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# FLORISTIC COMPOSITION AND LIFE–FORMS OF THE SAND-DUNE VEGETATION AT SEMI-ARID ZONE OF GREAT INDIAN DESERT

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Floristic composition of the sand-dune vegetation pertaining to various degrees of climatic, biotic and human interferences was studied on four fenced and open sites consisting various types of sand-dunes of the Indian Desert for two years [November, 1984 to October, 1986 ]. During favourable season vegetation consisted of many ephemerals, annuals and perennials comprising grasses, sedges, legumes and non-legumes. Seasonal changes in climate has shown marked effect on the vegetation composition. Maximum number of species was recorded during rainy season followed by winter and summer seasons. The floristic composition suggest that the strength of apparent vegetation response to water regime is strongly affected by the life-forms of the plant species involved. It is found that species richness was influenced by high numbers of therophytes, hemicryphophytes and nanophanerophytes while geophytes were entirely absent. However, beside the availability or moisture, habitat conditions biotic and human interferences considerably affect the composition of the vegetation on the sand-dunes.

**Key Words** : Sand-dune; Floristic composition; Water regime; Adaptation;Life-forms.

## Introduction

Seasonal flucfuations in arid and semi-arid parts of Great Indian Desert, considerably influence the pattern of vegetation distribution.Size and density of plant usually not only very from season to season but also from one site to another in the locality and in the same season. The floristic richness of a region which is called gamma diversity is closely related to the vegetation diversity of that region. This in turn depends upon the adaptability of the species in the particular community (Bliss, 1962). In a community, each constituent species shows its relationship with the environment and to the other species in its vicinity (Singh and Joshi, 1979) which constitute biological elements of an ecosystem.Life-form represents the sum of the adaptation of the plants in relation to climate which can be expressed by the statistical distribution of life-forms in the flora of a region (Raunkiar, 1934).

The data on population structure are very important for any meaningful and scientifically oriented conservation because much will depend on the initial size of population in *in situ* and the size of seed samples in *ex situ* conservation (Khoshoo, 1986). Studies on floristic composition and life-forms of the sand-

dune vegetation and their role in ecosystem are hardly available. The present study deals with the floristic composition and life-form of the constituent species on sand-dune ecosystem of semi-arid zone of Great Indian Desert.

## Material and Methods

After extensive survey, four research sites, rwo each in Churu district (27° 24′ to 29° OO′ north latitudes and 73° 40′ to 75°41′ east longitudes ) and Jhunjhunu district (27° 38′ and 28° 31′ north latitudes and 75° 02′and 76°96′east longitudes) representing different types of dunes orientation, vegetation, biotic and human interferences were selected. Two sites namely Gharsisar and Taranagar are located in Churu district while other two sites Sultana and Khetri are lacated in Jhunjhunu district.While selecting the sites, care was taken that open sites and enclosed sites(fenced by the forest department ) were available side by side for comparison. Therefore, each site represents a fenced as well as an open area.

Gharsisar (site 1-A) covers an area of 120 ha with 6 to 30 metres high longitudinal dunes. The area was treated for stabilization of sand-dune in 1980-81 by Forest Department. The large open area (I—B), adjacent to the fenced area consists of longitudinal sand-dunes as well as sandy plains and is dominated mainly by pure communities of *Caltigonum polygonoides*. At Taranagar (Site II-A) dunes are also of longitudinal type and their height varies from 10 to 150 metres. It covers a fenced area of 80 ha planted in 1980–81 for dunes stabilization. The open area ( II–B ) is almost barren and is subject to sand erosion. Sultana ( site III-A ) covers an area of 20 ha fenced in 1980-81. The sand–dunes are of fused barchan type and varies in height from 5 to 20 metres. Open site (III-B) nearby consists of a large-area of unstabilized barchan sand-dunes which are dominated by *Saccharum munja*. Sand erosion in open area occurs during summer season. At Khetri (Site IV—A) dunes are of longitudinal type with the height of more than 200 metres and surrounded by Aravalli hills. It covers an area of 50 ha which was fenced in 1981–82. The large open area (IV–B) near by is dominated by *Saccharum munja* and is subject to different types of biotic disturbances. Wind erosion in summer and gully erosion in rainy season also plays an important role.

