Pak. J. Bot., 35(5): 853-864, 2003.

HALOPHYTIC PLANT DIVERSITY OF SOUTH AEGEAN COASTAL ZONE IN TURKEY

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Abstract

Halophytic flora of approximately 2500 km long Aegean coastal zone situated between Dikili (Izmir) and Fethiye (Mugla) was investigated. In all 78 plant taxa were determined from this area. Families with highest number of taxa were Poaceae, Chenopodiaceae, Asteraceae, Cyperaceae, Fabaceae and Plumbaginaceae with dominating genera like: *Limonium, Chenopodium, Plantago, Tamarix* and *Juncus*. The representative species recorded were *Arthrocnemum fruticosum, Halimione portulacoides, Halocnemum strobilaceum, Hordeum marinum* var. *marinum, Juncus acutus, J. maritimus, Limonium bellidifolium, L. sieberi, Petrosimonia brachiata, Polypogon monspeliensis, Salicornia europaea, Suaeda prostrata* subsp. *prostrata* and *Tamarix* species. The percentage distribution of the phytogeographical elements was; 15.38 % Mediterranean, 8.98 % Euro-Siberian, 3.85 % Irano-Turanian, 2.56 % East-Mediterranean, 2.56 % Cosmopolite, 14.1 % Common and 52.7 % Imperfectly known. Halophyte types showed following distribution; Hygrohalophytes (42.3 %), Euhalophytes (26.92 %), Psammohalophytes (20.52 %) and Xerohalophytes (10.26 %). Physical and chemical analysis of soils and ground water showed that Na^+ is the dominant soluble cation whereas Cl^- is the dominant soluble anion. Impact of biotic stresses on the halophytic flora was also noted.

Introduction

All through the human history coastal areas have served as centres of great cultural activity. Even today we see a large part of the world population living alongside the coastal belt due to their esthetical appeal. The situation in Turkey has not been too different. Turkey is surrounded on three sides by sea namely: Black Sea in North, Marmara around Istanbul, Aegean Sea in the West and Mediterranean in the South; with a coast line of 8333 km (Fig. 1). The Aegean coastal zone extending from Meric river up to Dalaman stream is approximately 2500 km long (DIE, 2000), with beautiful bays, sandy beaches and plant communities peculiar to these sites. The favourable climatic features, many industrial establishments, tourism and great economic potential of the area have resulted in huge immigration. During last 30 years, heavy biotic pressures have led to a deterioration of coastal zone ecosystem in particular psammophytic and halophytic plant cover, which prompted us to undertake present investigation. The paper includes our observations on the halophytic plant cover of the Aegean coastal zone from Dikili (Izmir) to Fethiye (Mugla).

Materials and Methods

Aegean coastal zone starting from Dikili (Izmir) up to Fethiye (Mugla) was surveyed from 1994 to 2000 (Fig.1). Seasonal excursions were undertaken in the coastal cities of Dikili, Sasalı, Karaburun, Urla, Cesme, Alacatı, Selcuk, Pamucak, Kusadası, Soke, Bodrum, Dalaman, Gokova, Marmaris, Dalyan and Fethiye. Halophytic plant taxa

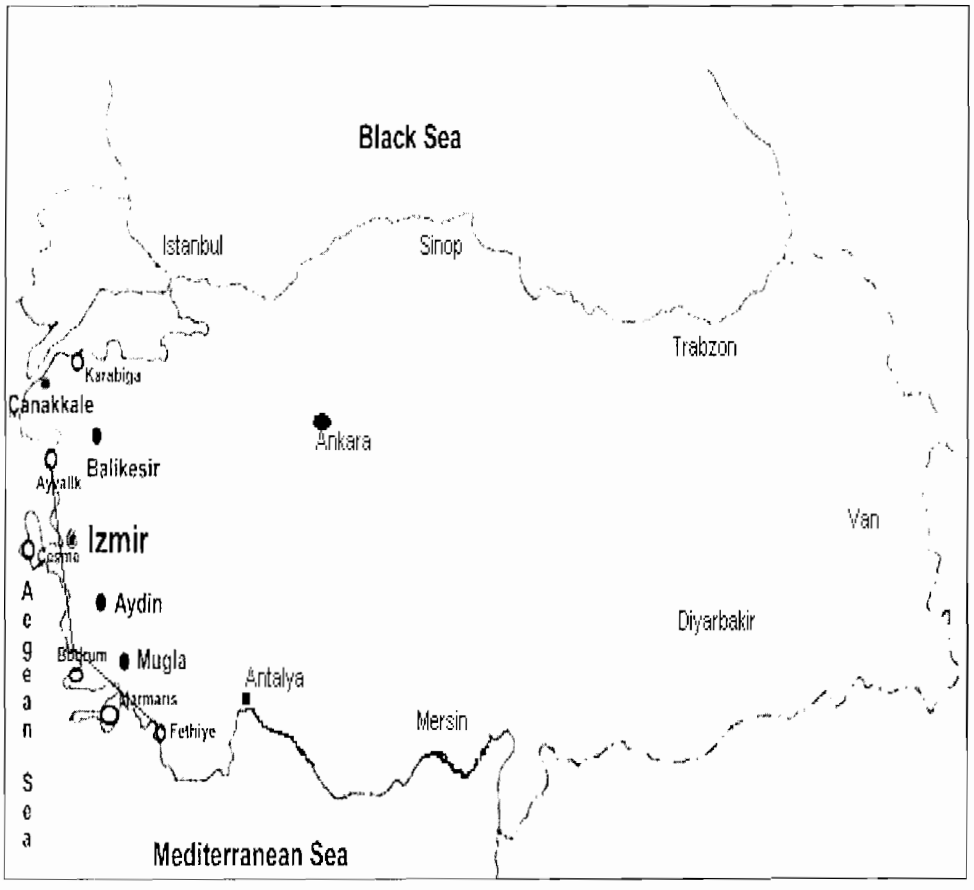

Fig. 1. Map showing coast line of Turkey and study sites.

