Pak. J. Bot., 33(1): 77-91, 2001.

SALT MARSHES AND SALT DESERTS OF S.W. IRAN

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Abstract

Using the Braun-Blanquet approach, 13 plant communities of the Persian Gulf salt marshes were distinguished on the S.W. Iran. Vegetation types have been defined by physiognomic-floristic system. These have been assigned to the following five main groups of communities: (1) Woody shrub and perennial halophytic communities (Class Suaedetea fruticosae) including 3 association, (2) Semi-woody shrub and perennial halophytic communities (Class Halocnemetea strobilacei) including 4 associations and 1 subassociation, (3) Hydrophilous halotolerant communities (Class Phragmitetea) including 1 association, (4) Salt marsh brushwood communities (Class Tamaricetea) including 3 associations, (5) Woody shrub and perennial halotolerant communities (Class Anabasetea articulatae) including 1 association. The soil of these communities was analysed and their habitats described and discussed.

Introduction

The coastal salt marshes comprise area of land bordering the seas and lakes, more or less covered with vegetation and subject to periodic inundation by tide. They have certain characteristics which are related to the proximity to the sea and lake, that distinguishes them from inland salt marshes (Chapman, 1977). Littoral salt marshes are essentially fringes of inland deserts, their landward boundary being defined by desert conditions. Ecological factors, such as terrain or climate, can be used to delimit the littoral marshes. When there is a narrow belt along the coast surrounded by a steep barrier of mountains (e.g., part of the studied area), the limits are clear. But in a broad plain that stretches inland from the coast, there may be no distinct physiograhic barrier, therefore, other habitat features including vegetation type have to be used. Vegetation characteristics, related to physiographic attributes reflecting both climatic and edaphic factors, provide the best single basis for delimiting littoral salt marshes. These salt marshes may be only a narrow belt within the reach of salt spray. They can be a hundred metres wide or they may extend inland for many kilometers (Zahran & Willis, 1992).

Iran is the classical country of the great salines and kavirs (Zohary, 1973). The coastal salt marshes in Iran are located within areas having a high water table. The largest of these salines are situated around the Persian Gulf in S.W. Iran. Halophytic communities of Iran are still among the most poorly known vegetation units. The distribution of halophytic communities has been depicted cartographically (Mobayen & Tregobov, 1970; Mobayen, 1976; Freitage, 1977; Kramer, 1984; Carle & Frey, 1977; Frey, 1982; Frey *et al.*, 1985). The physiognomic and ecologic-geographic data on such communities have been given by Kunkel (1977), Ghorbanli & Lambinon (1978), Frey & Probst (1986), Breckle (1982, 1983), Assadi (1984), Akhani (1989) and Akhani & Ghorbanli (1993). There have been relatively few investigations using the phytosociological approach on salt marshes of Iran, including floristic survey of salt desert vegetation (Zohary, 1963, 1973; Leonard, 1991) and littoral salt marsh vegetation (Asri *et al.*, 1995, 1997).

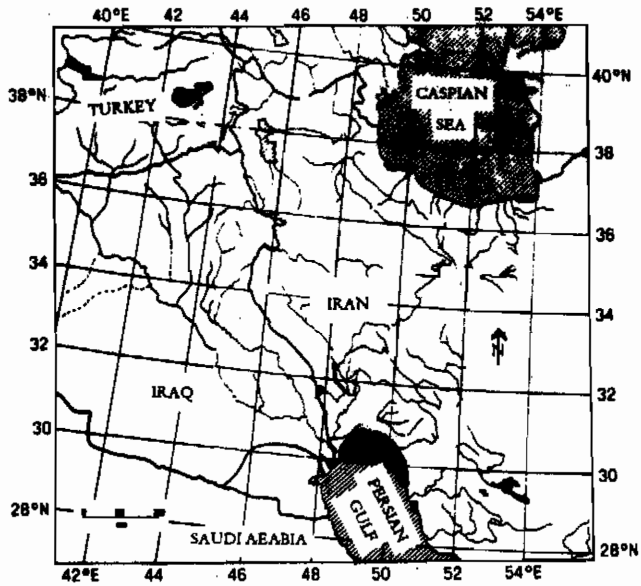


Fig. 1. Situation and map of SW Iran with the study area.

Study area

The area of the present survey is a Persian Gulf coastal belt of about 40 km wide and 110 km long, extending between latitude 30° 33 N and latitude 30° 92 N. The study area comprises the coastal plains of Persian Gulf; a rather flat alluvial plain at 0-50m elevation, it rises gradually toward a small mountains range with about 200m of elevation (Fig. 1). The coast land is fairly narrow and consists of saline land alluvial plains. The geological substratum mainly consists of alluvium, coastal plains and swamps corresponding to the Quaternary and recent deposits. Other formations (Gachsaran, Aghajari and Bakhtyari) belong to the Pliocene and Miocene (Tertiary) periods (Anon., 1960). A major part of the soils belongs to heavy saline soil series. They are chiefly Solonchaks, which fall into the aridisols category according to the US comprehensive system of soil classification (Dregne, 1976). Also there are low-humic gley and alluvial soils groups, that belong to the inceptisols and entisols categories, respectively.