Afforestation in all the four fenced sites was carried out by state Forest Department. A leguminous fast growing exotic tree species i.e. *Acacia tortitis* has been planted alongwith local shrubs, herbs, and grasses. The area in general is covered by huge mass of rolling sand. The dune soils are saline with poor water holding capacity and shows low amounts of nutrients. The pH generally varies from 7.1 to 9.6. The vagetational attributes in the fenced sites are *Calligonum — Acacia — Leptadaenia* on site 1-A, *Acacia — Ziziphus — Calotropis* on site II-A, *Saccharum — Acacia* on site III-A and

*Saccharum* — *Crotalaria* — *Acacia* on site IV-A.

The climate of the area is monsoonic and characterised by the sparse and highly variable precipitation, high evaporation, low humidity and higherdiurnal variation fo temperature.In Churu the lowestabsolute minimum air temperature (--)0.9°C was in year 1984 in the month of January and the highest absolute maximum was 48.1°C in the month of May, 1984. While in Jhunjhunu, the lowest absolute minimum (—) 0.8° C was recorded in the year 1986 in the month of December and absolute maximum 44.6°C was in the month of April and May of 1984 and 1986 respectively. During the year the temperature fluctuates from below the freezing point to the extremely high temperatures (Figs. 1 and 2).

The rains are the most important climatic element in the region and usually determines the density and characters of vegetation. The average annual rainfall is above 400 mm. The annual rainfall in the last five years at Churu varies between 345.9 mm in 1985 to 527 mm in 1983. From 1984 to 1986 the average annual rainfall is below 400mm. In Jhunjhunu, the annual precipitation,

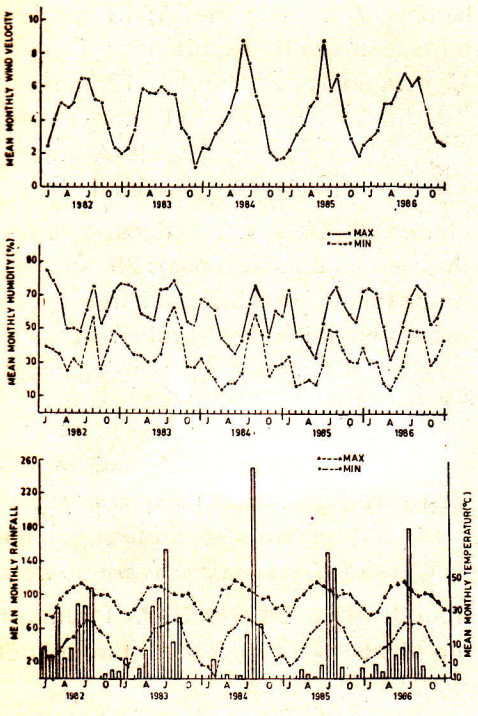


**Fig. 1** Meteorological data summarised for years reported of Churu District.

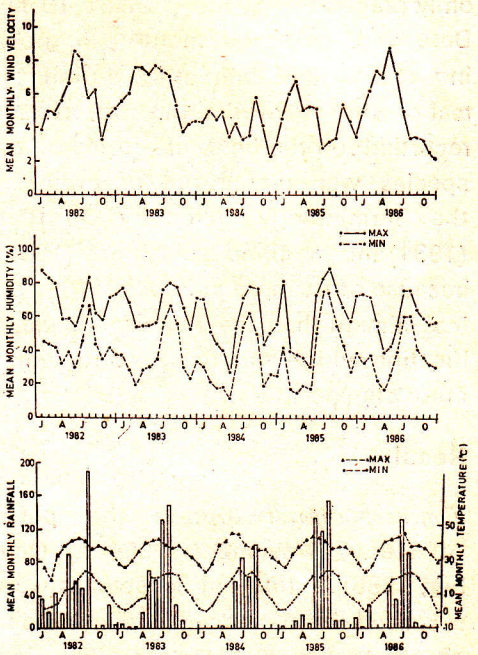


**Fig. 2** Meteorological data summarised for years reported of Jhunjhunu District.

i.e.,550.8 mm was recorded in 1982 and 311.4 mm in 1984. In Churu and Jhunjhunu the mean maximum humidity values have been recorded in the month of August and January respectively. The mean minimum humidity value was recorded in the month of May. The wind velocity varies between 1.2 to 8.68 km per hour at Churu and 2.26 to 8.7 km per hour at Jhunjhunu (Figs. 1 and 2). Sand-dunes formation and structure is greatly influenced by these high velocity winds.

