Journal of Arid Environments (1996) **34**: 81–87

Seed bank dynamics of a semi-arid coastal shrub community in Pakistan

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(*Received 26 March 1994, accepted 20 June 1995*)

The relationship between the seed bank and existing vegetation was studied. Seed bank flora and existing vegetation show a high degree of similarity and *Cressa cretica* dominated both; a few rare species were also present. Seasonal variation in the seed bank was also studied for the 1989–90 and 1990–91 growing seasons. Most species demonstrated the persistent nature of the seed bank with their numbers increasing after seed dispersal and decreasing in subsequent months. The seed bank of a coastal community in Sindh, Pakistan could be used to predict existing vegetation.

Keywords: *Cressa cretica*; coastal community; desert; halophyte; seed bank; semi-arid; subtropical

Introduction

Recent studies on saline desert communities have attempted to describe the relationship between existing vegetation with that of the seed bank and their seasonal dynamics (Khan, 1991, 1993; Zaman & Khan, 1992; Gulzar & Khan, 1994). Khan (1991) reported a poor relationship between seed bank and vegetation. The seed bank included a large number of annuals in addition to the perennials present in the vegetation. Khan (1993) studied six inland halophytic communities and reported a similar pattern. He found *Suaeda fruticosa* (L.) Forssk. dominated the seed bank of all six communities and showed a persistent presence in the seed bank irrespective of the dominant above-ground species. All other perennials had a transient presence in the seed bank.

Zaman & Khan (1992) studied the temporal dynamics of two inland halophytic shrub communities. They reported that perennial halophytic shrubs dominated both the vegetation and seed bank. The quantities of *Cressa cretica* L., *Salsola imbricata* Forssk. (syn. *S. baryosma* (Roem. & Schultes) Dandy), and *Haloxylon recurvum* (Moq.) Bunge ex Boiss. seeds varied with the growing season, showing a transient presence, while *Suaeda fruticosa* persisted in the soil in large numbers. Gulzar & Khan (1994) reported a close relationship between the seed bank and existing vegetation in coastal desert shrub communities. Maximum seed density reported was 10,000 seeds m^{-2}.

The temporal seed bank dynamics of coastal desert communities have not been

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studied intensively. The aim of the present study was to determine the relationship between seed reserves and vegetation and the seasonal dynamics of seed banks.

Study area

Sands Pit, a sandy beach, is located on the Karachi coast (24° 54' N, 66° 56' E). A phytosociological survey of the community was carried out during October 1989 using the point centred quarter method of Cottam & Curtis (1956). The community was dominated by an almost pure stand of *Cressa cretica* with rare specimens of *Atriplex griffithii* Moq., *Halopyrum mucronatum* (L.) Stapf, *Cyperus conglomeratus* Rottl. and *Polycarpaea spicata* Wight & Arn. also present. A few individuals of *Suaeda fruticosa*, *Zygophyllum simplex* L., and *Heliotropium curassavicum* L. were to be found in the vicinity, albeit outside the study area. Elsewhere the coastal desert communities of Karachi and its vicinity included such additional species as *Haloxylon recurvum*, *Halosarchia indica* (Willd.) P.G. Wilson (syn. *Arthrocnemum indicum* (Willd.) Moq.), *Limonium stocksii* (Boiss.) Kontze and the perennial grasses *Aleuropus lagopoides* (L.) Trin. ex Thwaites, *Sporobolus arabicus* Boiss. and *Urochondra setulosa* (Trin.) C.E. Hobbard.

Materials and methods

Twenty random soil cores were collected using a 1·5-cm diameter corer to a depth of 15 cm. Samples were collected in plastic bags at monthly intervals over a period of 2 years from October 1989 to September 1991. Seeds were manually sorted with the help of a binocular microscope, identified from a master collection, and counted.

Results

The seed bank of the coastal community showed a close relationship with the vegetation. The seed bank was represented by nine species while the vegetation survey indicated that there were only five species (Table 1); both were clearly dominated by

Table 1. *Vegetation and seed bank characteristics of a* Cressa cretica *community*