collected from these sites were identified with the help of "Flora of Turkey and East Aegean Islands" (Davis, 1965-1988). Representative soil and ground water samples from the coastal cities (16 sites) were also analysed from their physical and chemical characteristics using the methods outlined in detail in Soil Survey Staff Handbook (1951) and Ozturk *et al.* (1996).

Results and Discussion

***Climatic features of the study area*:** The area in general experiences a mediterranean climate with dry-hot summers and mild-rainy winters. The precipitation regimes of Izmir, Aydın and Mugla follow the course as WSASu (Table 1). The winter and spring seasons are rainy, and maximum precipitation value was observed in Mugla (1206.3 mm). Annual temperature varies between 21^0 – $30\ ^0$C in summer and 3^0 –$10\ ^0$C in winter. An evaluation of bioclimatic features according to Akman & Daget (1971) reveals that Izmir is mild with low precipitation, Aydın milder with low precipitation and Mugla is cool with high precipitation (Table 2).

Table 1. Precipitation of the study area (1994- 2000).

Cities	Winter (W)	Spring (S)	Summer (Su)	Autumn (A)	Precipitation regimes
Izmir	a 399.8 b 57.3	a 146.8 b 21.0	a 14.1 b 2.0	a 137.5 b 19.7	WSASu
Aydın	a 355.0 b 53.3	a 149.4 b 22.5	a 21.1 b 3.2	a 139.9 b -	WSASu
Mugla	a 722.0 b 59.8	a 231.3 b 19.2	a 36.0 b 3.0	a 217.0 b 18.0	WSASu

a : Seasonal rainfall (mm) **b :** Seasonal rainfall (%)

Table 2. Bioclimatic features of the study area.

Cities	P (mm)	M (^{0}C)	m (^{0}C)	Q_2	PE (mm)	PE/M	Bioclimatic stage
Izmir	698.2	32.8	5.5	87.5	14.1	0.42	Low precipitation mild
Aydın	665.4	35.6	4.2	72.3	21.1	0.59	Low precipitation milder
Mugla	1206.3	32.9	1.6	132.8	36	1.09	High precipitation cool

P: Annual total precipitation (mm.), **M:** Mean maximum temperature of hottest month (^{0}C), **m:** Mean minimum of coldest month (^{0}C), Q_2 **:** Emberger constant, **PE:** Total summer rains, **PE/M:** Summer drought

Plant diversity: The coastal vegetation in Turkey was first studied by Koch (1846), followed by Davis (1951), Altay (1965), Zeybek (1969), Zeybek *et al.* (1976), Uslu (1977), Cetik (1982), Lovric & Rac (1991), Kılınc & Ozkanca (1991), Guvensen (1994), Ozturk *et al.* (1994), Uslu & Bal (1995), Guvensen *et al.* (1996) and Akbas *et al.* (1999).

The heavy saline soils on the Aegean coastal belt are mainly occupied by species belonging to the class *Salicornietea europaea* order *Salicornietalia*. The distribution of halophytic taxa in this order and class is closely correlated to salt-moisture gradient. Major associations found are: *Salicornietum europaeum, Arthrocnemum fruticosum – Halimione portulacoides, Juncetum maritimi* and *Phragmitetum communis.* These belong to the alliances *Salicornion, Arthrocnemum fruticosi* and *Junco – Phragmition.* A total of 78 taxa (Table 3) were collected from the coastal zone. These are listed below:

Table 3. List of halophytic taxa collected from the study area together with their ecological features.

Ranunculus marginatus d'Urv. var. *marginatus* (T, IN, HG, AN, FL 3-6).....(Ranunculaceae)
Frankenia pulverulenta L. (T, IN, E,AN, FL 7-8).....(Frankeniaceae)
Tamarix hampeana Boiss *et* Heldr. (P, IN, E, PR, FL 4).....(Tamaricaceae)
T. parviflora D.C. (P, IN, E, PR, FL 3-6).....(Tamaricaceae)
T. smyrnensis Bunge. (P, IN, E, PR, FL 4-8) .....(Tamaricaceae)
T. tetrandra Pallas *ex* Bieb. (P, IN, E, PR, FL 5) .....(Tamaricaceae)
Arthrocnemum fruticosum (L.) Moq. (CH, IN, E, PR, FL 8).....(Chenopodiaceae)
Atriplex davisii Aellen. (T, IT, E, AN, FL 5-7).....(Chenopodiaceae)
A. lasiantha Boiss. (T, IN, XH, AN, FL 5-7).....(Chenopodiaceae)
Chenopodium album L. var. *album* (T, IN, XH, AN, FL 5-8).....(Chenopodiaceae)
C. botrys L. (T, CM, PH, AN, FL 5-7).....(Chenopodiaceae)
C. murale L. (T, Cosm., XH, AN, FL 5-7).....(Chenopodiaceae)
C. opulifolium Schrad. (T, IN, XH, AN, FL 5-8).....(Chenopodiaceae)

