Original Research Article

Assessment Of Phytosociological Parameters of Halophyte Species Along Gulf of Khambhat, Gujarat, India

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ABSTRACT

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Phytosociology, a fundamental branch of vegetation science, focuses on the study of plant communities as they exist in their natural environment at the scale of vegetation stands. Its primary objective is to identify and characterize distinct vegetation types based on a comprehensive understanding of their floristic composition, encompassing all plant species present within a defined area. Historically, phytosociological studies often relied on the concept of a "typical" relevé to represent an entire stand of vegetation. However, contemporary approaches recognize the inherent variability within plant communities and employ statistical methods to analyse data collected from multiple, often smaller, sampling plots. This shift underscores the necessity of employing robust sampling strategies to effectively capture the full spectrum of diversity present within halophyte communities. Among the various biodiversity regions, coastal flora is extremely important for eco-physiological studies and economic utility. The present study, allied diversity measures were analysed for halophyte species occurring at eight different locations along Gulf of Khambhat. Total 12 species out of them 4- succulent; 2- non succulent; 3- mangrove, 1- shrubby, 1 facultative and 1 strand species were occurred in study area. The *A. lagopoides* non succulent halophyte was observed at high frequency, density abundance in all locations.

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Key words: Allied diversity measures, Halophytes, Khambhat.

INTRODUCTION

Biological diversity in the coastal ecosystem differs from terrestrial ecosystem both in respect to pattern of diversity and to the functional application of those patterns. In general, coastal systems have not only high diversity at species level, but also at higher taxonomic level. They show greater diversity of types of organisms and types of adaptive specialities than the terrestrial system. (Ajmal Khan, 1999).

Phytosociology is the mainstream method elaborating plant community structure and communal relations of plant species, are important for understanding the functioning of an ecosystem. Such studies imply knowledge of structure and composition of the component species. A mixture of species, which live in a habitat and are held together by common ecological tolerances, form a community. As number of plant species, individuals of each species, their density etc. are used in computing plant diversity, quantitative phytosociological characters such as frequency, density and abundance further elaborate role of individual species in ecosystem. Thus, phytosociological parameters, namely frequency, density and abundance etc., are generally measured to determine the distribution and ecological aspects of the species, can also be utilized as vital diversity measures (Gbènakpon et. al., 2021). The knowledge of the floristic composition of an area is a perquisite for any ecological and phytogeographical studies and conservation of plant diversity.

Halophytes, a specialized group of plants, are distinguished by their remarkable ability to thrive in environments characterized by high salinity levels, such as salt marshes and coastal regions (Hameed et.al., 2024). These unique plants play a pivotal ecological role in a variety of saline ecosystems, including estuaries (Bueno and Cordovilla, 2020), where they contribute significantly to the stabilization of sediments, the reduction of erosion, and the improvement of water quality through the filtration of pollutants. Furthermore, the intricate root systems of halophytes provide essential habitat and serve as crucial nursery grounds for a diverse array of aquatic organisms, including various fish species (Hameed et.al., 2024). Their capacity to colonize and flourish in conditions that are inhospitable to most other plant life highlights their importance as keystone species in many marginal environments, where they deliver critical ecosystem services and support a rich biodiversity (Concenço et. al., 2013).

The application of phytosociological methods offers understanding of the composition and distribution of halophyte species within their respective plant communities (Concenço et. al., 2013). These surveys are not only valuable for ecological description but also hold significant applicability in the realm of conservation, particularly in the management and protection of ecologically sensitive areas (Pereña-Ortiz 2023). By examining the specific associations of halophyte species, phytosociological studies can elucidate the underlying environmental gradients and intricate ecological relationships that govern these unique saline habitats.

The present investigation aims to provide a comprehensive review of the phytosociological study of halophyte species by using frequency (%), density and abundance of halophyte communities as allied diversity measure. Study area restricted to ~ 800 km-long-coast of Saurashtra, the Gulf of Khambhat (8 districts, namely Amreli, Bhavnagar, Ahmedabad, Anand, Bharuch, Surat, Navsari and Valsad on Saurastra and South Gujarat coast). Out of eight locations one (Surat) of these habitats was sandy-muddy, whereas remaining all habitats were marshy.

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MATERIAL AND METHODS

FIELD STUDIES

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Eight different habitats (Fig 1) were selected for present study. The random sampling approach was adapted to acquire data. Two twin belt transects (5 x 50 m Fig. 2) were laid down at right angle to or parallel with sea coast or creeks area between high tide and low tide at all selected locations. Halophyte species were counted in five alternative quadrats (5 x 5 m) of either of the belts.

Fig. 1. Maritime districts with the selected locations along south-west part of Gujarat coast.