Floristic composition and life-forms of the constituent species were studied from November, 1984 to October, 1986 at the four study sites by randomly placed 30 quadrats of $2 \times 10$ m$^2$. Data were collected monthly in growing season and bimonthly during the rest of the year.From the observation recorded on the field, life-forms of the species wers recognized according to the terminology given by Du Rietz (1931)and modified by Cabrera (1952), because of its more suitability for tropical climate than the Raunkiaer's classification which was designed for temperate climate.

## Results

*Floristic composition*-During the period of study (November, 1984 to October, 1986) a total of 56 species were recorded from fenced and open sites of all the four locations. This includes 3 trees, 15 perennial herb/shrubs, 15 grasses, 2 sedges, 4 legumes and 17 non-leguminous herbs. Maximum number of species were found during the rainy and winter season followed by summer season or after the grazing (as in fenced site I-A Gharsisar and site III-A Sultana). Out of 56 species, 23 species were found common in all the sites.

Among the sites the species composition were as follows: 37 species on fenced sitel–A Gharsisar(2 tree species, 9 perennial herb/shrubs, 11 grassees, 2 sedges, 3 legumes, 10 non-legumes); 33 species on fenced site II–A Taranagar ( 2 trees, 9 perennial herb/shrubs, 13 grasses, I sedge, I legume, 7 non-legumes ); 43 species on fenced site III-A Suitana ( 3 trees, 11 perennial herb/shrubs, 12 grasses, 2 sedges, 4 legumes, 11 non-legumes ); 31 on fenced site IV-A Khetri ( 1 tree species, 7 perennial herb/shrubs, 9 grasses, 2 sedges, 4 legumes, and 8 non-legumes); 29 species on open site IV-B Khetri (1 tree species, 6 perennial herb/shrubs,7 grasses, 1 sedge, 4 legumes, 10 non-legumes) (Table 1).

On open site I–A Gharsisar only one shrub species of *Calligonum polygonoides* and on site III-A Sultana, single species of grass *Sacccarum munja* were found while on site III-A Taranagar no plants were recorded throughout the period of study.

*Life-Forms*—Life-forms of plants indicates the major feature of the climate. The various life–form classes are repr-

**Table 1.** Distribution of trees, perennial shrubs/herbs, grasses, sedges, legumes and non-legume herbs on all the four sites (fenced as well as open ) from November, 1984 to October, 1986

| Plant Categories | *Fenced Sites* | | | | *Open-Site* | Common |
|---|---|---|---|---|---|---|
| | *I* | *II* | *III* | *IV* | *IV-A* | species |
| Trees | 2 | 2 | 3 | 1 | 1 | 1 |
| Perennial herb/shrubs | 9 | 9 | 11 | 7 | 6 | 6 |
| Grasses | 11 | 13 | 12 | 9 | 7 | 7 |
| Sedges | 2 | 1 | 2 | 2 | 1 | 1 |
| Legumes | 3 | 1 | 4 | 4 | 4 | 1 |
| Non-legumes | 10 | 7 | 11 | 8 | 10 | 7 |
| Total | 37 | 33 | 43 | 31 | 29 | 23 |

esented in Table 2.

The sand-dune flora of the semi-arid region is predominantly therophytic in growing season. Twenty five species are Theophte ( 45% ), although these species do not form stable associations. Hemicryptophytes (herbs) are represented by 15 species (27%) while Geophytes are entirely absent. Haloxiles consists of 16 species (29%) and form stable associations. The most characteristic life-form of the region are trees (5%) which are found in different associations. The most important are *Acacia tortilis, Prosopis cineraria* and *Maytenus emarginata.* Haloxiles rank next to therophytes in the number of species followed by herbs. Haloxiles which constitute the characteristic permanet vegetation during the year, is 31 percent of the total species recorded.