Halimione portulacoides (L.) Aellen. (CH, IN, E, PR, 6-8).....(Chenopodiaceae)
Halocnemum strobilaceum (Pall.) Bieb. (H, IN, E, PR, FL 7-9).....(Chenopodiaceae)
Halopeplis amplexicaule (Vahl.) Ung.-Sternb. (T, IN, E,AN, FL 5-8).....(Chenopodiaceae)
Petrosimonia brachiata (Pallas.) Bunge. (T, IN, HG,PR, FL 6-9).....(Chenopodiaceae)
Salicornia europaea L. (T, IN, E, AN, FL 7-9).....(Chenopodiaceae)
Salsola kali L. (T, CM, PH, PR, FL 5-7).....(Chenopodiaceae)
S. ruthenica Iljin. (T, CM, PH, PR, 5-7).....(Chenopodiaceae)
Suaeda prostrata Pall. subsp. *prostrata* (T, IN, E, AN, FL 6-9).....(Chenopodiaceae)
Spergularia rubra (L.) J. *et.* C. Presl. (T, IN, PH, PR, FL 4-8).....(Caryophyllaceae)
Alhagi pseudalhagi (Bieb.) Desv. (CH, IT, PH, PR, FL 6-8).....(Fabaceae)
Medicago minima (L.) Bart. var. *minima* (T, IN, PH, AN, FL 3-5).....(Fabaceae)
Melilotus messanensis (L.) All. (T, M, E, BN, FL 2-4).....(Fabaceae)
Trifolium repens L. var. *repens* (H, IN, HG, PR, FL 5).....(Fabaceae)
T. resupinatum L. var. *resupinatum* (T, IN, HG, AN, FL 5).....(Fabaceae)
Bupleurum euboeum Beauverd. (T, EM, PH, AN, FL 6-8).....(Apiaceae)
Eryngium campestre L. var. *virens* Link. (H, IN, PH,PR, FL 9).....(Apiaceae)
Samolus valerandi L. (H, Cosm., PH, PR, FL 5-9).....(Primulaceae)
Limonium bellidifolium (Gouan) Dumort (H, ES, E, PR, FL 6-9).....(Plumbaginaceae)
L. gmelinii (Willd.) O. Kuntze. (H, ES, E, PR, FL 5-10).....(Plumbaginaceae)
L. sieberi (Boiss.) O. Kuntze. (H, EM, E, PR, FL 5-7).....(Plumbaginaceae)
L. sinuatum (L.) Miller. [H, M, E, PR, FL 5-7 (-10)].....(Plumbaginaceae)
L. virgatum (Willd.) Fourr. (H, IN, E, PR, FL 6-10).....(Plumbaginaceae)
Blakstonia perfoliata (L.) Hudson. subsp. *perfoliata* [T, IN, HG, AN, F 4-8 (-10)].....(Gentianaceae)
Centaurium erythraea Rafn. subsp. *erythraea* (H, ES, HG, BN, FL 5-8).....(Gentianaceae)
C. tenuiflorum (Hoffman. et Link.) subsp. *tenuiflorum* (T, IN, HG, AN, FL 7-10).....(Gentianaceae)
Cressa cretica L. (H, IN, HG, PR, FL 6-8).....(Convolvulaceae)
Bellardia trixago (L.) All (T, IN, HG, AN, FL 3-6).....(Scrophulariaceae)
Plantago coronopus L. subsp. *coronopus* (T, ES, HG, AN, FL 4-11).....(Plantaginaceae)
P. crassifolia Forsskal. (H, M, PH, PR, FL 5-10).....(Plantaginaceae)
P. lagopus L. (T, M, HG, AN, FL 4-8).....(Plantaginaceae)
P. lanceolata L. (H, CM, HG, PR, FL 4-10).....(Plantaginaceae)
Bellis annua L. (T, M, HG, PR, FL 3-8).....(Asteraceae)
Carlina lanata L. (T, M, XH, AN, FL 6-8).....(Asteraceae)
Chondrilla juncea L. var. *juncea* (H, IN, HG, PR, FL 7-9).....(Asteraceae)
Crepis foetida L. subsp. *commutata* (Spreng.) Babcock. (H, CM, XH, AN, FL 4-6).....(Asteraceae)
C. sancta (L.) Babcock. [T, CM, PH, AN, FL (2-) 3-7 (-8)].....(Asteraceae)
Hedypnois cretica (L.) Dum.-Cours. (T, M, PH, AN, FL 3-5).....(Asteraceae)
Inula crithmoides L. (CH, M, HG, PR, FL 9-11).....(Asteraceae)
I. viscosa (L.) Aiton. (CH, M, HG, PR, FL 5-7).....(Asteraceae)
Juncus acutus (L.) (CH, CM, HG, PR, FL 3-5).....(Juncaceae)
J. maritimus Lam. (CH, CM, HG, PR, FL 5-7).....(Juncaceae)
J. subulatus Forsskal. (CH, IN, HG, PR, FL 4-6).....(Juncaceae)
Bolboschoenus maritimus (L.) Palla. var. *maritimus* (H, IN, HG, PR, FL 5-9).....(Cyperaceae)
Carex divisa Hudson. (C, ES, HG, PR, FL 6-8).....(Cyperaceae)
Cyperus capitatus Vandelli. (C, IN, HG, PR, FL 6-8).....(Cyperaceae)
Schoenoplectus litoralis (Schader) Palla. (C, CM, HG, PR, FL 4-10).....(Cyperaceae)
Schoenus nigricans L. (H, IN, HG, PR, FL 3-7).....(Cyperaceae)
Scirpoides holoschoenus (L.) Sojak. (C, IN, HG, PR, FL 3-7).....(Cyperaceae)
Aeluropus littoralis (Gouan.) Parl. (C, IN, PH, PR, FL 6).....(Poaceae)
Aira elegantissima Schur. var. *elegantissima* (T, M, XH, AN, FL 4-5).....(Poaceae)
Bromus tectorum L. (T, CM, XH, AN, FL 3-6).....(Poaceae)
Catabrosa aquatica (L.) P. Beauv. (C, IN, HG, PR, FL 5-8).....(Poaceae)
Crypsis aculeata (L.) Aiton. (T, IN, HG, AN, FL 6-10).....(Poaceae)