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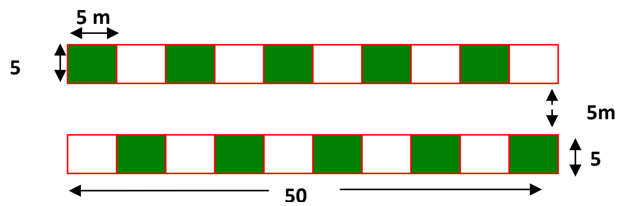
H1 = Victor Port, H2 = Sartanpar, H3 = Navagam, H4 = Machhipura, H5 = Mooler, H6 = Sunwali (Sandy-Muddy), H7 = Matwad and H8 = Umargam.

Fig. 2. Design of a Twin Belt Transect



Floristic data recorded in data sheet for twenty alternate sample units (20 × 25 m^2) admeasuring 500 m^2 in all selected habitats were considered for computing diversity indices and allied diversity measures. Mean value of 10 sample units –quadrats– belonging to each of twin belt transects (**T1** and **T2**) laid down at all selected habitats were considered for evaluating all allied diversity measures.

ALLIED DIVERSITY MEASURES

It is widely accepted that diversity indices elaborate the whole and composite picture of halophyte community structure. Therefore, in order to explain the role and contribution of individual species, other quantitative parameters *viz*., frequency, density and abundance were used as supporting or allied diversity measures. Following formulae were used for calculating these parameters.

$$Frequency\ (\%) = \frac{\text{Number of units in which the species occurred}}{\text{Number of units studied}}\ \text{X}\ 100$$

$$Density = \frac{\text{Total number of individuals of a species in all the sample units}}{\text{Total number of sample units studied}}$$

$$Abundance = \frac{\text{Number of individuals in all the sample units}}{\text{Number of sample units, in which species occured}}$$

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RESULTS

CONTRIBUTION OF SAMPLED SPECIES

In the present study. data of the allied diversity measures (frequency, density and abundance) to elaborate comparative occurrence, distribution and quantitative contribution of the individual halophyte species growing at different habitats and its role in beta diversity between habitats diversity of halophytes. Mean values of frequency, density and abundance of each halophyte species recorded for sampled area (500 m^2) in two twin belt transects at each site were considered for this objective.

A halophytic grass *Aeluropus lagopoides*, (L.) Trin. ex Thw was the only species, which occurred at all the selected seven marshy and one sandy-muddy habitats (Fig 1). Its frequency varied between 50 to 100 % at different locations. Minimum frequency (50 %) was recorded just at one sandy-muddy site Sunwali (H6), while at all other locations, it was found with very high frequency (80 to 100 %). Moreover, its extremely high density (Fig. 3a) was observed at three sites H1 (1630.65), H4 (1527.2), H7 (890.15); it grew with moderate density at three other locations (H3 = 254.2; H5 = 126.5; and H8 = 181.85); and at two habitats, it grew with almost negligible density (H2 = 9.25; H6 = 11.05). Due to its high frequency at many sites, similar trend was also observed for abundance of *A. lagopoides* (Fig.3a). For instance, abundance was remarkably very high at H1 (1637.85), H4 (1527.2), H7 (890.15); moderate at H3 (260.80), H5 (126.5) and H8 (213.66); and abundance was obviously very low at H2 (10.28) and H6 (11.05).

These results suggested that *A. lagopoides* was the most numerically dominant and the most abundant species at as many as six locations in the region. It can, therefore, be considered as a major species playing the most significant role in deciding diversity level of halophyte flora reported here. Additionally, it was often associated with the second dominant, but a succulent halophyte *Suaeda nudiflora* at seven sites.

Suaeda nudiflora, (Willd.) Moq.

This perennial succulent halophyte was also found in six marshy and one sandy – muddy habitats and was the second dominant species in the study area. Frequency of *S. nudiflora* fluctuating between 15 % to 100 % (Fig. 3b) reflected that it grew with extremely high frequency at four marshy location H3 (100 %), H4 (95 %), H5 (100 %) and H7 (80 %). Its moderate frequency was noted at two sites H1 (50 %) and

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H6 (45 %), which in turn, declined to minimum (15 %) at one marshy location (H2). It was further observed that this species was found with moderate density (Fig. 3b) at four out of seven sites (H3 = 16.6; H4 = 24.5; H5 = 18.35; and H7 = 17.15), with low density at H1 (7.3) or with quite low (0.3, 1.6), respectively at H3 and H6. As a result of its high frequency values, its abundance also varied in similar way as its density. For instance, its moderate abundance was recorded for four habitats (H3 = 16.6; H4 = 26.42; H5 = 18.35; H7 = 22.19), whereas at three locations (H1 = 7.3; H2 = 2; and H6 = 2.44) it occurred with quite low abundance.

These data further reflected that although this succulent (*S. nudiflora*) was highly frequent at seven habitats, its less individuals per unit area were observed at all the sites. This happened as its large and diffused (spreading) habit occupied greater area than a grass species.

Sesuvium portulacastrum, (L.) Linn.

