship between seed bank and shrubby vegetation. Species diversity of vegetation as well as seed bank was very low. There is a need to understand the seasonal dynamics and also the role of seed bank in populations predominantly recruited through vegetative reproduction.

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