The hot southern gulf region with its high winter and summer temperature and scant amount of rain displays a climatic regime similar to that of tropical northeast African and hot Sindinan deserts, but occasionally with more extreme maxima and minima (Zohary, 1973). Means of over 20 years from six meteorological stations, show that the total annual precipitation is around 200 mm, with the maximum occuring in the winter and spring months. Mean maximum and minimum temperatures are 44°C for July and 7°C for January. Therefore, hot desertic climate of S.W. Iran is characterized by high temperature and erratic, often scanty rainfall.

Materials and Methods

Sample releves were performed according to the Braun-Blanquet method (Mueller-Dombois & Ellenberg, 1974; Westhoff & Van Der Maarel, 1978). The releve size was determined by establishing a species area curve in each vegetation type. The releves of hydrophilous halotolerant communities were recorded on an area of 0.24 - 4m^2, those of the halophilous communities on 0.25-16m^2.

The releve and species groups were defined by the program AFC (for correspondence analysis), using the computer program of Anaphyto (Briane, 1991). The strategy of AFC has become an effective tool for phytosociological clustering and table sorting. The AFC method developed by Benzecri (1969), allows all the points (species and releves) to be represented on the same diagram. The species with the most similar patterns from groups, which are placed in or near, groups of releves with similar species composition. The ordination is a floristic one, and the inter pretation of a floristic axis in terms of environmental factors may be reflected on two or more floristic axes. The releve species clusters have been defined by numerical analysis of AFC data, using a CAH technique included in the program. CAH is essentially a clustering procedure base on releve similarity, combined with a procedure for obtaining a diagonal structure clusters in the table. In the phytosociological table, species and releves are ordered in such a way that the species with a more or less similar distribution pattern over the releves are grouped together and, similarly, releves with a more or less similar species content are placed next to one another. The name of syntaxa correspond with the code of phytosociological nomenclature (Barkman *et al.*, 1986).

The next step comprises the replacement of each association data by a column in which for each participating species the presence degree is indicated. Such a table is called synoptic table. After comparison of the synoptic table with those from other types of vegetation from the same region an idea can be formed about the local diagnostic species groups in the table under study. The syntaxonomical research step starts when a vegetation type is to be fitted into the hierarchic syntaxon tables. Syntaxonomical interpretation of the classification was elaborated by comparsion with the available literature from Egypt, Israel, African Red Sea, S.W. Asia and Europe based on the Braun-Blanquet approach.

A few samples of the upper layer of the soil were taken from each community. Analysis of soil samples has been carried out following Richards (1954), Jackson (1960), Walsh (1971) and Forth (1972).

Results

The program used produced an ordination with five axes. The distribution of species or releve groups is better revealed on axes 1-2 than others (Figs. 2&3). The floristic gradient in Fig. 3 can be interpreted ecologically as an overall salinity gradient ranging from low to high saline environments. Also, this gradient is related to the structural complexity of the vegetaion from pioneer to brushwood and semi-woody shrub communities. The other floristic gradient (axes 2-3) can be interpreted as related to moisture ranging from herbaceous halotolerant communities to perennial halophytic communities.