S. portulacastrum was mainly confined to margins of the creeks or adjacent areas regularly inundated by daily tides and as a result, it was present at two marshy and one sandy-muddy locations. Its frequency was low (15 %) at H6; moderate (35 %) at H2; and quite high (100 %) at H8 (Fig.3c). Though its density was low in the last habitat, the value (8.05) was higher than its density either at H2 (0.60) or at H6 (0.65). Similar trend was also observed for abundance, that was 8.05 at H8 and extremely low at H2 (1.67) and H6 (2.16). A patchy habit of *S. portulacastrum*, as a consequence of its much-branched creeping long stem often buried in the mud or sand occupying greater area, was responsible for its low density and abundance and it is very important component of diversity of intertidal halophyte flora.

Salicornia brachiata, Roxb.

A typical succulent, but annual halophyte *S. brachiata*, grew in two marshy habitats, while it was absent at remaining six sites (Fig. 3d). Though its frequency at Victor Port (H1) (95 %) and at Sartanpar (H2) (90 %) was almost equal, its density (373.1) and abundance (375.92) at the former location were remarkably greater than its density (89) and abundance (94.55) at the latter habitat.

Avicennia marina, (Forsk.) Vierh. var. *acutissima* Stapf.

Out of eight sites, *A. marina* was found just at two (H2, H8) habitats, but with very high frequency (100 %, Fig. 3e). Since its frequency being cent per cent, its density (24.1) and abundance (35.25) were equal at both the locations. Despite of its moderate density, this intertidal mangrove influenced the mosaic as well as the diversity of halophytes prominently.

Arthrocnemum indicum, (Willd.) Moq.

This rare perennial, diffused succulent halophyte having jointed numerous branches was found at two marshy habitats with moderate frequency (H1 = 45 %; H7 40 %, Fig 3f). However, its density (51.2) and abundance (56.89) at Victor Port (H1) were noticeably very high as compared to that (density = 1.6; abundance = 5.67) at Matwad H7. A mention may be made here regarding very rare occurrence and for paucity of individuals as well, of some sampled species, that were recorded only in one habitat and that, too, in one belt transect.

For instance, a non-succulent halophyte *Sporobolus maderaspatanus* Bor. and two mangroves *viz., Sonneratia apetala* and *Acanthus illicifolius* were found just in one sample unit (quadrat) in whole area (Figs. 3g,h,i). Likewise, a collective range of their frequency (5 %), density (0.05 to 5.7) and abundance (0.5 to 57) were also of a low order. A shrubby halophyte *T. troupii* (Fig. 3j) grew in two sample quadrats of one transect at Navagam (H3) site. Because of its extremely low density (0.15) and abundance (0.75), it happened to be one of the species having minimum values of the said ecological characters.

Two other species, a strand species *I. pes-caprae* and a facultative halophyte *C. cretica* occurred at one location only, but in both the belt transects and in four out of twenty sample units (Fig. 3k,l). *I. pes-caprae* with its low frequency (20 %), density (2.5) and abundance (10.67) had a little influence on the diversity indices. On the other hand, *C. cretica* though present at just one site, played a crucial role in halophyte diversity due to its extremely high frequency (100 %) and density/abundance (168.5).

DISCUSSION

Several authors have pointed out that the spatial distribution of halophytic vegetation over salt marshes is not random, but organized in characteristic patches (Chapman, 1964; Pignatti, 1966; Silvestri *et al.,* 2000; Youssef, 2001; Marani *et al.,* 2003; Youssef *et al*., 2003; English *et al*., 2005; Mossalam, 2007), which in turn, has stimulated an increasing interest in the study of plant zonation. Likewise, many authors (Waisel, 1972; Chapman, 1974; Beeftink, 1977; Olff *et al*., 1988; Sanchez *et al.,* 1996; Bockelmann *et al.,* 2002) have excellently described plant zonations in salt marsh environment.

Similarly, many detailed reports on mangroves (Gujarat-Singh *et al*., 1999; Karnataka-Rao and Suresh, 2001; Tamil Nadu- Blasco, 1975; West Bengal- Naskar, 2004) and on coastal vegetation (Banerjee *et al*., 2002) growing along sea coast of India have been published. Nevertheless, much remains to be done on effective role of allied diversity measures of component species in deciding magnitude of the diversity of halophyte flora.

This study indicated that a dominant succulent species *Suaeda nudiflora* occurred at seven habitats, while another dominant species *Salicornia brachiata* was found at only two sites. Their frequency varied between 50 to 100 % but *S. nudiflora* also grew with less frequency at two locations. Two other succulents namely, *Arthrocnemum indicum* and *Sesuvium portulacastrum* had low to high frequency ranging between 15 to 100 %.

These data clearly showed that *S. brachiata* was the most frequent and numerically abundant species, though occurring at only two habitats, followed by *S. nudifloa*, a perennial succulent growing with high frequency, moderate density and abundance at four locations in study area.