Hordeum marinum Hudson. var. *marinum* (T, IN, HG, AN, FL 5-6).....(Poaceae)
Hordeum marinum Hudson. var. *pubescens* (Guss.) Nevski. (T, ES, HG, AN, FL 5-6).....(Poaceae)
Imperata cylindrica (L.) Raeuschel. var. *cylindrica* (C, IN, HG, PR, FL 4-7).....(Poaceae)
Lagurus ovatus L. (T, M, PH, AN, FL 4-6).....(Poaceae)
Phragmites australis (Cav.) Trin. *ex* Steudel. (H, ES, HG, PR, FL 8-10).....(Poaceae)
Parapholis incurva (L.) C. E. (T, IN, PH, AN, FL 4-7).....(Poaceae)
Phalaris canariensis L. (T, M, E, AN, FL 5-7).....(Poaceae)
Phleum exaratum Hochot. *ex* Griseb. subsp. *exaratum* (T, IN, E, AN, FL 5-7).....(Poaceae)
Poa trivialis L. (C, IN, HG, PR, FL 5-8).....(Poaceae)
Polypogon monspeliensis (L.) Desf. (T, CM, HG, AN, FL 4-8).....(Poaceae)
Puccinellia distans L. subsp. *distans* (H, IT, E, PR, FL 7-8).....(Poaceae)
Sporobolus virginicus (L.) Kunth. (C, IN, PH, PR, FL 4-10).....(Poaceae)

IT: Irano-Turanian, **ES:** Euro-Siberian, **M:** Mediterranean, **EM:** East Mediterranean, **Cosm:** Cosmopolitan, **IN:** Imperfectly known, **CM:** Common, **End:** Endemic, **H:** Hemicryptophytes, **CH:** Chamaephytes, **T:** Terophytes, **C:** Cryptophytes, **P:** Phanerophytes, **HG:** Hygrohalophytes, **XH:** Xerohalophytes, **PH:** Psammohalophytes, **E:** Euhalophyes, **AN:** Annual, **BN:** Bienneal, **PR:** Perennial, **FL:** Flowering time

In all 17 families are distributed in this area. Out of these Poaceae, Chenopodiaceae and Asteraceae show highest number of taxa with a value of 21.79 %, 19.23 % and 10.26 % respectively (Table 4). The genera *Limonium, Chenopodium, Plantago, Tamarix* and *Juncus* embody highest number of taxa (Table 4). Out of these 78 taxa percentage of imperfectly known is the highest (52.57 %) followed by commonly known ones (14.10 %). Other elements are Mediterranean (15.38 %), Euro-Siberian (8.98 %), and Irano-Turanian. (3.85 %). Majority are Therophytes (48.75 %) and Hemicryptophytes (24.35 %). Hygrohalophytes top the list followed by Euhalophytes and Psammohalophytes (Table 5).

Table 4. Numbers of major families and taxa collected from the study area.

Family	Genera	Species	Species (%)
Poaceae	16	17	21.79
Chenopodiaceae	10	15	19.23
Asteraceae	6	8	10.26
Cyperaceae	6	6	7.70
Fabaceae	4	5	6.41
Plumbaginaceae	1	5	6.41
Plantaginaceae	1	4	5.13
Tamaricaceae	1	4	5.13
Gentianaceae	2	3	3.85
Juncaceae	1	3	3.85
Apiaceae	2	2	2.56
Caryophyllaceae	1	1	1.28
Convolvulaceae	1	1	1.28
Frankeniaceae	1	1	1.28
Primulaceae	1	1	1.28
Ranunculaceae	1	1	1.28
Scrophulariaceae	1	1	1.28
Total	**56**	**78**	**100.00**

Table 5. Chrotypes, life forms, halophyte types, major genera and families from the study area

Chorotype	%	Life forms	%	Halophyte type	%	Major genera	Major families
IN	52.57	T	48.75	HG	42.30	*Limonium*	Poaceae
CM	14.10	H	24.35	E	26.92	*Chenopodium*	Chenopodiaceae
M	15.38	CH	10.25	PH	20.52	*Plantago*	Asteraceae
ES	8.98	C	11.53	XH	10.26	*Tamarix*	Cyperaceae
IT	3.85	P	5.12			*Juncus*	Fabaceae
EM	2.56						Plumbaginaceae
Cosm.	2.56						

IN: Imperfectly known, **CM:** Commonly known, **M:** Mediterranean, **ES:** Euro-Siberian, **IT:** Irano-Turanian, **EM:** East Mediterranean, **Cosm:** Cosmopolitan