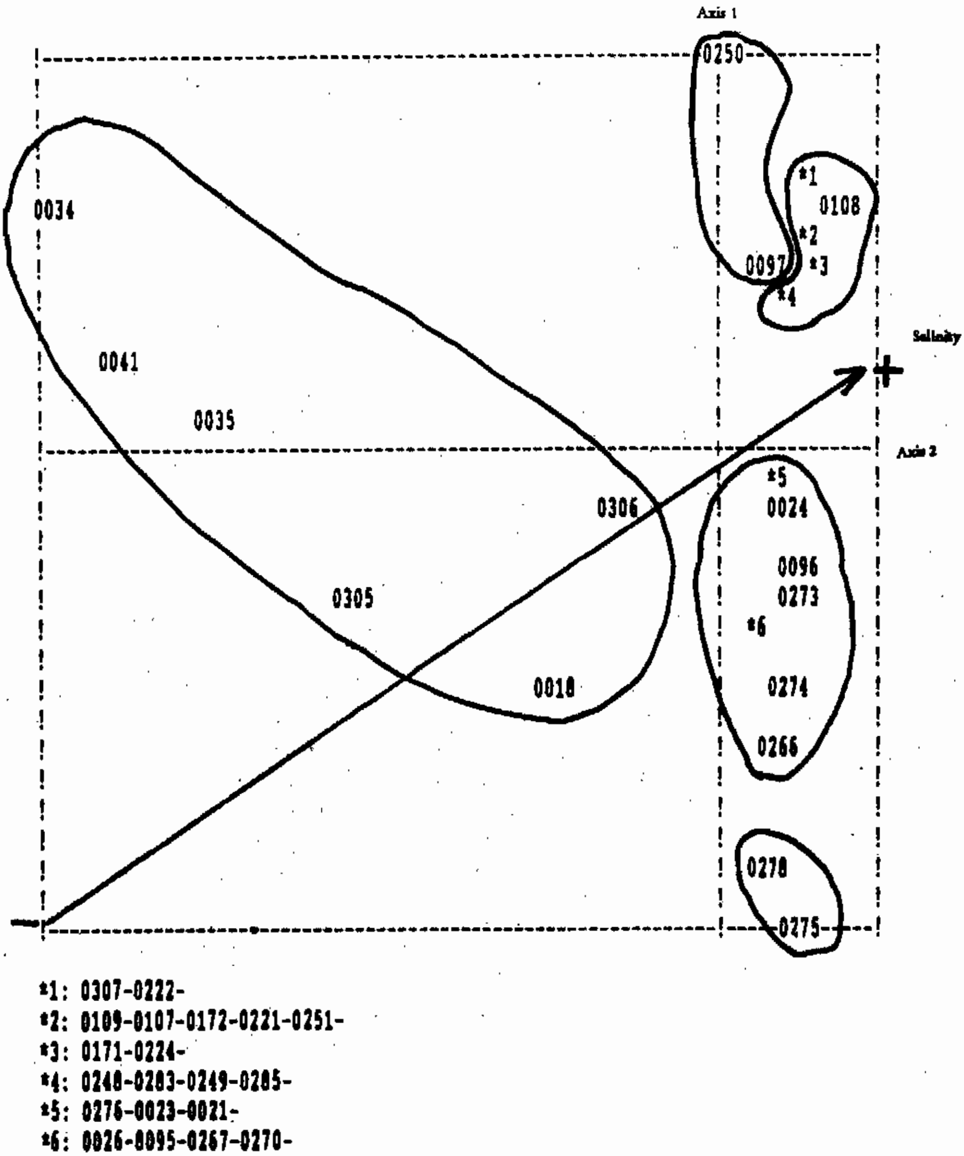
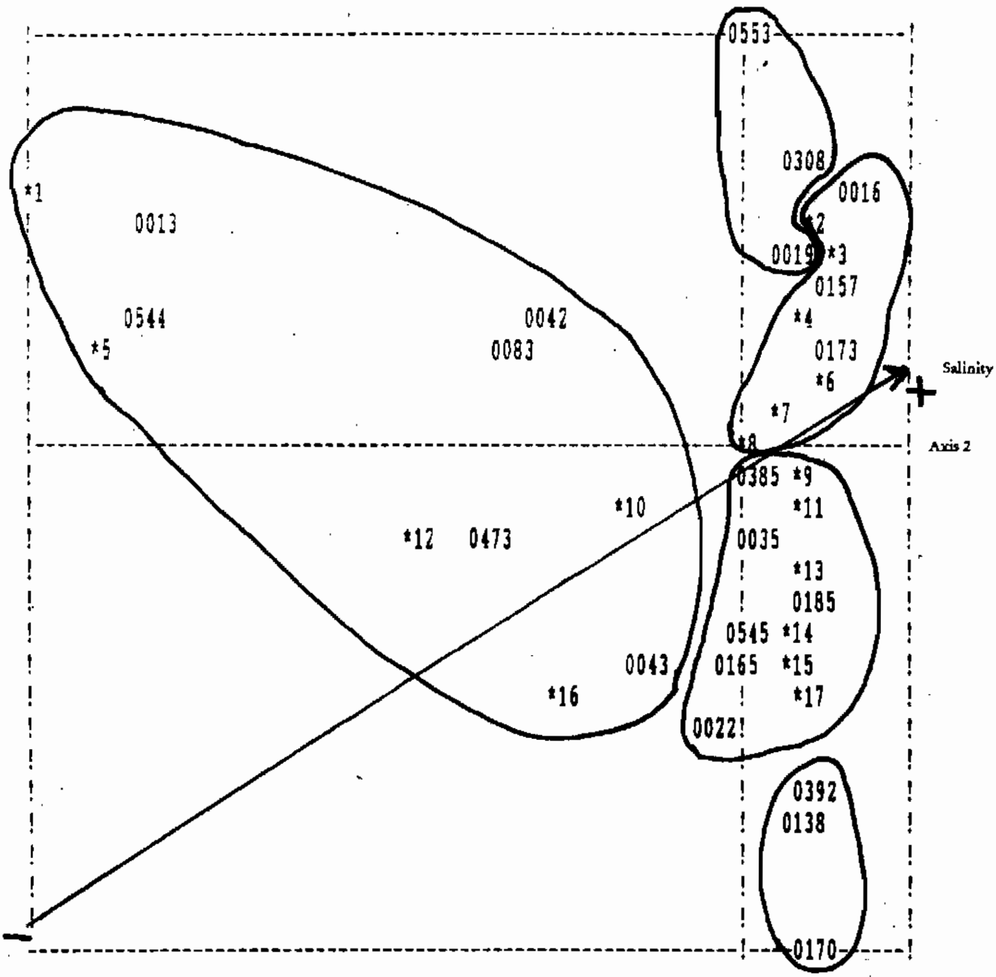