Similar results were also obtained by Shukla (2007) while examining allied diversity parameters of halophyte flora on Diu island off Gujarat coast. She reported that two succulent species *i. e*., *Arthrocnemum indicum* and *Salicornia brachiata* were highly frequent (70 to 100 %) and their density (3.96 to 34.1) and abundance (2 to 101.07) were either extremely low or of intermediate magnitude at respective sites. Another succulent species *Suaeda nudiflora* was found with similar frequency (30 to 65 %) and low density (0.66 to 5.6) and abundance (1.35 to 12.44). *A. indicum* growing at only one habitat also showed similar characteristics.

Singh *et al*. (1999) had recorded that *Suaeda nudiflora* and *Suaeda fruticosa*, occurred with respective frequency of 3.14 % and 25.85 %; density of 0.25 and 1.21; and abundance of 7.95 and 4.70. Thus, these two succulent species were found with less intensity in the National Wild Ass Sanctuary in Gujarat. On the other hand, Vyas (2007) and Talekar (2009), who studied plant diversity of 'Bhal' wetland flora noticed a succulent halophyte *Suaeda nudiflora* growing with moderate to high frequency (53 to 100 %), low density (0.3 to 17.1) and abundance (4 to 17.1). According to them, comparatively large plant habit and size were reasons for their low density and abundance in the area.

Narasimha Rao and Prayaga Murty (2010) reported lower number of individuals (density) of *Arthrocnemum indicum* (974) and *Sesuvium portulacastrum* (962) than that of two other species *Suaeda* *maritima* (1260) and *Suaeda monoica* (1520) in coastal area of Vashista and Vainateyam estuaries in Andhra Pradesh in India. These numbers are apparently high, because they had further computed their results for a large area of one hectare.

Likewise, Youssef and Al-Fredan (2008), too, noted frequency in the range of 20 to 100 %, density fluctuating between 0.2 to 3.7 and abundance between 0.8 to 6.2 of four halophyte species (*Arthrocnemum macrostachyum, Suaeda vermiculata, Salsola* spp., and *Haloxylon* spp.) occurring in coastal area of Al-Uquair in Saudi Arabia. They opined that the variation in frequency, density and abundance between the species might be attributed to habitat differences and species characteristics for adaptation.

Another report on allied diversity measures of halophytes of the Valley of Oued Righ, Low Sahara Basin in Algeria (Youcef *et al*., 2012) indicated that two succulent species *i. e*., *Suaeda fructicosa* and *Suaeda mollis* growing at different saline conditions showed following characteristics: saline condition – F = 26 %, 13 % and D = 0.30, 0.030; sub-saline situation – F = 94 %, 26.6 % and D = 0.54 0, 0.013; waterlogged habitats – F = 40 %, 13 % and D = 0.097, 0.002). They concluded that distribution of halophyte vegetation types was most strongly correlated with soil salinity and moisture.

It may be added here that Naz *et al*. (2012), who examined above mentioned parameters for halophyte communities occurring in the Cholistan desert in Pakistan, noted that moderate salinities resulted in an increase in the density and frequency of two dominant species of *Haloxylon*, whereas higher salinities significantly reduced their number.

Therefore, results of allied diversity measures of succulent species found during this investigation obviously show that *Salicornia brachiata* with its high numerical abundance played a significant role in determining level of diversity of halophyte flora than that of the any other species. *Suaeda nudiflora* was also equally important contributor to floristic diversity in the study area.

A reference should be made here regarding contribution of non-succulent species in floristic diversity. A halophytic grass *Aeluropus lagopoides* had remarkably high frequency (80 to 100 %), density (126.5 to 1630.65) and abundance (126.5 to 1637.85) at six out of eight sites, though its quite low density and abundance were observed for two remaining locations. In contrast, another halophytic grass *Sporobolus maderaspatanus* grew at only one habitat, and that, too, with quite low frequency (5 %), density (5.7) and moderate abundance.

Talekar (2009) found that *A. lagopoides* occurred with high frequency (76.67 to 00 %), but with low density (9.67 to 45.17) and abundance (11.36 to 46.05) in 'Bhal' wetland in Gujarat. Vyas (2007), too, noted the same species growing just at one location with similar frequency (50 to 90 %), density (12.5 to 22.8) and abundance (15.1 to 28.5) in nearby maritime district. In addition, the last author noticed one more grass *Sporobolus coromandelianus* being present in a grassland habitat with 100 % frequency, 22.4 density and abundance.

Similar observations have been recorded by some other researchers in India. For instance, Singh *et al*. (1999) during their investigation on National Wild Ass Sanctuary reported quite low values of allied diversity measures for three halophyte grasses namely, *Aeluropus lagopoides* (F = 7.85 %, D = 2.49, A = 31.76), *Sporobolus coromandelianus* (F = 17.71 %, D = 3.80, A = 21.49) and *Urochondra setulosa* (F = 2.14 %, D = 0.32, A= 15.33).

