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Chapter 2

LIFE HISTORY CHARACTERISTICS OF A COASTAL POPULATION OF CRESSA CRETICA

SEEMI AZIZ AND M. AJMAL KHAN

Department of Botany, University of Karachi, Karachi-75270. Pakistan

Seed bank and life-history characteristics of the rhizomatous perennial *Cressa cretica* (Convolvulaceae) population present on Sand's pit, an Arabian sea coastal area near Karachi, Pakistan was studied. *Cressa cretica* has a persistent seed bank which peaked at 2800 seed m^{-2} in May. Recruitment through ramets started in July and the population increased from 30 to 60 plants m^{-2}. This population suffered heavy mortality in November. Plant growth reached its maximum in January and succulence decreased with aging of plants. Relative biomass allocation varied with the phenological state. Belowground biomass has about 60% allocation. Reproduction at its peak made up 55% of the biomass, significantly reducing the share of vegetative parts.

INTRODUCTION

The rhizomatous perennial shrub *Cressa cretica* Linn. (Convolvulaceae) is a dominant species in coastal salt marsh communities of Pakistan, usually occurring in monospecific stands along the landward edge of marshes. *C. cretica* regenerates vegetatively while it produce large number of seeds (Aziz, 1994). Khan (1991a) reported that the primary cause of seed dormancy in *C. cretica* is a hard seed coat. Scarified seeds germinated three times more as compared to non-scarified seeds. Higher temperature and salinity could also inhibit seed germination. A low alternating temperature regime (10-20 ^{o}C) and low salinity resulted in about 80% germination. Aziz (1994) found that a few seedlings were recruited from seeds after a considerable monsoon shower but they failed to survive perhaps due to burial through sand accretion or increased drought due to rapid evaporation of rainwater from the soil. Vegetative propagation is a substitute for sexual reproduction in areas where seedling establishment is infrequent. The relative investment and mode of spread has been one of the major problems in the life history of perennials (Kranjnyk and Maun, 1981; Pitelka et al., 1981; Shea and Grant, 1986). Data on seed bank, recruitment, survivorship, reproduction and relative biomass allocation of *C. cretica* is sparse.

In this paper seed bank, survivorship, demography, reproduction and relative biomass allocation of coastal population of *C. cretica* at Karachi, Pakistan will be studied.

MATERIALS AND METHODS

Study site - The study was conducted on a salt marsh present at Manora creek, on sands pit at Karachi, Pakistan. This region receives an average of 220 mm of rain per year with 90% of it falling in the months from June to September. However, the area rarely receives winter rains during December and January. The *Cressa cretica* community is located at the landward edge of salt marsh and is rarely inundated with seawater.

Seed bank - Twenty soil cores per population were randomly collected using a soil corer (2.5 cm diameter, 4.9 cm^2 area with a depth 15 cm) every month for the year 89-90 and 90-91. Seeds were manually extracted from the soil samples with the help of a binocular microscope and identified.

Demography - Twenty permanent quadrats (40 x 40 cm) per population were established subjectively to sample the population densities at 30 day intervals. Emergence and death of seedlings were noted at every visit and 20 plants were randomly collected from the area close to each quadrat, washed, their size was measured and then aboveground and belowground parts were separated and dried at 80 ^{o}C to a constant weight.

RESULTS

Seed Bank - Coastal communities of *Cressa cretica* maintained a persistent seed bank (Fig. 1). The number of seeds increased after dispersal which starts in March and peaked to 2800 and 2000 seeds m^{-2} in May of 1990-91 and 1989-90, respectively. The number of seeds in the soil declined progressively thereafter. Seed bank dynamics of the two years studied showed a similar pattern.

Fig. 1. Distribution of seeds (Number m^{-2}) of *Cressa cretica* in the seed bank sampled during the 2 years of study.

Demography and Survivorship - Recruitment of new *Cressa cretica* plants takes place through ramets in August and the number of individuals increased from 37 plants m^{-2} to 60 seedlings m^{-2}. (Fig. 2a). As they start growing in size juvenile mortality increased (Fig. 2b) and peaked in November. After November little change in population size was noticed.

Growth - Above and below ground growth showed a similar pattern (Fig. 3). Shoot and rhizome size progressively increased and attained their peak size in January. There was a significant (P = 0.0001) decrease in average plant size after March (Table 1). Succulence of the above ground parts declined substantially during the late summer and fall and remain unchanged during the rest of the year (Fig. 4). However, the succulence of belowground parts, remained the same throughout the year but declined in June (Fig. 4).

Fig. 2. Survival (A) and mortality (B) of *Cressa cretica* in coastal salt marsh population.

Fig. 3. Growth (cm) of above and belowground parts of *Cressa cretica* in coastal salt marsh population.

Table 1. Analysis of variance of characteristics of individual plant shoots, Rhizome length and dry weight, number of flowers.