Fig. 2. Releves ordination based on AFC (axes 1-2).

Generally, five groups can be recognized on axes 1-2 (Figs. 2&3). Similary, five species and releve clusters have been distinguished in dendrograms obtained with CAH method (Fig. 4). Partial analysis of groups resulting from AFC method has shown that each group may be divided to some subgroups. Finally 13 subgroups are distinguished on the basis of partial analysis. The synoptic table (Table 1) is then constructed, using the releve and species clusters obtained by CAH method followed by partial analysis. According to the results of the numerical analysis, all the associations distinguished are to be included in the following classes:



*1: 0310-0028-
*2: 0328-0073-0477-0166-0474-0203-0057-0068-0037-0172-
*3: 0034-0359-
*4: 0242-0027-0324-0447-
*5: 0329-0082-
*6: 0052-0533-
*7: 0471-0159-0025-
*8: +----0167-
*9: 0307-0026-
*10: 0249-0245-
*11: 0176-0175-
*12: 0543-0546-
*13: 0169-0183-0284-
*14: 0413-0184-0259-
*15: 0178-0179-0180-
*16: 0374-0017-
*17: 0177-0393-

Fig. 3. Species ordination based on AFC (axes 1-2).

Class phragmitetea: The communities characterized by hydrophilous plant on margins of salty and brackish swamps, streams, areas, with high ground water and localities where fresh water flows down into the salt marsh are to be included in the class Phragmitetea. This class was suggested by Zohary (1963), Ellenberg (1986) and Best (1988) for the vegetation type. The association belonging to this class is Bolboschoenetum maritimi (Table 1).

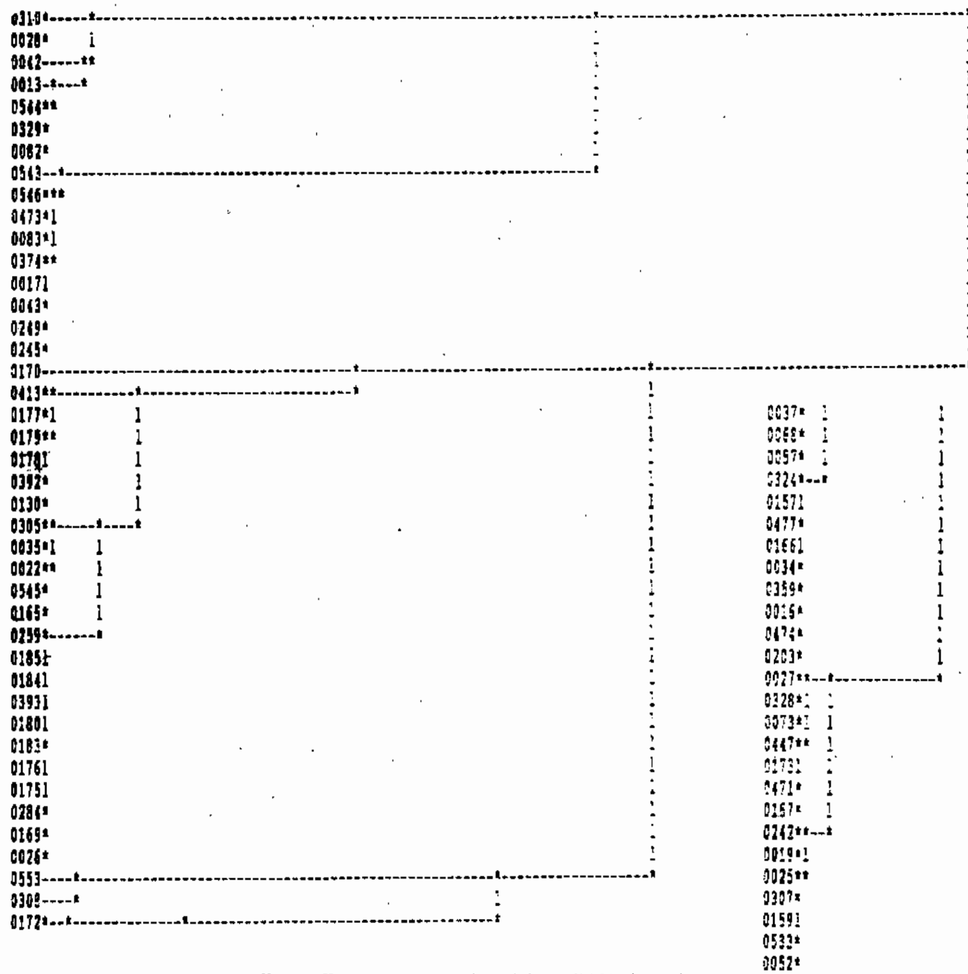


Fig. 4 Dendrogram produced from CAH clustering.