***Soils and ground water analysis*:** An evaluation of soils on the basis of their chemical constituents was followed according to the scale provided by Ozturk & Gork (1979). Soils show a clayey–loam, silty-loam, silty-clay, sandy-loam, silty, loamy and clayey texture (Table 6). Organic matter content varies between 2.05-4.22 %. In general soils of 3 areas are medium rich (2.05-2.19 %), 12 are rich (2.51-3.76 %) and 1 is very rich (4.22 %) in organic matter content. The $CaCO_3$ values lie between 2.21-21.88 %, thus depicting that majority of the soils show a medium value. pH ranges between 7.26-8.40 with 7 of the soils being weakly alkaline (7.49-7.78), 8 medium alkaline (7.83-8.40) and 1 neutral (7.26). Total salt content and B values vary between 0.87-3.46 % and 1.28-2.44 ppm respectively. Dominant exchangeable cation in all soils is Na^+ (22.49-655.58 me/lt), whereas dominant soluble anion is Cl^- (212.3-777.4 me/lt), thus enlightening the fact that NaCl is the major salt of primary level (Table 6).

Table 6. Soil analysis of the representative samples collected from the study area.

	Exchangable cations %				%			Texture	Organic	$CaCO_3$
Localities	Na^+	K^+	Ca^{++}	Mg^{++}	Sand	Clay	Silt		matter (%)	(%)
Dikili	37.15	3.74	27.12	16.25	48.3	17.10	34.6			
Sasalı	35.00	3.85	26.42	21.01	29.04	16.81	54.15	Silty-Loam	3.08	2.83
Karaburun	31.25	2.08	29.45	20.19	53.00	13.00	34.00	Clayey-Loam	2.51	3.97
Urla	33.23	2.56	25.45	22.14	39.68	19.68	40.64	Silty-Loam	3.52	8.65
Cesme	26.47	3.41	23.78	20.46	27.20	40.30	32.50	Clayey-Loam	2.19	5.50
Alacatı	22.49	2.24	21.15	19.21	44.68	23.68	31.64	Loam	3.16	7.94
Selcuk	57.31	1.45	20.69	20.27	9.58	7.69	82.72	Silt	3.61	2.21
Pamucak	30.02	2.05	29.19	21.15	76.68	9.68	13.64	Sandy-Loam	3.81	8.65
Kusadası	43.46	2.54	29.48	24.65	27.20	40.30	32.50	Clayey-Loam	2.51	5.50
Soke	45.10	4.08	31.75	25.05	29.20	19.83	51.00	Silty-Clay	3.30	21.88
Bodrum	61.02	2.17	31.07	20.38	18.40	16.87	64.72	Silty-Clay	3.62	6.96
Dalaman	42.45	1.48	31.74	25.42	20.90	7.15	71.99	Silty-Clay	3.58	19.38
Gokova	52.92	1.85	21.48	23.76	17.30	9.39	73.30	Silty-Loam	3.76	5.91
Marmaris	41.94	2.73	20.87	30.19	68.7	10.79	20.53	Sandy_loam	4.22	10.57
Dalyan	53.46	4.56	20.19	24.14	34.80	10.98	54.25	Silty-Clay	3.20	17.74
Fethiye	32.00	3.03	29.16	24.00	14.68	58.41	26.91	Clay	2.12	6.70

Table 6. (Cont'd.)

Localities		Soluble ions in the saturation extract							Bor (ppm)	Salt (%)
		Cations me/lt				Anions me/lt				
	pH	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4		
Dikili	8.40	24.56	135.25	462.23	6.28	9.52	631.12	64.18	1.71	2.58
Sasalı	7.68	38.68	85.23	366.25	3.14	22.53	430.18	36.21	1.31	1.70
Karaburun	7.87	41.26	128.19	456.12	6.23	22.21	542.12	36.45	1.86	2.36
Urla	7.58	36.08	125.32	486.23	5.28	14.08	514.27	31.95	1.28	2.50
Cesme	8.32	15.21	41.25	156.12	4.56	29.43	251.23	25.16	2.13	1.39
Alacatı	7.26	32.47	128.23	451.25	5.12	13.14	445.32	27.23	1.92	2.70
Selcuk	7.75	40.26	115.99	569.82	5.45	25.61	706.75	56.51	1.93	3.46
Pamucak	7.95	38.12	126.32	523.11	5.36	11.14	512.28	33.21	1.45	1.75
Kusadası	7.97	24.63	123.29	452.10	4.27	8.55	602.13	54.14	1.51	1.68
Soke	7.78	40.81	137.28	474.55	7.09	27.65	550.92	34.22	1.79	2.51
Bodrum	7.83	22.15	131.18	497.10	4.11	9.70	622.18	68.96	1.93	3.02
Dalaman	7.49	49.07	99.90	385.60	3.29	22.20	436.90	42.92	1.48	1.91
Gokova	7.62	34.27	141.77	507.03	5.92	10.91	548.70	39.36	1.34	2.43
Marmaris	8.30	18.73	50.02	193.90	3.04	23.51	235.80	26.05	2.44	0.87
Dalyan	7.71	31.52	158.12	655.58	8.18	16.87	777.40	84.54	1.48	2.97
Fethiye	8.15	15.13	46.24	162.19	2.85	21.54	212.30	20.14	2.15	1.84

Table 7. Ground water analysis of the representative samples collected from the study area.

