

The Lowland Meadow Vegetation of the Central Black Sea Region of Turkey

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Abstract

The vegetation of the lowland meadows in the central Black Sea region of Turkey was analyzed according to the Braun-Blanquet method with the help of TWINSpan clustering, CCA, and DECORANA ordination methods. Three plant associations were discovered and described in the study area as new. The most abundant and frequent life form in the associations is hemicryptophytes. The Shannon Diversity Index and Evenness was also used for calculations of the associations. The syntaxonomical status of the described associations was ordered as follows:

Molinio-Arrhenatheretea Tüxen 1937

Holoschoenetalia vulgaris Br.-Bl. ex Tchou 1948

Gaudinio-Hordeion bulbosi Galan, Deil, Haug and Vicente 1997

Alopecuro pratensis-Juncetum littoralis Yalçın et al. 2013 ass. nova

Plantaginietalia majoris Tüxen 1950

Trifolio fragiferi-Cynodontion Br.-Bl. and O. Bolòs 1958

Polypogono monspeliensis-Hordetum geniculati Yalçın et al. 2013 ass. nova

Ranunculo ophioglossifolii-Paspaleetum distichi, Yalçın et al. 2013 ass. nova

Keywords: Black Sea, ecology, meadow, syntaxonomy, Turkey

Türkiye'nin Orta Karadeniz Bölgesinde Düşük Rakımlı Düzlük Alanların Çayır Vegetasyonu Özet

Türkiye'nin Orta Karadeniz Bölgesinde ova alanların çayır vegetasyonu Braun-Blanquet metodu ve TWINSpan kümeleme, CCA ve DECORANA ordinasyon yöntemleriyle analiz edilmiştir. Araştırma alanında üç yeni bitki birliği tanımlanmıştır. Bu birliklerde en bol ve sıklıkla bulunan hayat formu hemikriptofitlerdir. Birliklerin Shannon çeşitlilik indeksi ve evenness değerleri de hesaplanmıştır. Tanımlanan bitki birliklerinin sintaksonomik durumları aşağıda hiyerarşik olarak verilmiştir:

Molinio-Arrhenatheretea Tüxen 1937

Holoschoenetalia vulgaris Br.-Bl. ex Tchou 1948

Gaudinio-Hordeion bulbosi Galan, Deil, Haug and Vicente 1997

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Anahtar Kelimeler: Çayır, ekoloji, Karadeniz, sintaksonomi, Türkiye.

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INTRODUCTION

Although almost all of the forest vegetation is well-known from a phytosociological point of view, there are only a few studies (Tatlı 1987, Kılınç and Karakaya 1992, Vural 1996) about the meadow vegetation of Turkey with most of them are related to the alpine and subalpine meadows (Yalçın et al. 2011). However, the number of studies regarding

the lowland meadow vegetation of the Black Sea coasts is scarce (Korkmaz et al. 2012).

Meadows and pasture, a total area of 21,754,690 hectares, constitute 28.3 percent of the land area of Turkey. Of this total, 644,373 hectares are meadows and the remaining area is pasture (Anonymous 1986). It has been reported that meadow areas are declining day by day in Turkey and Europe mainly

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due to overgrazing (Prach 2008).

The classical Zürich-Montpellier approach is the most commonly used method for studying vegetation in Europe (Tomaselli et al. 2000, Mueller-Dombois and Ellenberg 2002) and in Turkey (Korkmaz et al. 2011, Uysal et al. 2011, Altay et al. 2012). Within the phytosociological approaches, the syntaxonomical typification is one of the major aims for most researchers (Escudero and Pajaron 1994). Several numerical methods have also been used for the classification of meadow vegetation (Bruehlheide and Chytrý 2000, Havlova et al. 2004, Botta-Dukat et al. 2005). However, in Turkey, numerical methods have not been widely used in the classification of meadow vegetation.

Meadow vegetation is a very valuable habitat for numerous plants and animal species, so phytosociological classification of lowland meadow vegetation is of importance for the protection of nature. From the economic standpoint, there is also a source of livestock, and also a habitat for medicinal and melliferous plants (Stancic 2008).