Class Tamaricetea salina: Zohary (1963) described the class Tamaricetea salina for salt marsh brushwood communities of Iran, but he did not give a hierarchical classification for it. Also, Asri & Ghorbanli (1997) have studied this class for Orumieh lake salt marshes. This class is represented here by three associations. All are limited to the fore-shore of the Persian Gulf and riverine brushwood (Table 1). The associations belonging to the class Tamaricetea are th,.e following: Tamarico leptopetalae-tetragynae, Tamaricetum leptopetalae, Tamarico arceuthoidis-tetragynae. The syntaxonomical scheme of this class is shown in Table 2.

Class Suaedetea fruticosae deserti: This class comprises of a number of halophytic associations which require higher winter temperature and accordingly limited to the Sudanian territory or to its borderland. The class has been studied mainly by Zohary & Orshan (1949), Borovin (1963) and Zohary (1982). The plant communities of the Suaedetea are definitely confined to the shore of the Persian Gulf and borderland (e.g.

Table 1. Synoptic table of 12 association and 1 subassociation in the salt marshes of S.W. Iran.

1. Tamarico arceuthoidis - tetragynae, 2. Tamarico leptopetalae - tetragynae, 3. Tamaricetum leptopetalae, 4. Cornulacetum leucacanthae, 5. Cresso creticae - Suaedetum fruticosae, 6. Salsolo incanescenti - Suaedetum fruticosae, 7. Suaedetum fruticosae, 8. Hordeo marini - Halocnemetum strobilacei, 9. Frankenio pulverulentae - Halocnemetum strobilacei, 10. Halocharitetosum sulphureae, 11. Halocnemetum stobilacei, 12. Psylliostachyo spicatae - Halocnemtum strobilacei, 13. Bolboschoenetum maritimi.

Association and subassociation number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Number of releves	**3**	**3**	**3**	**2**	**4**	**3**	**3**	**4**	**4**	**2**	**5**	**3**	**4**
Number of species	**16**	**8**	**7**	**13**	**22**	**17**	**15**	**14**	**16**	**9**	**16**	**11**	**9**
Character-taxa of the associations													
Tamarix arceuthoides	100(1-4)										20(+)		25(+)
Tamarix tetragyna	100(3-4)	100(2)	66(1)		50(+1)	33(1)							
Tamarix leptopetala		100(3)	100(4)										
Elecocharis palustris			100(2)										
Cornulaca leucacantha				100(2-3)									
Cressa cretica				50(+)	(100(2-3)						20(+)		
Salsola incanescens					25(1)	100(1-3)							
Suaeda fruticosa					100(+-2)	100(2-3)	100(2-3)	25(+)					
Salicornia europaea							66(+)						
Hordeum marinum								100(2)					
Asthenatherum forsskalii								100(+-1)					
Frankenia pulverulenta								50(+-1)	100(2-3)	100(2)		66(+-1)	
Halocnemum strobilaceum					75(1-2)	100(2)	66(2-3)	100(1-3)	100(2-3)	100(2)	100(3-4)	100(3)	25(+)
Psylliostachys spicata								50(2)	75(+)			100(2-3)	
Sphenopus divaricatus												66(+)	
Bolboschoenus maritimus											20(+)		100(3-4)
Typha australis													50(1)
Differential-taxa of the Subassociation													
Halocharis sulphurea								50(1)		100(2)			
Companions													

Table 1 (Contd.)