Localities	E.C dS/m	PH	Cations me/lt				Anions me/lt			Bor ppm	Na (%)
			Na^{+}	K^{+}	Ca^{++}	Mg^{++}	HCO_3^-	Cl^-	$SO_4^{=}$		
Dikili	62.15	8.02	489.23	7.43	26.14	169.25	12.20	724.36	73.23	2.21	71.19
Sasalı	46.54	7.52	501.20	5.03	41.12	107.21	29.32	512.32	51.01	1.78	72.45
Karaburun	54.58	7.63	592.12	6.76	46.25	136.12	19.54	602.10	44.09	2.65	76.40
Urla	61.51	7.41	539.56	6.15	37.56	120.21	19.63	568.63	37.47	2.89	73.03
Çeşme	43.25	8.26	265.45	5.91	18.17	61.26	25.58	369.00	24.56	2.54	79.25
Alaçatı	52.12	7.14	605.03	6.23	33.00	64.52	18.52	552.32	23.15	2.66	72.00
Selçuk	54.41	7.42	582.83	7.37	32.47	130.19	20.05	711.43	38.40	3.29	77.09
Pamucak	57.00	7.63	609.45	6.47	39.54	201.12	16.36	601.25	41.56	3.01	71.23
Kuşadası	63.23	7.59	569.23	5.68	27.56	179.41	7.39	692.01	61.21	2.58	72.09
Söke	87.02	7.59	585.85	8.89	39.70	197.78	41.36	1012.88	77.62	3.56	71.44
Bodrum	56.49	7.27	531.54	6.51	35.49	124.56	16.18	689.38	78.26	3.05	72.21
Dalaman	56.39	7.48	575.44	5.98	49.47	18.93	33.99	769.09	43.1	2.48	72.81
Gökova	70.59	7.19	777.68	7.60	44.01	204.36	16.53	874.97	151.39	2.02	74.60
Marmaris	34.03	7.76	341.14	4.45	19.34	69.23	36.56	387.00	25.42	1.56	78.88
Dalyan	51.02	7.53	633.04	8.56	23.88	229.45	62.13	791.03	65.77	2.55	74.40
Fethiye	41.23	8.23	264.36	3.96	18.10	79.12	24.25	306.55	28.02	2.38	78.00

Ground water analysis (Table 7) shows EC values of 34.03-87.02 ds/m, pH 7.14-8.26, B 1.56-3.56 ppm, Na 71.19-79.25 %. Dominant soluble cation in the saturation extract is Na^{+} (264.36-777.68 me/lt) and dominant anion is Cl^- (369.00-1012.88 me/lt). Here again dominating salt is NaCl.

***Biotic pressures*:** Major criteria responsible for deterioration of coastal zone plant cover in the Aegean region are: hotel and motel constructions, tourism, urbanisation, industrialisation, lack of coastal zone management, mining, grazing and dune plantation. All these factors produce negative effects on the halophytic plant cover. The physical and chemical characteristics of the soils as well as ground water supporting these have drastically changed, because of the impact of pollutants coming from the industry as well as pesticides entering the Aegean sea through Great Menderes, Small Menderes and

Gediz Rivers. Nearly 6 % of the pollutants are of industrial origin, 20 % from city wastes, and 20 % from marine traffic (Erdem *et al.*, 1994).

Aegean coastal zone occupies an important place in the tourism of Turkey and makes great contributions to the economy of the country. A favourable climate of the area together with heavy industrialisation have attracted a large population from East, South-East and Central Anatolia. Last 30 years show intensive demographic developments in the area. In the states of Mugla and Aydın an increase has been around 2.5 and in Izmir 4 times (Fig.2). Net immigration rate lies around 23.9 % for Mugla, 22.3 % for Izmir, and 14.21 % of Aydın (Fig. 3). During this period increase in major coastal cities like Marmaris, Kusadası and Bodrum has been 6.5, 4.5 and 3.5 times respectively (Fig. 4).

Annual ratios of emmigration during the last 10 years in these cities has followed the trend as: Marmaris (63.92 %), Bodrum (54.31 %), Kusadası (41.01 %), Edremit (38.63 %), Foca (35.83 %), Cesme (23.77 %), Ayvalık (22.66 %) and Fethiye (18.92 %) (Fig. 5). This demographic pressure increases 5 – 10 times during summer season. As such, every year hundreds of summer resorts are built on the coastal areas embodying a great biodiversity. Halophytes get a major share during this destruction. The number of tourists visiting the area is increasing rapidly (Fig. 6), which creates a need for the construction of more hotels, motels, and other resorts. Number of tourists visiting this area has increased 8 fold during last 10 years because of a higher seawater temperature in the Aegean and Mediterranean seas (DIE, 2000). More than 10,000 ha of coastal zone have been destroyed in Turkey during 1975 – 1999 by this industry without stakes theirby destroying the coastal fragile ecosystems tremendously (Uslu & Gehu, 1990).