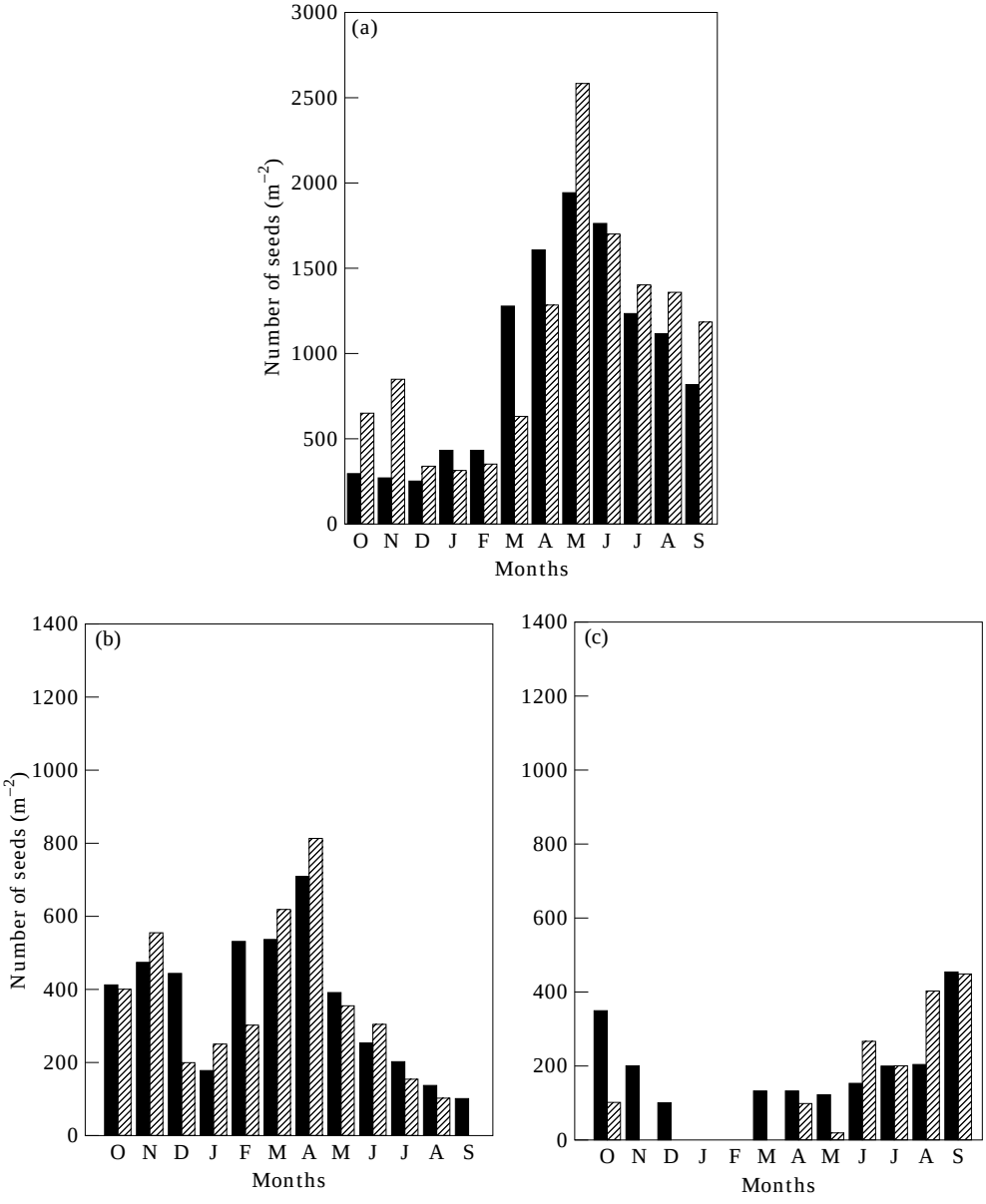
	Vegetation			Seed bank density (m^{-2})	
Species	RD	RF	RC	1989–90	1990–91
Cressa cretica	86	77	92	1930	2520
Atriplex griffithii	3	8	4	810	540
Cyperus conglomeratus	5	7	1	380	300
Halopyrum mucronatum	2	4	3	350	250
Polycarpaea spicata	2	4	1	30	–
Aleuropus lagopoides	–	–	–	1550	1100
Suaeda fruticosa	–	–	–	350	250
Zygophyllum simplex	–	–	–	330	200
Heliotropium currassavicum	–	–	–	440	–
Total seeds				6170	5160

RD = relative density; RF = relative frequency; RC = relative cover.