Arbustiform comprises 13 species ( 23% ) of the total species recorded, which include most of the shrubs such as *Calligonum polygonoides, Leptadenia pyrotechnica, Crotalaria burhia, Aerva persica, Zizighus nummularia, Calotropis procera, Tephrosia purpurea, Capparis decidua, Panicum antidotale, Dactyloctenium sindicum, Withania somnifera, Lantana indica* and *Adathoda vasica.* Similarly 27 percent of vegetation is composed of hemicryptophytes such as *Aristida hirtigluma, Lasiurus sindicus, Saccharum munja, Cyperus rotundus, Cymbopogon martinii, Cynodon dactylon, Sida cordifolia, Momordica balsamina, Launea procumbens, Mukiamaderaspatana, Cocumis callosus* and *Citrulus colocynthis.* The most important

**Table 2.** Life-forms of the sand-dunes in semi-arid region of the Indian Desert on the basis of terminology given by Du Rietz (1931) and modified by Cabrera (1952)

| Plant forms | Number of species | Percentage of species |
|---|---|---|
| 1. Haloxiles (HL) | 16 | 29 |
| A. Arboriform [A] | 3 | 5 |
| a. Trees [T] | 3 | 5 |
| b. Rosulates [Ro] | — | — |
| c. Cereiform [Ce] | — | — |
| B. Arbustiform = Nanophanero—phytes [Arbu] | 13 | 23 |
| a. Upright shrubs [Us] | 13 | 23 |
| b. Creeping shrubs [Cs] | — | — |
| c. Pulviform shrubs [Ps] | — | — |
| d. Thick stemmed shrubs [Tss] | — | — |
| 2. Hemxiles = Suffrutices [Hx] | — | — |
| 3. Herbs [Hb] | 15 | 27 |
| A. Hemicryptophytes [Hc] | 15 | 27 |
| a. Hemicryptophytes [Hc] | 2 | 4 |
| b. Rosular [Rl] | 1 | 2 |
| c. Caulifoliates [Cf] | 9 | 16 |
| d. Creepers [Cp] | 3 | 5 |
| B. Geophytes — Cryptophytes [Gp] | — | — |
| a. Rhyzomata [Rm] | — | — |
| b. Tubers [Tu] | — | — |
| c. Bulb—geophytes [Bg] | — | — |
| d. Radicigemadas [Rg] | — | — |
| 4. Therophytes [Th] | 25 | 45 |

therophytes are *Farsetia hamiltoni*, *Indigofera cordifolia*, *Indigofera linifolia*, *Gisekia pharnacioides*, *Cenchrus biflorus*, *Cenchrus setigerus*, *Cenchrus ciliairs*, *Eragrostis ciliaris*, *Eragrostis tremula*, *Dactyloctenium aegyptium*, *Mollugo cerviana*, *Corchorus tridens*, *Polycarpea corymboso*, *Pulicaria crispa*, *Heliotropium marifolium*, *Evolvulus alsinoides*, *Artemisia scoparia*, *Achyranthus aspera*, *Boerhavia diffusa*, *Tribulus terrestris*, *Justicia procumbens* and *Cassia tora*.

## Discussion

The coarse nature of sand, low erratic precipitation and high evaporation, higher diurnal variation of temperature, poor water holding capacity of the soil and its low nitrogen and high carbonate contents are the major features of the habitat of sand-dunes. The vegetative growth during favourable season (rainy season from late June to September) indicates that system is exclusively moisture controlled and varies considerably with the variation in rainfall. Water and temperature factors are so important that the significance of competition and soil nutrients is greatly reduced and most of the dune flora escape drought rather than withstand it. During rainy season the soil attains enough moisture for the germination, growth and development of a number of plant species. Relatively few plant species are able to establish themselves on the active dunes and grow. These are capable of sand-binding, resistance to be covered by sand and absorb moisture in coarse substrates. It includes ephemerals, annual herbs and shrubs. Therefore, vegetation composition varies according to the relative stability of dunes. During succession, these specialized species give way to those species which are less adapted to the unstable nature of shifting sand due to action of wind.