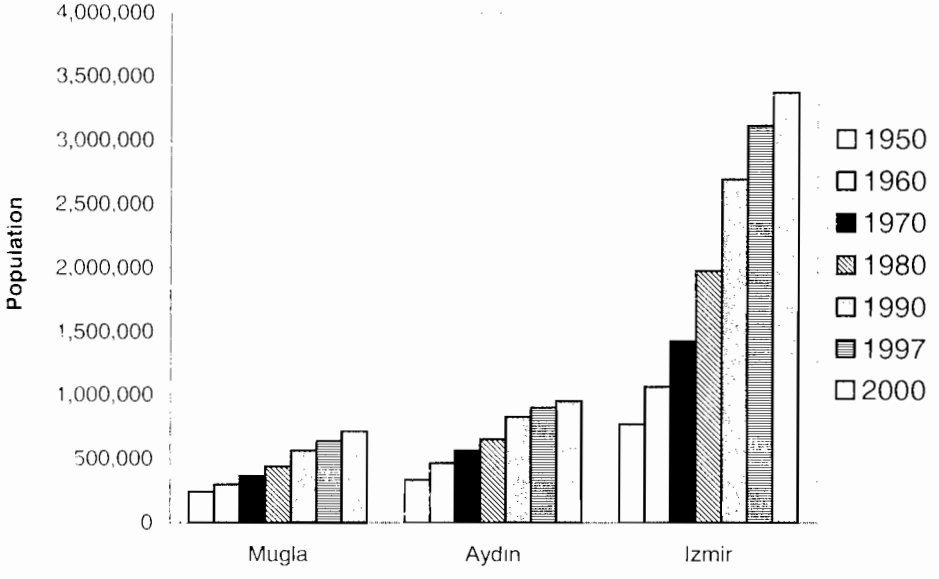

Fig. 2. Population of three coastal states.

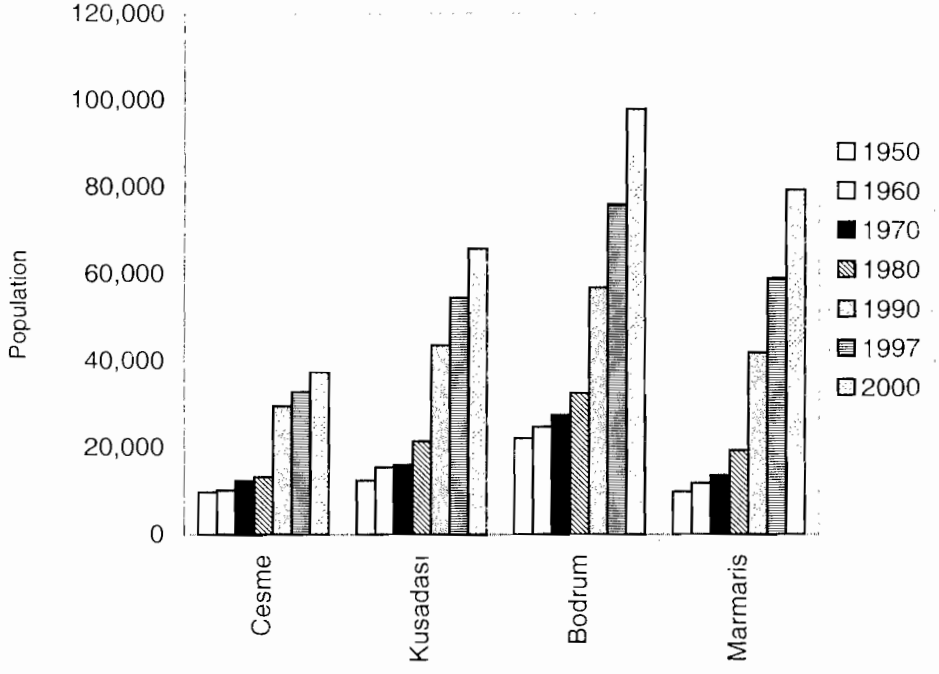

Fig. 3. Population of important touristic coastal cities.

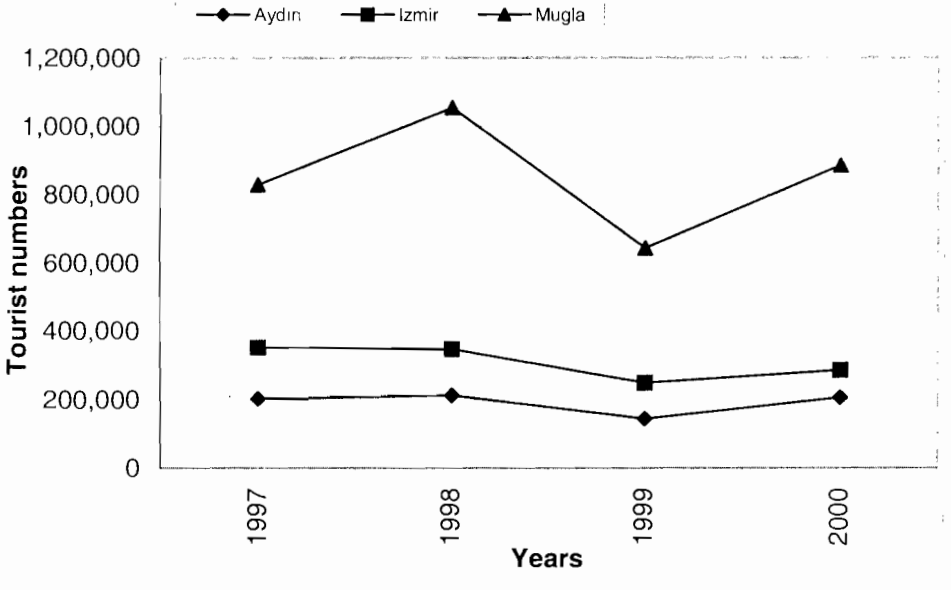

Fig. 4. Number of tourists visiting the study area on yearly basis.