Later on, Shukla (2007) found that allied diversity measures of three halophytic grasses *viz*., *Aeluropus lagopoides*, *Heleochloa setulosa* and *Aristida fumiculata* occurring at marshy locations in Diu island were suggestive of low to high frequency (20 to 90 %) and quite low to moderately high density (0.57 to 94.4) and abundance (1.36 to 102.88).

According to Youcef *et al*. (2012), a halophytic grass *Phragmites comminus* grew with frequency in the range of 20 to 100 % and its density fluctuated between 0.070 to 7.42 in saline, sub-saline and waterlogged sites in Sahara Basin in Algeria.

It becomes clear from what has been discussed above, that a non-succulent species *A. lagopoides* being present at all studied habitats and also having remarkable high frequency, density and abundance dominated over all other associated species recorded during this investigation. As a consequence, it played a noteworthy role in floristic diversity in study area.

In addition, it was further observed that less dominant species namely, *Cressa cretica*, *Ipomoea pes-caprae* and *Tamarix troupii* were noticed just at one location. Among these species, a facultative halophyte (*C. cretica*) had high frequency (100 %), density (168.5) and abundance (168.5), whereas remaining two species (*I. pes-caprae* and *T. troupii*) grew with quite low frequency (10 to 20 %) density (0.15 to 2.5) and abundance (0.75 to 10.67).

However, Talekar (2009) reported that a shrubby halophyte *Tamarix troupii* had higher frequency (50 to 60 %) in 'Bhal' area and its density and abundance fluctuated between 1.45 to 4.56. According to

Vyas (2007), a salt tolerant shrub *Prosopis chilensis* occurred with 100 % frequency at inland saline site in the same region, while its low density and abundance
varied between 1.83 to 2.3.

Similar characteristic was also observed in case of another petty halophyte shrub *Limonium stocksii* found on Diu island. Shukla (2007) found its very high frequency (80 to 100 %) as well as good density and abundance (4 to 14) per unit area.

Likewise, while examining allied diversity measures of coastal flora, Youssef and Al-Ferdan (2008) observed two shrubby halophytes *i.e.*, *Zygophyllum* spp. and *Limonium axillare* occurring with frequency of 10 to 60 %; density 0.1 to 1.8 and abundance of 0.6 to 2.3 in Al-Uqair in Saudi Arabia.

Later on, Youcef *et al*. (2012) studied halophyte communities in Sahara Basin in Algeria and reported that a facultative halophyte *Cressa cretica* showed almost equal range of frequency (20 % to 33 %) and density (0.010 to 0.012) in three different types of saline habitats. Recently, Naz *et al*. (2010) suggested that the same species grew as less associated species in the Cholistan desert in Pakistan.

Foregoing discussion makes it amply clear that though being a member of the presently identified less associated group of halophyte species, *Cressa cretica* growing with obviously very high ecological parameters, was the third dominant species in sequence, that played a remarkable role in diversity of halophyte flora.

It will be of interest to discuss here allied diversity measures of mangrove species, which occurred at only one or two studied locations. A mangrove, *Avicennia marina* was present at two sites with 100 % frequency, moderate density and abundance varying between 24.1 to 35.25). Nonetheless, remaining two species (*Acanthus illicifolius* and *Sonneratia apetala*) had quite low values of all parameters (F = 5 %, 5%; D = 1.6, 0.05 and A = 1.6, 0.5). Noticeably low frequency, density and abundance of the last two species reflected their rare presence in the area.

In contrast, Shukla (2007) had noted remarkable variations in frequency (20 to 100 %), density and abundance (0.2 to 199) of *A. marina* in marshy habitats on Diu island. It may be added here that upper values of the last two parameters in this case, were much greater than those recorded during this study.

Likewise, greater density of mangroves were recently noticed by Narasimha Rao and Prayaga Murty (2010) in Vashista and Vainateyam estuarine in Andhra Pradesh. According to them, density of two species namely, *Derris horrida* and *Avicennia officinalis* (68 to 88) was less that of *Avicennia marina* (124) or *Excoecaria agallocha* (152). The highest density was noted for *Acanthus illicifolius* (925). However, the unit area (hectare) they considered was much greater.

Clearly, the extensive discussion on relative contribution of major halophyte species found during this study supports a conclusion that a non-succulent halophyte *Aeluropus lagopoides* occurring at all selected sites with high values of allied diversity measures dominated over all associated species and thereby it was the most prominent species determining the magnitude of halophyte diversity along the lower half of Gujarat coast. Two succulent species (*Salicornia brachiata, Suaeda nudiflora*) and one facultative halophyte (*Cressa cretica*) were also equally important, because of their high numerical abundance in communities. Thirdly, less occurring species including mangroves, growing at one, two or three locations and again endowed with low ecological parameters, played a minor and secondary role in floristic diversity of halophyte vegetation reported here.