Variable	Mean Square	DF	F
Shoot length	0098.571	6	0637.243***
Shoot dry weight	8212.803	6	0051.304***
Rhizome length	0054.987	6	0565.582***
Rhizome dry weight	7398.375	6	1383.743***
Number of flowers	1005.520	6	0395.144***

*** = P < 0.0001

Fig. 4. Succulence of above and belowground parts of *Cressa cretica* in coastal salt marsh population.

Reproduction - Flowering started in August and peaked in November and continued until February (Fig. 5), while fruiting started in September and the highest number of fruits was found in April (Fig. 5).

Fig. 5. Number of flower and fruit per plant of *Cressa cretica* in a coastal salt marsh population.

Reproductive allocation pattern - Relative biomass allocation in *Cressa cretica* plants varied with their phenology (Fig. 6). At the initial stage of plant growth and development (July - October), more than half of the resources were allocated to belowground structures (Fig. 6). With the onset of flowering more of the aboveground biomass was allocated to reproduction. Allocation to reproduction was maximum (55%) during March and April and after flowering aboveground shoots usually died. Average allocation to belowground biomass at that time approached 70%.

Fig. 6. Biomass allocation pattern (%) of *Cressa cretica* in a coastal salt marsh population.

DISCUSSION

Cressa cretica is a salt tolerant shrub found in the coastal and inland saline patches around Karachi. Coastal communities show an inundation gradient. Those areas which have diurnal inundation were dominated by a mangrove *Avicennia marina* followed by the area which was inundated at least once or twice a month and was dominated by *Arthrocnemum indicum.* Those areas which are on elevated sand flats have few inundation's during monsoon seasons or very high tides are dominated by *C. cretica. Cressa cretica* usually produce a large network of rhizomes which penetrate one to one and a half meters to harvest the saline water table. Soils on the surface are dry and sand accretion is very common. Plants produce a lot of seeds but they have a seed coat dormancy (Khan, 1991a) and recruitment was primarily through ramets (Aziz, 1994). The lack of recruitment through seeds could be attributed to high salinity, drought, high wind velocity, insufficient hypocotyl elongation and heavy sand accretion (Aziz, 1994). High salinity and high temperatures which are very common in this area does cause seed dormancy in *C. cretica* seeds (Khan, 1991a). After monsoon rains, which substantially reduced the salinity and improve soil moisture conditions, some seeds germinated but the seedlings died either due to burial under sand or increased desiccation due to rapid evaporation of rain water. Similar lack of recruitment through germination due to moisture limitation was also reported by other researchers (Matlack, 1987; Zimmerman and Weis, 1984; McLead and Murphey, 1977). High rates of vegetative reproduction is reported to be the consequence of increased stress at the germination stage (Grime, 1977; Huiskes et al., 1985). *Cressa cretica* maintained a persistent seed bank in coastal communities (Gulzar and Khan, 1994; Aziz and Khan, 1995). However, inland *C. cretica* communities have a transient seed bank (Khan, 1991b;1993; Khan and Zaman, 1992). No recruitment through seeds was also reported for inland populations (Khan and Zaman, 1992).

Recruitment of *C. cretica* occurs on the terminal node of the rhizome next to the node which produced an aerial shoot last season. Only the terminal shoot of the rhizome bears a new shoot. This event coincides with the incidence of monsoon rains which helps the plant to grow rapidly in size. During October and November plants increased in number and size while the rain water already evaporated, causing the drought. This combined effect of density dependent and density independent factors caused the increased mortality. Mortality of the seedling could also be due to sand accretion (Watkinson and Harper, 1978), salinity stress (Wertis and Ungar, 1986), or most perennials show a high rate of mortality during the period of most active growth (Lovett Doust, 1981; Newell et al., 1981; Angevine, 1983). The population size stabilizes after this mortality. *Cressa cretica* also exhibited a good relationship between plant size and survival (Aziz, 1994) and a similar pattern was also reported for *Erigeron canadensis* (Regher and Bazzaz, 1979) and *Viola adunca* (Newell, 1982).

Individuals of *C. cretica* reached a critical size before flowering, which generally commences in August and peaks during November, with fruiting during April. Large individuals produce large number of seeds in *C. cretica* and similar finding are also reported for *Dispacus fullosum* (Werner, 1975), *Cakile edentula* (Payne and Maun, 1984) and *Erucastrum gallicum* (Klemow and Raynal, 1983).

Cressa cretica allocated a large proportion of its biomass to rhizomes because its fitness is dependent upon the efficient harvesting of water which is 60 cm or more below the ground. A similar response was also reported by Ogden (1974) and Okusanya (1979, 1983). Half of the biomass in *C. cretica* was allocated to reproduction. Perennials usually allocate more biomass to vegetative organs than annual (Reekie and Bazzaz, 1987). Reproduction in *C. cretica* reduced the share of belowground biomass from about 60% to 30%. This slows down the clonal growth significantly. This kind of response was also noted in *Eichornia crassipes* (Watson, 1984) and *Potentilla anserina* (Eriksson, 1986).

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