The aim of this study is to identify, classify, and describe the plant associations which exist in the natural lowland meadows of the central Black Sea region of Turkey by using both numerical and traditional methods. Syntaxonomical classification of meadow vegetation will contribute to the rehabilitation studies of meadows and provide a reliable database for vegetation mapping in Turkey.

MATERIAL AND METHODS

Taxonomic nomenclature has been accomplished by Davis (1965-1985), Davis et al. (1988), Tutin et al. (1975-1980), and Güner et al. (2000) respectively. Plant life forms were identified according to Mueller-Dombois and Ellenberg (2002) and vegetation was studied using the traditional Braun-Blanquet method (1964). Phytosociological records were made using 4×5 m and 5×5 m relevés, respectively. A total of 380 relevés were collected by the first author during the summer months of 2002, 2003, and 2012. Plant associations were named according to the Syntaxonomical Nomenclatural Rules (Weber et al. 2000). Plant associations were compared with similar studies using Sørensen's (1948) similarity formula. Syntaxonomical interpretations were made using available phytosociological literature (Mucina 1997, Rivas-Martinez et al. 2002a, b, Dengler et al. 2003, Chytrý and Tichý 2003, and Dengler et al. 2004).

The TWINSpan method was also applied to our data (Hill 1979) so as to derive floristically and ecologically uniform units. Relevés with unclear position were initially removed from the table. The resulting data set (a matrix of 74 species and 80 relevés) was classified by TWINSpan (Hill 1979) and Detrended Correspondence Analysis (DECORANA) (Hill and Gauch 1980), using the "Community Analysis Package 1.50 version" software (Henderson and Seaby 1999). This calculation was based on the cover-abundance data of species corresponding to the transformations of the Braun-Blanquet scale as proposed by van der Maarel (1979).

The species diversity of the associations were calculated with the Shannon-Wiener Index (H') (Magurran 2004) in the Biodiversity 2.0 version software (McAlleece 1997).

Soil samples were taken in each plot at a depth of 30 cm during the mid-growing season. Soil samples were then air dried and sieved through a 2 mm mesh prior to analysis. Soil organic matter (%) was determined using the Walkley and Black method (Kacar 2009). Soil texture was determined using the Bouyoucos hydrometer method, and the clay content was expressed as %. The electrical conductivity (dS m^{-1}) was determined in soil-water extracts at 1:1 (w:v) using a Jenway analyser and converted to the percentage of the total salinity. The pH values were measured in deionized water (1:1) and the soil nitrogen (%) was determined by the micro Kjeldahl method. The soil phosphorus (ppm) was determined spectrophotometrically following the extraction by ammonium acetate. Soil potassium (ppm) was determined using a Petracourt PFP-7 flame photometer after nitric acid wet digestion. The CaCO_3 (%) concentrations were determined using a Scheibler calcimeter (Allen et al. 1986). The soil traits were interpreted according to Kacar (2009), and the descriptive statistical analyses were performed using the SPSS 17.0 version (Anonymous 2008).

The relationship between vegetation and soil chemistry was analyzed by Canonical Correspondence Analysis (CCA) (Henderson and Seaby 2000). The Canonical Correspondence Analysis (CCA) includes two matrices; one of which 80 relevés, classified into syntaxa by phytosociological analysis, × 74 species (average % cover values of species corresponding to the transformations of the

Braun-Blanquet scale as proposed by van der Maarel (1979)), and 80 relevés $\times$ 10 environmental parameters (Soil pH, Sand, Clay, Silt, Total Organic Matter Ratio, Total Nitrogen Ratio, Total Salinity, Calcium Carbonate Ratio, Potassium, and Phosphorus Concentration). The interpretation of the results was made by the first two axes because only these two axes were statistically significant. Statistically significant variables that derived from CCA were shown by a bold number.

The abbreviations in the CCA ordination diagram are as follows, JLT; *Alopecuro pratensis-Juncetum littoralis*, HGP; *Polypogono monspeliensis-Hordetum geniculati*, TRP; *Ranunculo ophioglossifolii-Paspaletum distichi*, OM; Organic Matter (%), and Sal; Total Salinity (%).