Association and subassociation number	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of releves	**3**	**3**	**3**	**2**	**4**	**3**	**3**	**4**	**4**	**2**	**5**	**3**	**4**
Number of species	**16**	**8**	**7**	**13**	**22**	**17**	**15**	**14**	**16**	**9**	**16**	**11**	**9**
Mesembryonthemum nodiflorum		33(+)									20(+)		
Sonchus oleraceus	33(+)												
Urospermum picroides	33(+)												
Ammania multiflora	33(+)												
Lophochloa phelaides	33(+)												
Cynodon dactylon	33(+)				25(+)								
Erodium cicutarium		33(+)											
Aizoon hispanicum		33(+)											
Lolium rigidum			33(1)										
Phrogmites australis		66(+)	33(2)										75(1)
Plantago ovata	33(+)	33(+)					33(+)						
Sisymbrium irio					25(+)								
Chenopodium murale					50(+-1)								
Atriplex leucoclada	33(2)			50(+)	50(+-1)	66(+)					20(+)		
Tamarix passerinoides	33(1)			50(+)	50(+-1)								25(+)
Londesia ariantha							33(+)						
Capparis spinosa				50(+)			33(+)						
Salsola crassa					25(+)	33(+)	33(+)						
Salsola baryosma				50(+)		33(1)	33(+)						
Suaeda acuminata						66(+)	66(1)						
Prosopis farcta				100(+-1)	25(2)		33(2)						
Alhagi mannifera	33(+)			100(+-1)	25(+)	100(+-1)	33(+)		25(+)	50(+)	40(+-1)		
Suaeda aegyptiaca	33(+)			50(+)	100(2)	100(1-3)	100(+-1)	100(+)	25(+)		40(+-2)		
Polypogan manspeliensis								50(+)	50(+)	50(+)			
Plantago psyllium									25(+)				
Calendula persica									25(+)				
Erodium ciconium									25(+)				

Table 1 (Contd.)

Association and subassociation number	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of releves	3	3	3	2	4	3	3	4	4	2	5	3	4
Number of species	16	8	7	13	22	17	15	14	16	9	16	11	9
Senecio vulgaris					25(+)								
Asphodelus tenuifolius												33(+)	
Beta vulgaris								50(+)	25(+)		20(4)	100(+)	
Spergula fallax	33(+)				50(1)		66(+)	75(1)	75(+)	50(+)	40(+-2)		50(1)
Aeluropus logopoides	33(2)				50(2)	66(1)	66(+)	75(+-1)	75(+-1)	50(1)	60(2)	66(+-2)	50(+-1)
Aeluropus littoralis						33(+)	66(+-1)	25(+)	25(1)		60(1-2)		
Salsola jordanicola				50(+)	50(+-1)	50(1)					20(1)	33(1)	
Phalaris minor	33(+)				25(+)	66(+)							
Malva parviflora	33(1)				25(1)				25(+)				
Stipa capensis			33(+)	50(+)									
Cyperus rotundus					50(+)						20(+)		25(+)
Plantago coronupus						33(+)						33(+)	
Melilotus indicus						33(+)					20(+)	33(1)	
Bienertia cycloptera		33(+)							25(+)	50(+)			
Lophochloa obtusiflora								25(+)				33(+)	
Spergularia diandra					25(+)								
Lycium shawii											20(+)		
Hordeum glaucum				50(+)					25(+)	50(+)			
Bromus danthoniae			33(+)	50(+)		33(+)							

Red Sea). The associations belonging to this class are the following: Suaedetum fruticosae, Salsolo incanescenti-Suaedetum fruticosae and Cresso creticae-Suaedetum fruticosae (Table 1). *Suaeda aegyptiaca* is a prominent characteristic species in all associations. Our results suggest the syntaxonomical scheme for this class (Table 2).

Table 2. Syntaxonomical scheme of vegetation.

Suaedetea fruticosae deserti	Halocnemetea strobilacei
Suaedetalia fruticosae	Halocnemetalia strobilacei
Suaedion fruticosae	Halocnemion strobilacei
Suaedetum fruticosae	Halocnemetum strobilacei
Salsolo incanescenti- Suaedetum fruticosae	Frankenio pulverulentae- Halocnemetum strobilacei
Cresso creticae- Suaedetum fruticosae	Hordeo marini- Halocnemetum strobilacei
Phragmitetea	Psylliostachyo spicatae- Halocnemetum strobilacei
Phragmitetalia	Halocharitetosum sulphurea
Bolboschoenion maritimi	Tamaricetea salina
Bolboschoenetum maritimi	Tamaricetalia
Anabasetea articulatae	Tamaricion tetragynae
Anabasetalia articulatae	Tamarico arceuthoidis-tetragynae
Anabasion articulatae arenarium	Tamarico leptopetalae-tetragynae
Cornulacetum leucacanthae	Tamaricetum leptopetalae

Class Halocnemetea strobilacei: According to the results of the numerical analysis, most of the communities characterized by semi-woody shrub and perennial halophytes on muddy and dry salty flats should be included in the class Halocnemetea strobilacei. This class comprises the bulk of the halophytic vegetation of S.W. Iran. According to Zohary (1973) and Asri (1997) most of halophytic communities of Iran should be reffered to the class Halocnemetea strobilacei irano-anatolica. Also, our syntaxonomical scheme (Table 2) is not in accordance with the scheme of European salt marsh vegetation proposed by Chapman (1974). According to Chapman (1974) this vegetation type should be assigned to the class Halostachyetea. The associations and subassociations belonging to this class are: Hordeo marini-Halocnemetum strobilacei, Frankenio pulverulentae-Halocnemetum strobilacei, Halocharitetosum sulphureae, Halocnemetum strobilacei, Psylliostachyo spicatae, Halocnemetum strobilacei (Table 1).