C. cretica, with *A. griffithii* and *Cyperus conglomeratus* forming the larger proportion of the minor constituents.

The seasonal distribution of all nine species was followed for two growing seasons (Fig. 1(a–c)). *Cressa cretica* persisted in the seed bank (Fig. 1(a)). The number of seeds peaked at 2800 seeds m^{-2} after seed dispersal during May in both seasons and declined thereafter. Seeds of *Aleuropus lagopoides* (L.) Trin. ex Thwaites, *Halopyrum mucronatum* and *Cyperus conglomeratus* were found in the soil samples throughout the season and their number increased slightly after dispersal (Fig. 1(b,c,e)). Seeds of *Polycarpaea spicata* were rare and were found only after dispersal (Fig. 1(d)).

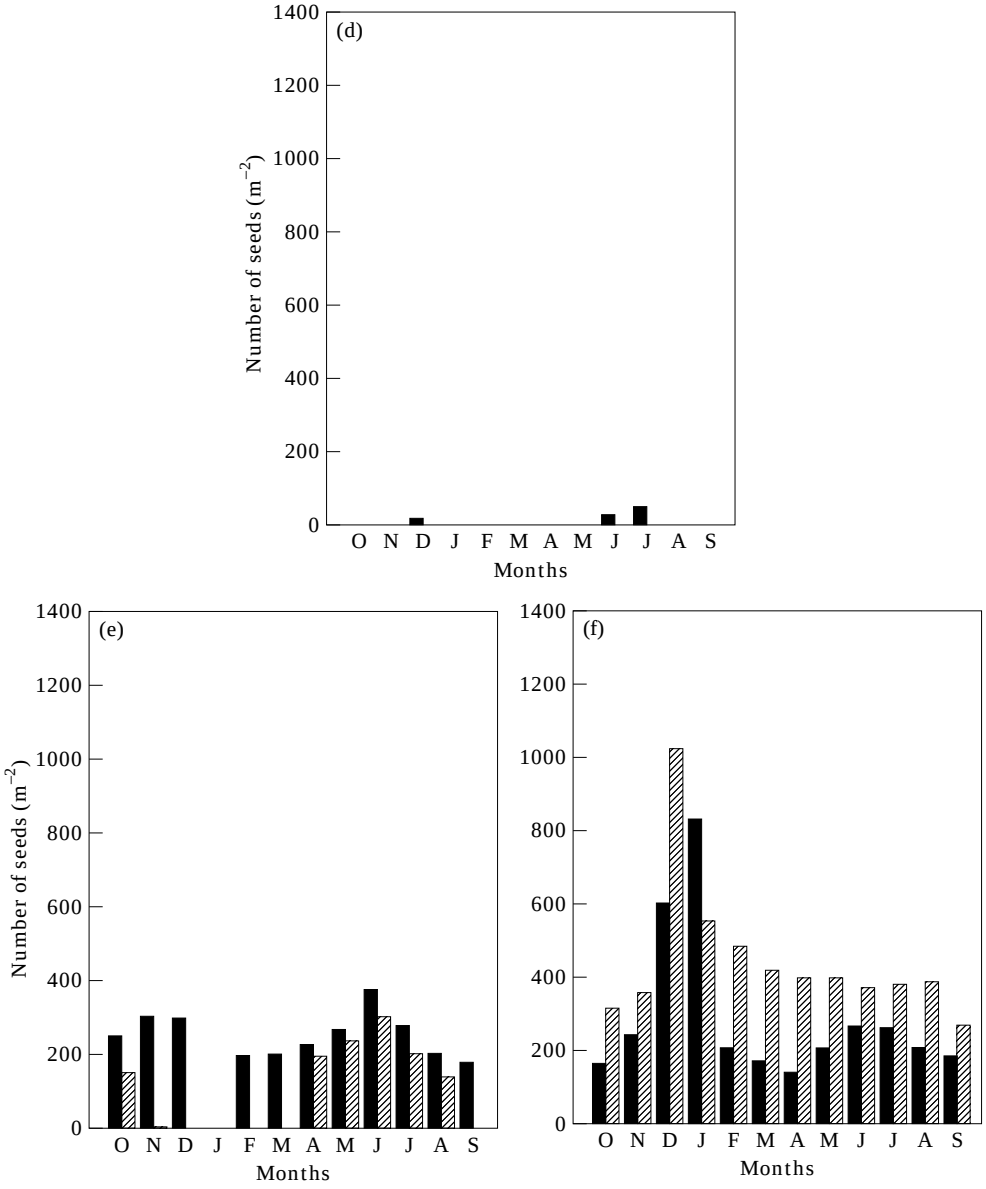
Very low numbers of *A. griffithii*, *S. fruticosa* and *Z. simplex* were usually present in



the seed bank throughout the season (Table 1). There was apparently no change in the seed bank of *Z. simplex* and *S. fruticosa* after dispersal but *A. griffithii* showed some increase in number. Seeds of *Heliotropium curassavicum* also occurred rarely.