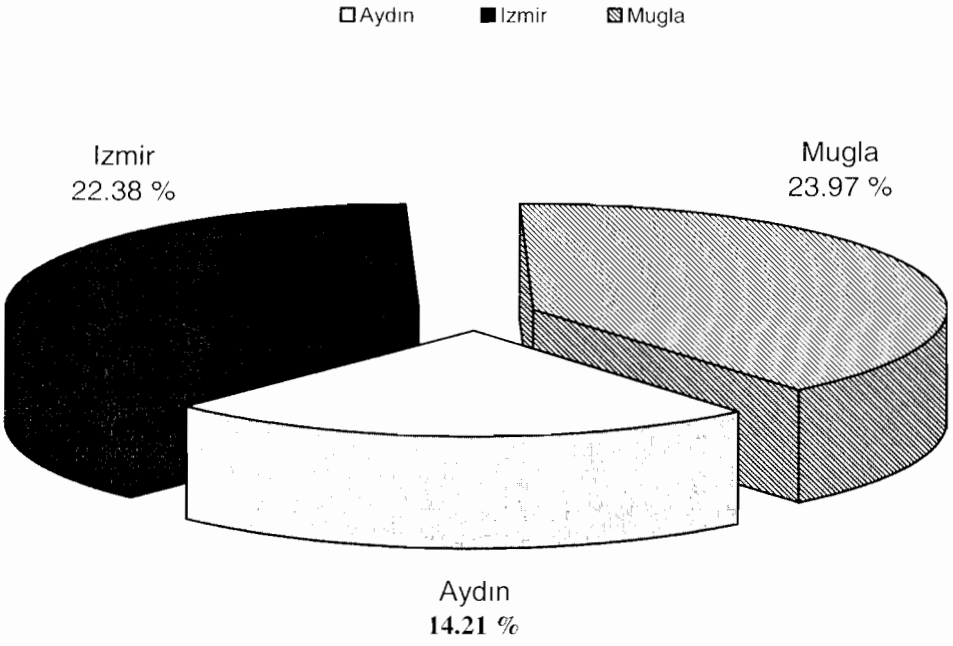

Fig. 5. Mean immigration percentage of last 10 years in the coastal states.

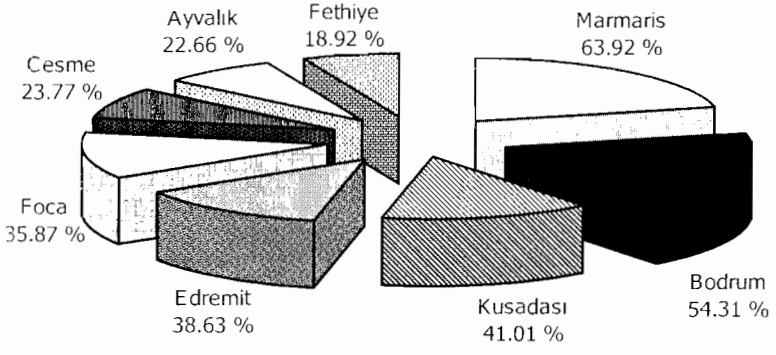

Fig. 6. Mean immigration percentage of last 10 years in important coastal cities.

Conclusions

During last 30 years Aegean coastal zone in Turkey is deteriorating at a fast speed. Activities like tourism, industry, sand excavation, grazing and summer house constructions have engulfed more than 20000, 12000, 5000, 4000 and 1500 hectares of coastal zone respectively (Uslu & Gehu, 1990). The plant diversity has suffered much from these biotic presures. *Triglochin barrelieri* reported earlier by Zeybek (1969) and *Ranunculus constantinopolitanus* (Ranunculaceae); *Astragalus homosus, Trifolium bullatum, T. spumosum, T. tomentosum, Vicia angustifolia* (Fabaceae); *Oenanthe fistulosa* (Apiaceae); *Silene nocturua* (Caryophyllaceae); *Salicornia fragilis* (Chenopodiaceae); *Limonium angustifolium* (Plumbaginaceae); *Mentha aquatice* (Lamiaceae); *Plantago coronopus, P. lagopus* (Plantaginaceae); *Galium tricorne* (Rubiaceae), *Bellis sylvestris, Sonchus oleraceus* var. *integrifolium* (Asteraceae); *Triglochin barrelieri* (Juncaginaceae); *Avena sterilis, Bromus rubens, B. scoparius, Catapodium loliaceum, Koeleria phleoides, Lolium rigidum* (Poaceae) reported by Zeybek *et al.* (1976) from the Aegean coastal zone are no longer found in this area. According to Uslu & Gehu (1990) *Plantago crassifolia, Salsola kali* and *Suaeda prostrata* ssp. *prostrata* are under a threat of extinction, *Halopeplis amplexicaule* too is included in the list of threatened taxa by Ekim *et al.* (2000). As such, there is an urgent need to take following measures:

- ♣very strict laws should be enforced for the constructions along the coast,
- ♣a data bank for coastal zone based on scientific observations need be established,
- ♣ecological planning should be applied and studies undertaken on virgin and deteriorated sites, full protection, protection-use and biological rehabilitation,
- ♣ecotechnological aspects need be used while evaluating the coastal zone,
- ♣national coastal zone management policy should be established,
- ♣sand excavation on the coast and drainage of swamps should be prohibited.

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