CONCLUSION

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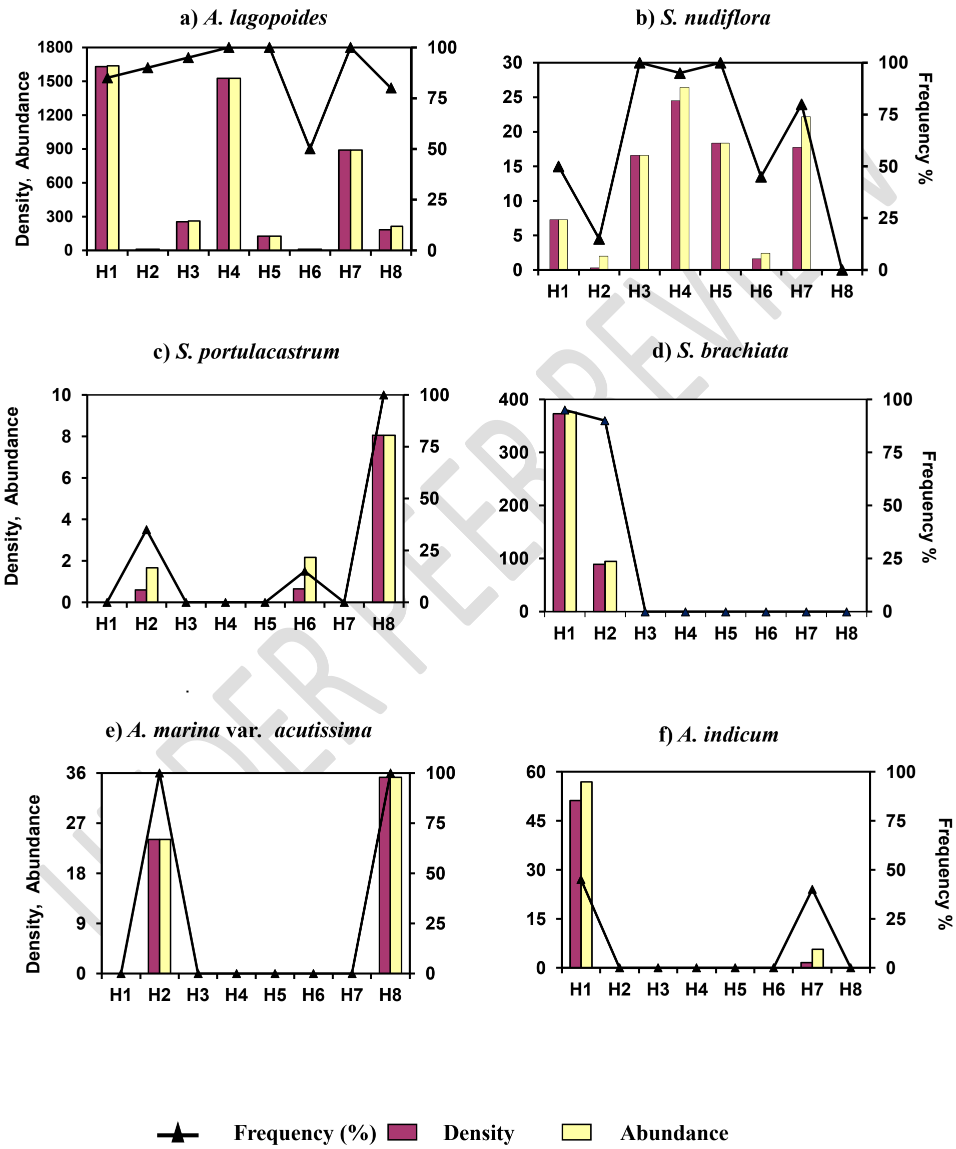
With a couple of exceptions, a non-succulent halophyte *Aeluropus lagopoides* showed remarkably high frequency, density and abundance in entire study area. Two succulent species (*Salicornia brachiata* and *Suaeda nudiflora*) were also found with high numerical abundance. In addition, a facultative halophyte species (*Cressa cretica*), although present at only one location, had high values of allied diversity parameters. A mangrove *Avicennia marina* reflected its high frequency, but low density. Moreover, a group of six less dominant species indicated their rare occurrence in the study area. Three dominant species (*Aeluropus lagopoides*, *Salicornia brachiata*, *Suaeda nudiflora*) contributed significantly to integrated outcome of halophyte diversity at different sites.

Fig. 3. Contribution of sampled species to diversity of halophytes. Each value represents mean of data recorded for two twin belt transects.