Discussion

High soil salinity is probably the cause of low species diversity. Rain, inundation by sea, and depth of water table play a prominent role in regulating coastal halophytic communities. Very few seedlings were observed and recruitment was largely by



vegetative growth. The water table is < 1 to 2 m deep and plants develop an extensive rhizome system in order to harvest the water from that depth. Only a few seeds of *C. cretica* germinated after the rains and they failed to establish due to rapid drying of the soil.

The *Cressa cretica* community occurs on a dry elevated sandy area above the mangrove community of *Avicennia marina* (Forssk.) Vierh. which is inundated regularly by seawater.

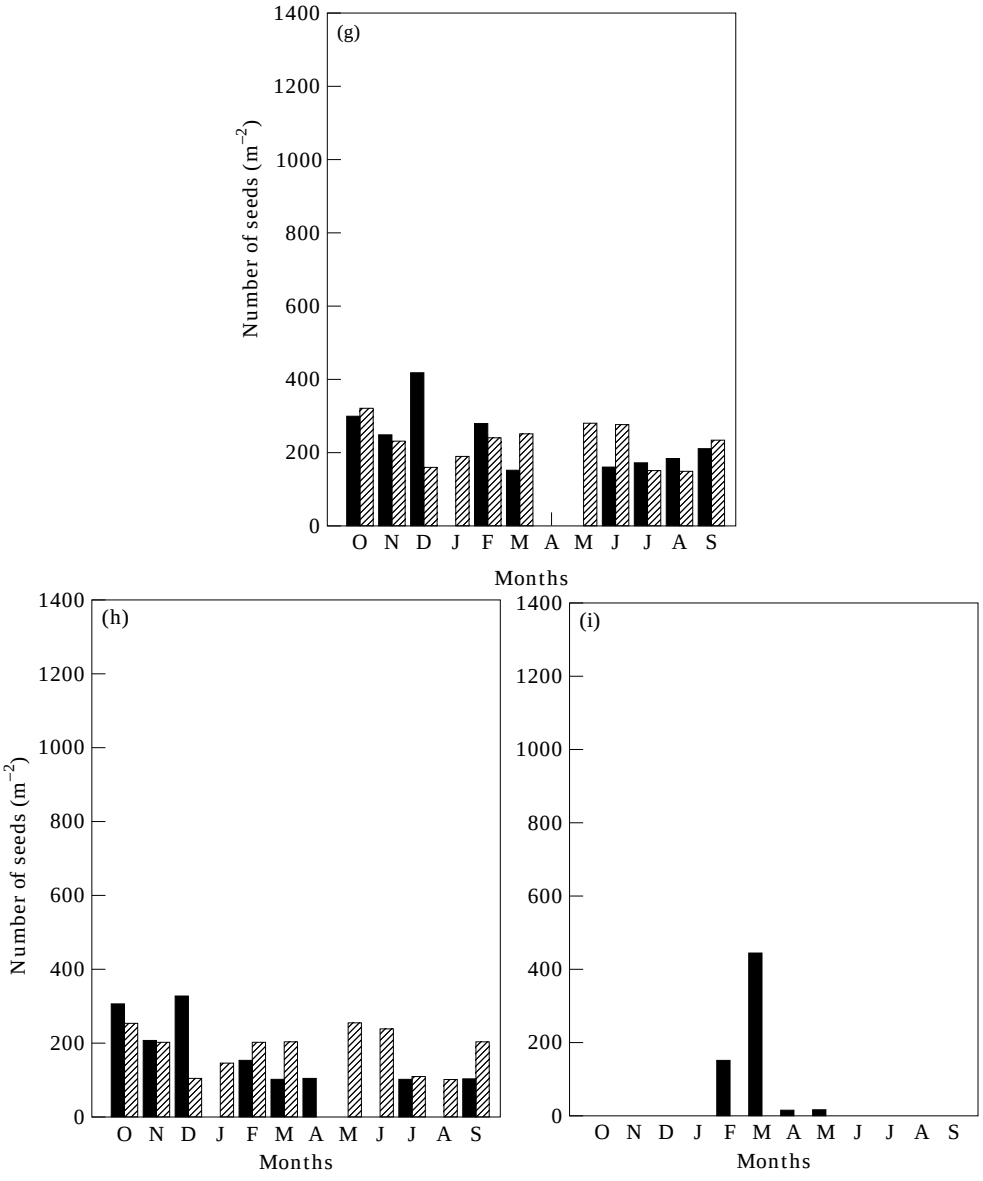


Figure 1. Distribution of seeds (m^{-2}) in the seed bank sampled during the 2-year study period. (■) = 1989–1990; (▨) = 1990–1991. (a) = *Cressa cretica*; (b) = *Aleuropus lagopoides*; (c) = *Halopyrum mucronatum*; (d) = *Polycarpaea spicata*; (e) = *Cyperus conglomeratus*; (f) *Atriplex grifithii*; (g) = *Suaeda fruticosa*; (h) = *Zygophyllum simplex*; (i) = *Heliotropium curassavicum*

Shrubby halophytes are reported to maintain a seed bank (Khan, 1991, 1993; Zaman & Khan, 1992; Gulzar & Khan, 1994; Aziz & Khan, 1994, 1995). *Cressa cretica* was the dominant species in the soil as well as in the vegetation. The number of *Cressa cretica* seeds in the soil peaked in May after dispersal and then declined. This decrease in seed number could be attributed to seed predation by birds and insects, grazing, heavy sand accretion, and high wind velocity.

The seed bank was represented by nine species and the vegetation by five species (Table 1). The four additional species in the seed bank, which were rare in abundance, could be found in adjacent areas. Seeds of some species are persistent in nature while others are transient. Transient seed banks have also been reported for *Cirsium vulgare* (Sav.) Ten. (De Jong & Klinkhamer, 1988), and *Cressa cretica* (Zaman & Khan, 1992).

Existing vegetation of our study site is closely represented in the seed bank samples, but seed bank species were not well represented in the above-ground vegetation. Our results agree somewhat with those of Hopkins & Parker (1984) who suggested that in highly saline areas the existing vegetation is usually well-represented in the seed banks. Since seed banks may include seeds from previous years, there is no reason to expect similarity between the vegetation and underground seed reserves. Khan (1993) likewise reported a poor relationship between existing vegetation and underground seed reserves in inland saline desert communities. However, Jerling (1984), in a study of the composition and viability of seed bank on a Baltic seashore meadow, found that the ground cover of *Triglochin maritima* L. and the density of its seeds in the seed bank were directly correlated, i.e. increase in cover increased the number of seeds in the soil, which might be due to poor dispersal or absence of seed predators. Gulzar & Khan (1994) found a good relationship between the seed bank of six coastal communities and existing vegetation in southern Sindh, Pakistan.