Study Area

The study area is situated along the coastline of the Central Black Sea Region in the north of Turkey (Fig. 1). This area floristically belongs to the Euxine province of the Circumboreal phytogeographical region. The studied grasslands have been used as rangeland. The study area consists of alluvial sediment soils transported by the Kızılırmak and the Yeşilirmak Rivers. The mean annual temperatures in the Kızılırmak and the Yeşilirmak deltas is 13.6°C and 15.1°C, respectively, whereas, the annual rainfall is 672.4 and 922.1 mm in the Kızılırmak and the Yeşilirmak deltas respectively (Anonymous 1970-2011).

The study area is situated along the A5 and A6 squares according to the grid system of Davis (1965-1985). The natural alluvial grasslands in the Central Black Sea Region are situated along the Kızılırmak and the Yeşilirmak deltas, respectively. The Yeşilirmak delta is a candidate wetland that is to be registered as a Ramsar wetland and is also under the national protection law of wetlands, whilst Kızılırmak delta has also been considered as Ramsar wetland in the Black Sea coast (Kuleli et al. 2011). These large areas have been grazed and mowed traditionally since the 1900's, but no management or conservation studies were carried out in the area prior to last decade and the lowland meadow vegetation in the study area is subject to long-term dense grazing (Yılmaz 2007).

RESULTS

Results of Numerical Analysis

The results of TWINSpan and DECORANA were consistent with each other (Fig. 2 and 3). The

main indicator species is *Juncus littoralis* C.A.Mey. in the TWINSpan diagram (Fig. 2). Eigenvalues of the first two axes were 0.81 and 0.17 in the DECORANA diagram, respectively. If the Eigenvalues is over 0.5, it often denotes a good separation of the relevés along the axes.

The DECORANA results showed that axis 1 represented distance from the sea and the associations were separated along a gradient far from the seashore and axis 2 represents the moisture gradient. It was noted that *Polypogono monspeliensis-Hordetum geniculati* occurred on more dry soils as compared to other syntaxa, whilst *Ranunculo ophioglossifolii-Paspaletum distichi* indicated the wettest soils in the study area (Fig. 3).

The eigenvalues of the CCA axes and the correlations between vegetation and soil traits are listed in Table 1. The CCA axes of vegetation are closely related to the soil chemistry. The first CCA axis was significantly and positively correlated with the CaCO₃ (%), K (ppm) and the second axis was significantly and positively correlated with the N (%) concentrations. The Eigenvalues for the first two axes were found to be 0.75 and 0.55, respectively (Fig. 4).

Syntaxonomy

Three different plant associations were separated in the study area and these associations have been described for the first time. All syntaxa were assigned to the higher units according to the following order: Class, Order, Alliance, and Association.

These are listed and described below;

Molinio-Arrhenatheretea Tüxen 1937

Holoschoenetalia vulgaris Br.-Bl. ex Tchou 1948

Gaudinio-Hordeion bulbosi Galan, Deil, Haug and Vicente 1997

Alopecuro pratensis-Juncetum littoralis, Yalçın et al. 2013 ass. nova

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Polypogono monspeliensis-Hordetum geniculati, Yalçın et al. 2013 ass. nova

Ranunculo ophioglossifolii-Paspaletum distichi, Yalçın et al. 2013 ass. nova

Alopecuro pratensis-Juncetum littoralis, Yalçın et al. 2013 ass. nova (Holotypus: Table 2, relevé 331)

This association was seen in the western part of

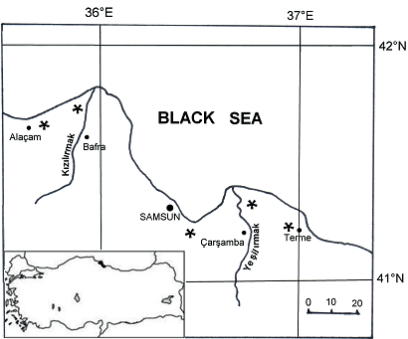


Fig 1. Map of the study area (*Selected stands)