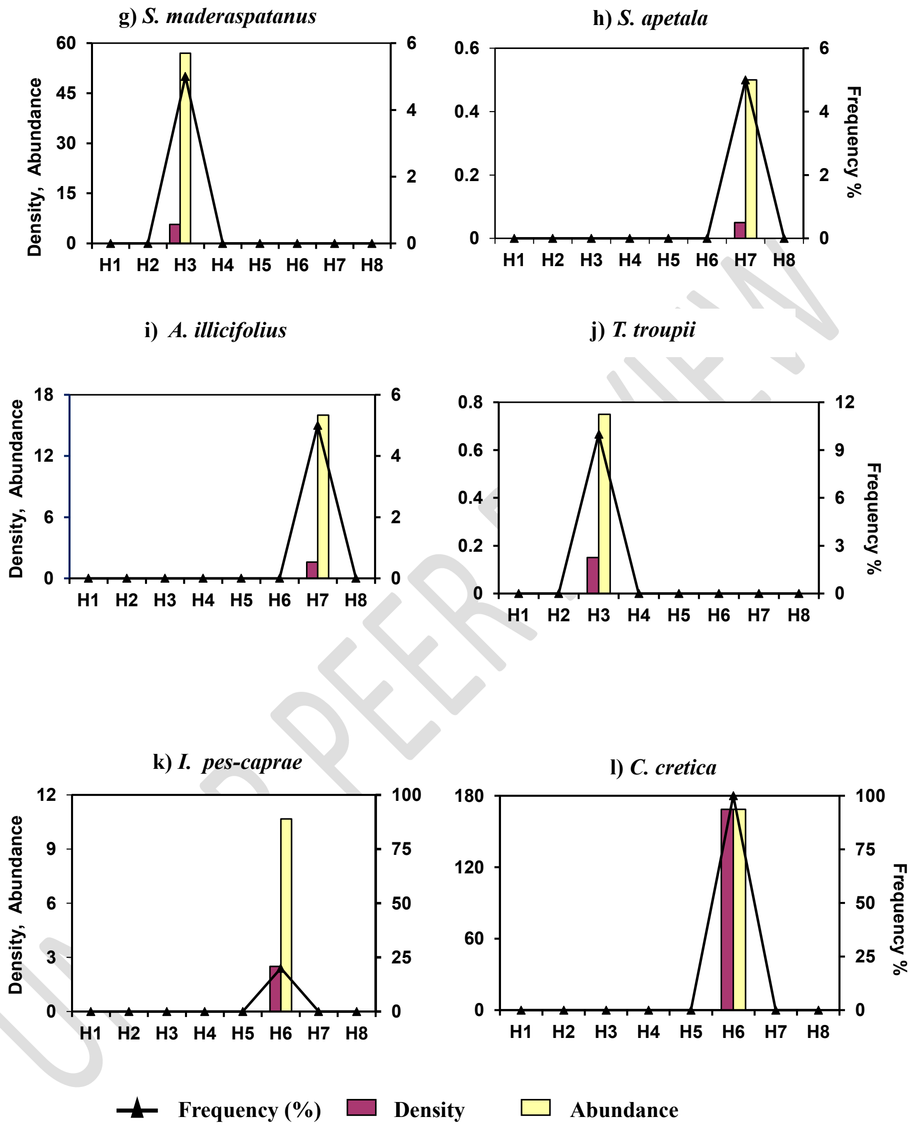

g) S. maderaspatanus
Density, Abundance
60
45
30
15
0
6
4
2
0
H1 H2 H3 H4 H5 H6 H7 H8
h) S. apetala
0.6
0.4
0.2
0
6
4
2
0
Frequency %
H1 H2 H3 H4 H5 H6 H7 H8
i) A. illicifolius
Density, Abundance
18
12
6
0
6
4
2
0
H1 H2 H3 H4 H5 H6 H7 H8
j) T. troupii
0.8
0.6
0.4
0.2
0
12
9
6
3
0
Frequency %
H1 H2 H3 H4 H5 H6 H7 H8
k) I. pes-caprae
Density, Abundance
12
9
6
3
0
100
75
50
25
0
H1 H2 H3 H4 H5 H6 H7 H8
l) C. cretica
180
120
60
0
100
75
50
25
0
Frequency %
H1 H2 H3 H4 H5 H6 H7 H8
Frequency (%)
Density
Abundance

Table 1. Occurrence of halophyte species at different locations.

Name of species	Halophyte Group	Selected locations							
		H1	H2	H3	H4	H5	H6	H7	H8
Arthrocnemum indicum (Willd.) Moq.	Succulent	√	×	×	×	×	×	√	×
Salicornia brachiata Roxb.	Succulent	√	√	×	×	×	×	×	×
Sesuvium portulacastrum (L.) Linn.	Succulent	×	√	×	×	×	√	×	√
Suaeda nudiflora (Willd.) Moq.	Succulent	√	√	√	√	√	√	√	×
Aeluropus lagopoides (L.) Trin. Ex Thw.	Non-succulent	√	√	√	√	√	√	√	√
Sporobolus maderaspatanus Bor.	Non-succulent	×	×	√	×	×	×	×	×
Tamarix troupii Hole.	Shrubby	×	×	√	×	×	×	×	×
Cressa cretica Linn.	Facultative	×	×	×	×	×	√	×	×
Ipomoea pes-caprae Linn.	Strand species	×	×	×	×	×	√	×	×
Acanthus illicifolius Linn.	Mangrove	×	×	×	×	×	×	√	×
Avicennia marina (Forsk.) Vierh. var. *acutissima*, Stapf.	Mangrove	×	√	×	×	×	×	×	√
Sonneratia apetala Buch.-Ham.	Mangrove	×	×	×	×	×	×	√	×