Smith & Kadlec (1983) compared the size and species composition of the six vegetation types in a North American marsh and reported that seed bank and field data did not reflect similar species composition. Marked differences in the buried seed reserves and existing vegetation of halophytic communities were also noted by Roach (1983) and Parker & Leck (1985), while Volodina (1993) reported that seed banks were lower in species diversity than the vegetation of a Caspian saline desert community. He found that the seeds of composites and grasses were very poorly represented in the seed bank. The proportion of perennials in the plant communities was also higher than in the seed bank.

In Pakistan both coastal and inland areas have communities with persistent shrubby perennials and seasonal communities dominated by annuals. All of them appear to differ in regulating their seed bank (Khan, 1991, 1993; Zaman & Khan, 1992; Gulzar & Khan, 1994; Aziz & Khan, 1994, 1995). The inland shrubby communities of southern Sindh maintain a transient seed bank for most perennials except *Suaeda fruticosa*, which persists in the seed bank (Khan, 1991, 1993). Their seed banks have more species present than those represented in the vegetation, while the inland seasonal desert communities of southern Sindh are dominated by annuals following major rainfalls and bear a close relationship with the seed reserve (Aziz & Khan, 1994, 1995). Most of the annual species persist in the seed bank.

Coastal communities of southern Sindh, however, did not vary greatly after rainfall and are dominated by perennial grasses or shrubs and bear a close similarity to their seed banks (Gulzar & Khan, 1994). The seasonal dynamics of coastal populations of halophytes in southern Sindh studied in this investigation indicate that species have a persistent presence in the seed bank. Recruitment of annuals in inland habitats obviously occurs solely through seeds while perennials are recruited mainly by vegetative means; recruitment of perennial species from seeds is seldom recorded and may only occur during those occasional years when rainfall is exceptionally high and persistent throughout the monsoon season.

The authors are grateful to Prof. Dr Irwin A. Ungar and an anonymous reviewer for their critical comments on the manuscript.

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