In both the years of study the maximum number of species recorded during the rainy season is due to coming up of many annuals, herbs, shrubs, creepers and other perennials. Winter season had compartively less number of species in comparison to those found in rainy season. However, during summer season absolutely low moisture and high temperature act as a limiting factor and therefore, minimum number of species werc observed as most of the winter annuals produced the seeds and completed their life-cycle. The effect of season on the distribution of the species is quite frequent in monsoon grasslands (Kumar and Joshi, 1972; Singh and Yadava, 1974). In open area relatively less species were observed in comparison to the fenced sites. In open site regular high grazing pressure and human interferences are responsible for the quick ommission of the many palatable plant species as soon as they germinate. Kumar and Joshi (1972) and Singh and Joshi (1979) found increased number of species due to medium grazing and better moisture conditions on sand-dune. Where as in the fcnced sites , protec–

tion from any biotic interference provides the opportunity to the annuals to establish themselves. Due to accumulation of more organic matter, and availability of increase nutrients in the fenced sites ultimately affect the plant growth. According to Bliss (1956) microclimate, biotic conditions considerably affect the vegetational pattern and plant communities in a particular climate region. However, present study reveals that habitat conditions, physiography and biotic factors usually affect the composition of the vegetation.

Terrestrial communities represent large number of lifeforms. Due to evolution, plants are better adopted to the extreme environments than they are previously, to withstand the conditions of environment ( Bradshaw, 1971).

According to Cabrera's classification, the therophytes form almost one half of the plant components of the sand-dunes in this region. This biological type occurs frequently in the arid and semi-arid zone and due to short vegetative cycle is capable of surviving under adverse conditions. The therophytes in semi-arid region exploit moisture from the top few centimeters of the soil and are abundant only in rainy season. Moisture conditions of the dune surface soil vary less spatially than they do temporally. Thus spatial heterogenecity of therophytes as aresponse to the surface structure of their environment, is relatively low.It may be countered by bilogoically caused patterning (Ellner and Shmida,1982).The vegetative growth during rainy season indicates that the system is purely moisture controlled and show considerable changes with the variation in rainfall. Singh and Joshi (1979) also reported maximum number of therophytes during the rainy season. Winter and summer seasons however had a comparatively low species number than that found in the rainy season. The distribution of species in monsoon grasslands depends on the variation in seasons ( Kumar and Joshi, 1972; Singh and Yadava, 1974). The strength of apparent vegetation response to water regime is strongly affected by the life-form of the plant species involved ( Olsvig *et. at.*, 1983).

Haloxiles rank next to the therophytes and are represented by different associations which form the pseudo-forests. Arbustiform ( Nanophanerophytes ) and hemicryptopytes also consists of nearly one fourth number of total species and with their deeper rooting system than the therophytes are probably more affected by spatial heterogenicity of soil moisture below the top centimeters at different locations of the sand-dunes. With the increasing degree of dune stabilization, more psammophytic species invade and establish themselves. Some species seem to have difficulty in establishment of seedling and coping with the coarse sandy nature of soil,

extremely adverse environmental conditions particularly unusual heat imbalance of different soil strata during the year and shifting habit of dunes. That could well explain the absence of the geophytes. Freitag (1986) reported that annuals (including biennials) dominate with almost half of the species total, followed by shrubs and dwarf shrubs with about one-third and one-fourth other perennials in the sand deserts of Iran and Afghanistan while geophytes are poorly represented and occur only in the Irano–Turanian group.

The family representation shows a predominance of poaceae, in species number and formation of communities. While among the structurally important communities, the families-Mimosaceae,Polygonaceae,Asclepiadaceae, Rhamnaceae, Capparaceae and Fabaceae each are represented by either one or two species of herbs and shrubs. Compared with the biological spectrum of extreme arid region of Great Indian Desert given by Mertia and Bhandari (1980), (Th/49%, H/6%, N/31%, G/2%), the dune flora of semi-arid region also show similar type of life-forms.

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