H1= Victor Port, **H2** = Sartanpar **H3** = Navagam, **H4** = Machhipura, **H5** = Mooler, **H6** = Sunwali, **H7** = Matwad, **H8** = Umargam; √ = presence, × = absence

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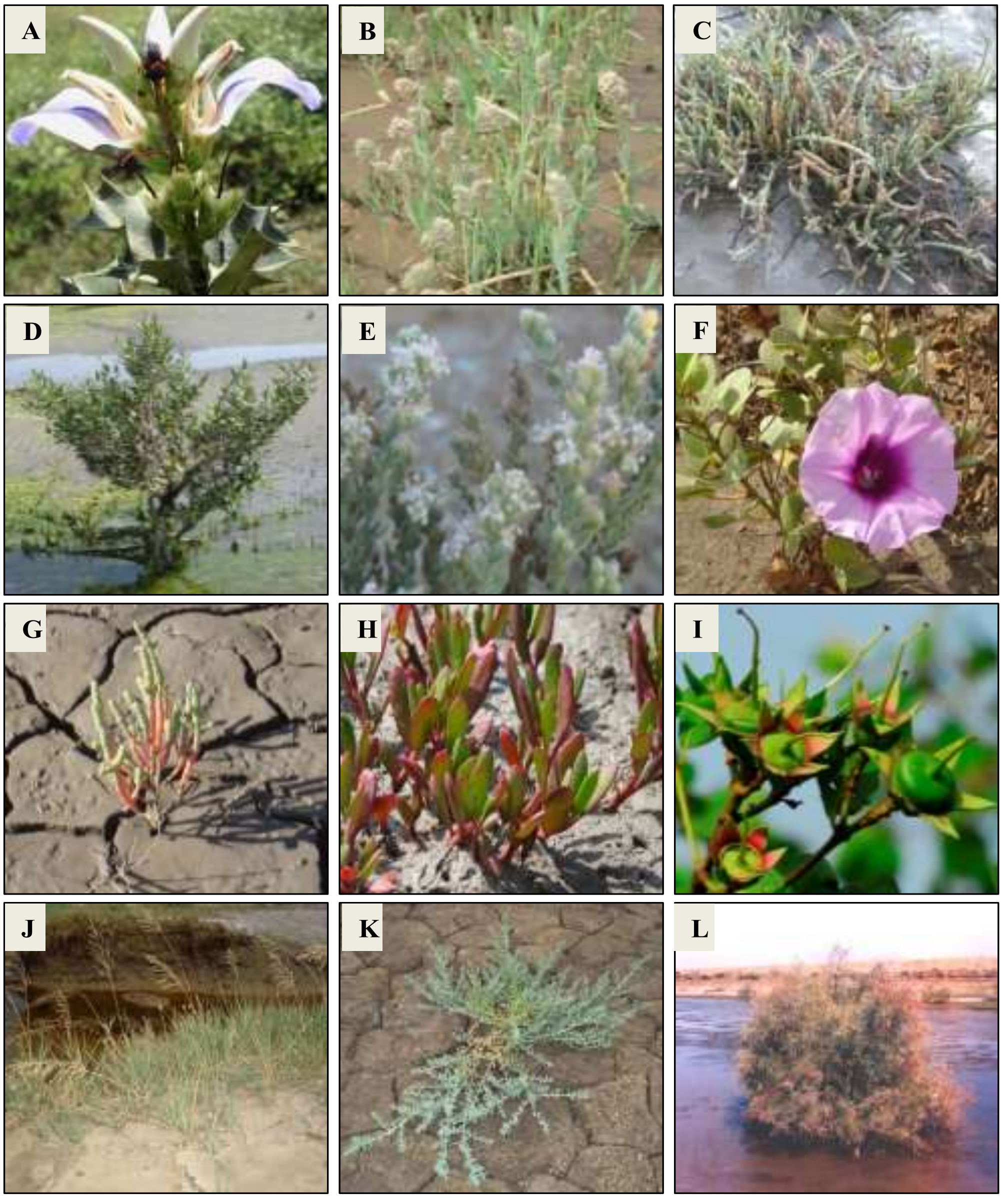
Plate 1



A - *Acanthus ilicifolius*; **B** - *Aeluropus lagopoides*; **C** - *Arthrocnemum indicum*; **D** - *Avicennia marina*; **E** - *Cressa cretica*; **F** - *Ipomoea pes-caprae*; **G** - *Salicornia brachiata*; **H** - *Sesuvium portulacastrum*; **I** - *Sonneratia apetala*; **J** - *Sporobolus maderaspatanus*; **K** - *Suaeda nudiflora*; **L** - *Tamarix troupii*

Commented [U11]: This image should be included in the results section, not as an attachment or supplement at the end.