Class Anabasetea articulatae: The vegetation of this class comprises a few communities occurring in irrigated areas in deserts where irrigational practices lead to salinization of the soil and to the occurrence of a special halotolerant vegetation. Vegetation is mainly confined to shallow ephemeral stream beds and runnels, which enjoy rather high amount of runoff water flowing from the adjacent uplands in addition to the scanty rainfall. In S.W. Iran this vegetation class occupies a small region; there are a few stands of semi-woody annual halotolerant communities. Zohary (1955, 1982) and Danin *et al.*, (1975) described this class for vegetation from Israel and adjacent areas. The association belongs to the class Anabasetea is Cornulacetum leucacanthae (Table 1).

The climatic conditions of the Persian Gulf coast have a pronounced effect on the edaphic characteristics of the salt marshes. Aridity of the climate increases the rate of evaporation. As precipitation is low, there is insufficient leaching and salts accumulate in the form of surface crusts. The soil is generally saline and alkline with a pH of 7.3 to 8.9, and little differences between associations and subassociations (Table 3). Data of the mechanical analysis reveals that most of the soils have heavy texture with considerable

Table 3. The mean values of soil characteristics of different vegetational types.

Associations and subassociations	Depth (cm)	pH	EC (mmhos cm^{-1})	Water content	Organic matter(%)	Textural class	Na^+	$Mg^{2+}+Ca^{2+}$	Cl^-	$SO4^{2-}$	$HCO3^-$
							(meq l^{-1})				
Tamarico leptopetalae-tetragynae	0-50	8.02	20.8	7.2	4.9	S.L.	126	206	100	43	3.6
Tamarico arceuthoidis-tetragynae	0-50	8.10	30.0	7.7	4.0	L.	113	267	160	38	3.1
Tamaricetum leptopetalae	0-50	8.20	34.0	8.0	4.1	Si.	230	192	112	270	2.8
Cornulacetum leucaeanthae	0-30	8.90	3.1	3.3	4.2	Si.C.L.	17	15	60	218	2.7
Suaedetum fruticosae	0-50	7.80	38.0	5.1	6.0	Si.L.	430	198	490	207	3.3
Salsolo - Suaedetum	0-50	7.60	24.0	5.3	3.7	C.L.	108	160	160	38	3.5
Cresso- Suaedetum	0-50	7.90	27.1	4.2	2.9	C.L.	152	223	230	57	3.7
Halocnemetum strobilacei	0-50	7.80	180.0	4.5	6.2	Si.L.	417	202	1430	166	3.0
Hordeo-Halocnemetum	0-30	7.60	190.0	3.7	6.3	C.L.	450	290	1790	172	3.0
Psylliostachyo- Halocnemetum	0-30	7.70	187.0	3.4	5.8	C.L.	410	331	2390	98	3.3
Frankenio- Halocnemetum	0-30	7.60	164.0	3.2	5.6	C.L.	395	338	2310	101	3.3
Bolboschoenetum maritimi	0-30	7.30	43.0	19.8	7.1	C.	57	108	103	177	2.5
Halocharitetosum sulphureae	0-30	7.75	135.0	3.1	4.8	C.L.	273	317	1880	111	3.0

differences between them. When data for total water-soluble salts are considered, it can be seen that the soils of the semi-woody annual halotolerant communities, and hydrophilous halotolerant communities have the lowest salt concentrations. The associations belonging to the vegetation types are the following: Cornulacetum leucacanthae, Bolboschoenetum maritimi; while those of the woody and semi-woody shrub and perennial halophytic communities such as Halocnemetum strobilacei, Suaedetum fruticosae, Salsolo incanescenti-Suaedetum fruticosae, Cresso creticae-Suaedetum fruticosae, Frankenio pulverulentae-Halocnemetum strobilacei, Psylliostachyo spicatae-Halocnemetum strobilacei and Hordeo marini-Halocnemetum strobilacei have the highest salt concentrations.

Discussion

The Persian Gulf littoral salt marshes are, in most instances, organized into zones following the shore line. Each zone is occupied by one of the vegetation types that are units of the salt marsh vegetation. It may however be noted that within any locality only a few of these zones are represented; and that a zone may include a mosaic of more than one communities depending on local climate or soil conditions. Zonation may appear to have a spacial relationship with the shore-line but it actually involves a complex edaphic pattern of amount and kind of salts (Table 3). Also the vegetation pattern includes a number of halotolerant or halophytic associations and subassociations that are clearly characterized from the floristic and ecological viewpoints. Inference about the ecology of the studied vegetation have been drawn from AFC. The ordination of vegetation types along axes 1-2 (Fig. 3) corresponds to a gradient of salinity decreasing from semi-woody shrub and perennial association (Halocnemetum strobilacei) to annual halotolerant association (Cornulacetum leucacanthae). The moisture gradient appears to be correlated with different ordination axes (2 and 3) from hyrophilous halotolerant association (Bolboschoenetum maritimi) to annual halotolerant association (Cornulacetum leucacanthae). The vegetation types belong to five classes; that with the exception of classes Halocnemetea strobilacei, Phragmitetea and Tamaricetea, the other i.e., Suaedetea fruticosae and Anabasetea articulatae are recored for the first time from Iran.

