1. INTRODUCTION

Biodiversity is a very popular approach in environmental science and has long remained a central theme in ecology (Yoccoz et al., 2001). As a shorthand description of this great variety of life, the term ‘biodiversity’ is a contraction of “biological diversity” and was first coined by Walter Rosen for the 1986 National Forum on BioDiversity (Wilson, 1988).

The United Nations Convention on Biological Diversity defines “Biodiversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems” (United Nations Environment Programme, 1992). Biodiversity is generally considered an ‘umbrella term’ referring to organisms found within the living world, i.e., the number, variety and variability of living organisms (Krishnamurthy, 2004).

Moreover, all measures must emphasize one or the other factor of diversity (i.e., species richness or species evenness), no single perfect diversity index is possible that can distil the information contained in a species abundance distribution into a single statistical number (Clarke & Warwick, 2001). Nonetheless, ecologists have invented a number of indices over the years, each of which has its own limitations (Magurran, 2004).

Similarly, to proceed very far with the study of biodiversity, we
need to pin the concept down. We cannot even begin to look at how biodiversity is distributed, or how fast it is disappearing, unless we can put units on it. Therefore, various indices of diversity are designed to measure both species richness the number of species in a community and the degree of evenness or equitability of the species relative abundances (Baczkowski, 1997).

Alpha diversity can be quantified in numerous ways. One is richness, which is defined as the number of species in a sampling unit (Magurran, 1988). The interpretation of richness is not always straightforward because it depends on sample size (Hurlbert, 1971; Peet, 1974). A second index of alpha diversity is evenness measures; these indicate how the individuals in a community are distributed among species and abundance or heterogeneity indices and are commonly used to quantify this aspect of alpha diversity.

The component of diversity that measures the differences among communities in terms of species composition is beta diversity (Whittakar, 1972; Magurran, 2004). Several factors influencing species turnover have been recognized. On the one hand, there are those related to the environment and its heterogeneity. On the other hand, there are those inherent to the species, like its dispersal ability and tolerance ranges to different environmental factors.

The central role of beta-diversity has been extensively investigated in fields as diverse as spatial ecology and conservation biology (Crist and Veech, 2006). Meta community diversity can be partitioned into within called alpha community components and among called beta community.
components.

The plant community is an assemblage of species population that occurs together in the same place at the same time. European ecologists have long before developed systems of description, classification and this aspect of ecology known as phytosociology. A mixture of species, which live in a habitat and are held together by common ecological tolerances, form a community (Singh and Singh, 2010).

Floristic composition as is a good floristic marker, because any kind of changing floristic compositions in different endogenous milieu show the existence of different ecological factors; thereby leading to inter-and intra-specific diversity. This has been established in various studies (Fakhre-Tababaei et al., 2000; Safidkon et al., 2003, 2005; Kalvandi et al., 2004; and Yavari et al., 2010). However, there are few studies on using and emphasizing phytosociological parameters to elaborate diversity of coastal flora.

Salt marshes are defined by Dijekema (1984) as natural or semi-natural terrestrial halophytic – ecosystems. They largely occur in the intertidal zone between land and the sea and are covered by salty or brackish water for at least some of the time. They replace mangrove in temperate and arctic regions. The dominant flora is composed of halophytic plant such as, grasses, shrub and herbs. The flora is rather species poor. The sediment consists of mud and sand. The salt marshes are normally associated with mud flates but also occurs on sand flates. According to Beeftink (1977), salt marshes are those areas, which are periodically inundated by the sea and which contain true halophytic and
salt tolerant plants occupying an area (approximate) between the mean high water neap tide and mean high water spring tide.

Various attempts to classify halophytes have been proposed in the last 70 years (Waisel, 1972). However, the simplest and clearest definition is probably that of Aronson and Le Floc’h (1996), stating that “halophytes species are those occurring in naturally saline conditions only” (Hamdy and Sardo, 2005).

Halophytes - plants that complete their life cycle in saline habitats-exhibit unique morphological, biological and physiological characters, which distinguish them from sea grasses and mangroves. There are a few hundred halophytic plant species recorded in the world. Halophytes could be utilised as crops for food, fibre, pot herb, edible oil, fibre materials, traditional medicines etc. (Glenn et al., 1999; and Zhao et al., 2002). Although voluminous information is available on general biology and eco-physiology of halophytes, only a few reports are available on diversity of this fascinating group of coastal flora (Lapping and Daniels, 2007).

As this study partly deals with 3 mangrove species occurring in the Gulf and marshy areas, a passing reference should be made on this group of plants. It is widely accepted that mangrove ecosystems are diverse communities growing in the inter-tidal zones of tropical to sub-tropical coastal rivers, estuaries and bays (Yim and Tam, 1999). Moreover, they act as a barrier against cyclones, protect coastal erosion and provide good nursery ground for a number of commercially important aquatic organisms.
Heavy metals are extremely toxic and they are present in our immediate environment. They occur in soil, surface water and plants, are readily mobilized by human activities that include mining and discarding industrialized waste materials in natural ecosystem that include rivers, lakes, and ocean (Larison et al., 2000). Consequently, heavy metals pose a potential threat to various terrestrial and aquatic organisms including human health (Hsu et al., 2006).

The residue and accumulation of heavy metals in the environment often cause problems. In a plant-soil system, strong absorption and fixation of heavy metals by soil can easily cause residual accumulation in the soil, resulting in over absorption of heavy metals by growing plants. These plant products are then harmful to the health of humans (Defew et al., 2005). For this reason, it is important and necessary to study the relation between the content of heavy metals in soil and the absorption and accumulation by plants. This is not only a problem of geochemistry circulation but also an approach for preventing heavy metal pollution of plant products. These facts have generated investigations on halophytes, which grow in habitats that are fully loaded with accumulation of heavy metals (Kamaruzzaman et al., 2009).

Forgoing facts generated the base of the present study, which included the objective of (1) assessing diversity of 15 halophytes and 3 mangroves growing along the Gulf of Kachchh and Saurastra coast; (2) utilizing phytosociological parameters as allied diversity measures to elaborate function of each species in a composite picture of diversity; and (3) examining habitats as a vital factor influencing halophytes diversity.
The state of Gujarat is situated on the north-western parts of India. It (20° 2’ - 24° 41´ N latitude and 68° 8´ - 74° 23´ E longitude) occupies an area of 1,96,024 sq.km and has 1663-km-long coastline, which spreads along 13 maritime districts and one Union Territory of Diu between Kachchh and Valsad. Interestingly, Gujarat coast is characterised by typical salt marshes, salt plains, sand dunes and rocky shore found along 1663-km-long sea coast of Gujarat out of 5700-km-long Indian coast.

Present investigation includes research on morphologically different halophytes growing in 9 maritime districts between Kachchh to Diu. The twin belt transect method was used for recording floristic data of halophytes and mangrove species occurring in 3 different types of habitats viz., marshy, sandy and rocky.

Biodiversity indices like Shannon’s, Simpson’s and Pielous were computed for alpha (within habitat) diversity, while, Jaccard’s, Sorensen’s and Morisita-Horn indices were calculated for beta (between habitat) diversity for 18 halophytes growing at 9 locations. Findings of allied diversity measures such as, frequency, density, abundance and relative density of halophytic species have been used to understand quantitative role of each species in various components of diversity of halophyte communities.

Variations in heavy metals such as, Fe, Mn, Zn, Cu, Pb, Ni and Cd and in inorganic ions viz., Na+, Cl-, K+, Ca2+ and Mg2+ in supporting habitats were recorded to find out their capacity and distribution with respect to diversity of halophytes. Similarly, accumulation of the said metals and inorganic ions in leaves and phylloclades of 5
morphologically different categories of halophytes *viz.*, succulent, non succulent, shrubby, facultative halophytes and strand species occurring in same habitat and same species growing at different habitats was also examined. Attempts were also made to study salinity and pH changes in the habitats. These results were used for abridging relationship of halophytes diversity with that of the supporting habitats.

Thus, the thesis presents a unique report on within the habitat (alpha) and between the habitat (beta) diversity of 18 species growing along Kachchh and Saurastra coast, allied diversity measures to quantify function of individual halophyte species in a composite picture of 3 alpha and 3 beta components; and on accumulation of heavy metals and mineral ions along with salinity changes in habitats to evaluate their influence and role in variation of diversity of halophytes. The data were subjected to 2-way ANOVA in order to make justifiable conclusions.

The thesis has been organized into chapters on review of literature, material and methods, results, discussion and summary and conclusions. The last and final chapter includes supporting literature.