According to the habitat and floristic composition it seems that the classes Halocnemetea and Suaedetea should be categorized into the super class Halocnemea (Table 1). However, this deduction requires further investigation. The marker plants of the Halocnemea will be the following: *Spergula fallax, Aeluropus lagopoides, A. littoralis, Salsola jordanicola, Cyperus rotundus, Suaeda aegyptiaca, Alhagi mannifera* and *Melilotus indicus*.

The structural organization of the vegetation type is on growth form of the dominant species and on the floristic composition of the phytocoenoses. The number of species varies from type to type; some have few, others have as many as 22 species (Table 1). Several factors (soil salinity or alkalinity, tidal movement, relief of ground, sea-water spray, etc.) seem to play substantial roles in determinig the zonation pattern of the vegetation of the littoral salt marshes, but their individual effects vary. The results of studies carried out by us on the vegetation of the littoral salt marshes of the Persian Gulf coast revealed that Zonation is usully attributed to varying gradients in soil salinity. The development of salinity, amount of salts (Na^+, Cl^-, Mg^{2+} and Ca^{2+}), pattern of salt content within the profile, kind of salts associated with increase in ground level and saline water table may differ in different zones. Again the dynamic processes of accretion, seem to produce different types of habitat within the different zones of the salt marsh.

The role of these factors in delimiting plant associations has been stressed by many authors (Abdel-Razik *et al.*, 1984; Asri & Ghorbanli 1997; Ayyad & El-Ghareeb 1982; and Zahran 1977). In the littoral salt marshes of the S.W. Iran, and probably in all the arid climate, the salinity gradient does not form a regular pattern of decreasing salinity further from the shoreline. Zonation sequence is complete only where the shore rises gently and gradually into the land, and this happens rarely. The communities of the saline flats occur in five main zones: the first or shoreline zone is the habitat of *Halocnemum strobilaceum*. The second zone is occupied by the *Suaeda fruticosa, S. aegyptiaca* and *Salsola incanescens*, the third zone is the habitat of *Cornulaca leucacantha, Alhagi mannifera* and *Prosopis farcta*. The fourth zone is accupied by *Tamarix tetragyna, T. arceuthoides* and *Tamarix leptopetala* that are all limited to the lower terrace of the alluvial plain and foreshore of the Persian Gulf and permanent rivers. They require a large amount of soil moisture. The fifth zone is the habitat of *Bolboschenus maritimus*, that is reed-swamp and rush habitat may be associated by *Typha australis* and *Phragmites australis*. The reed-swamps are restricted to certain creeks associated with rivers or mouth areas and their fringes crossing salt marsh zones e.g., the creeks crossing *Halocnemum strobilaceum* community types in Abadan area. From the discussion of the zonation of the Persian Gulf littoral vegetation we may conclude that a consistent pattern of zonation of the salt marsh communities may not exist in the field, and that any idealized pattern of zonation of a coastal stretch is only arbitrary. This is because (1) all the zones of idealized pattern do not appear in one locality, or (2) representatives of certain communities may occupy zones different from their normal zones. In general, Halocnemetum strobilacei is typical of vast areas of littoral marshes with high salinity and high ground-water level. The growth of *Halocnemum strobilaceum* occurs in two forms: (1) circular patches on flat tidal-muddy ground and (2) sheet of irregularly shaped patches far away from the shoreline. This community occupies the shoreline and also the inland side of the shoreline, where the usual associate is *Suaeda fruticosa.*

Apparently, saline water table is another factor determining the establishment plant communities. *Bolboschoenetum maritimi* and *Halocnemetum strobilacei* dominate the lower marshes which are subject to periodic inundation for varying periods. The constant occurrence of these associations in this habitat may suggest that salt-water inundation plays the key role in plant distribution. Inundation seems to act mainly through increased soil moisture and affecting soluble salt content to levels suitable for inhabitation of the plants.

Finally, Zohary's Classification (1963, 1973, 1982) is verified by our observations on different concrete segments of the Persian Gulf salt marsh vegetation.

Aknowledgements

I would like to express our gratitude to Dr. B. Mohajerani and Mr. A. Rezaeezadeh for providing various facilities which made this work possible and for valuable comments on the manuscript.

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(Received for publication 11 January 2000)