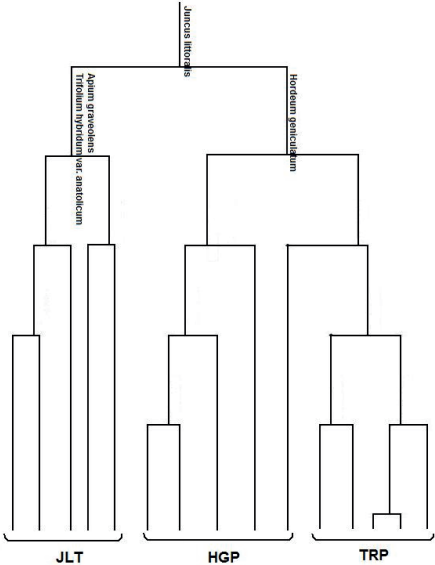


Fig 2. The TWINSpan clustering of relevés in the study area JLT; *Alopecurus pratensis*-*Juncetum littoralis*, HGP; *Polypogono monspeliensis*-*Hordetum geniculati*, and TRP; *Ranunculo ophioglossifolii*-*Paspaleum distichi*.

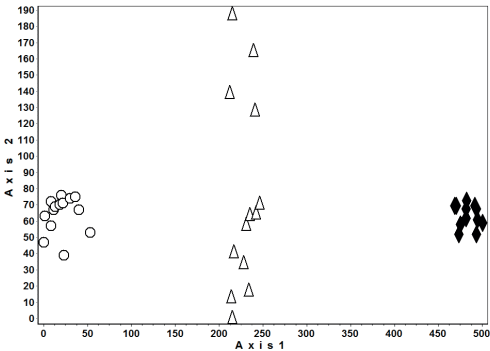


Fig 3. The DECORANA ordination diagram of relevés in the study area, ♦ JLT; *Alopecurus pratensis*-*Juncetum littoralis*, Δ HGP; *Polypogono monspeliensis*-*Hordetum geniculati*, and ○ TRP; *Ranunculo ophioglossifolii*-*Paspaleum distichi*.

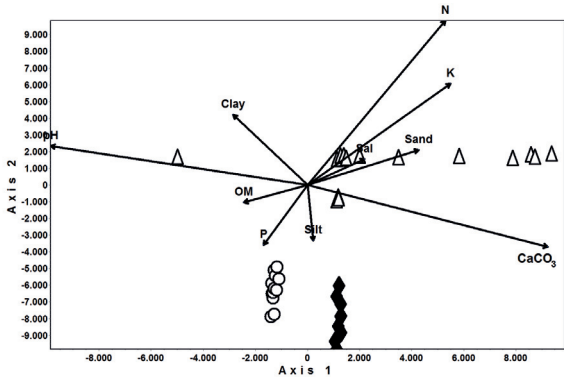


Fig 4. The CCA ordination diagram between species and environmental data, ♦ JLT; *Alopecurus pratensis*-*Juncetum littoralis*, Δ HGP; *Polypogono monspeliensis*-*Hordetum geniculati*, ○ TRP; *Ranunculo ophioglossifolii*-*Paspaleum distichi*, OM: Organic Matter (%), and Sal: Total Salinity (%).

Table 1. The canonical correlation coefficients of environmental variable were derived from the CCA and the Eigenvalues of the first two axes (Statistically significant variables are shown by a bold number).

	Can. Axis 1	Can. Axis 2
Canonical correlations		
Sand (%)	0.14	0.03
Clay (%)	-0.13	0.08
Silt (%)	-0.00	-0.00
Total Salinity (%)	0.00	0.03
Organic Matter (%)	-0.13	0.00
CaCO ₃ (%)	0.79	-0.16
pH	-0.03	0.00
P (ppm)	-0.00	-0.09
K (ppm)	0.51	0.17
N (%)	-0.05	0.81
Canonical Eigenvalue	0.75	0.55
% variance explained	28.79	21.24
Cumulative % variance	28.79	50.03
Pearson correlation species/environment scores	0.96	0.90
Kendal rank correlation of species/environment scores	0.68	0.50

the study area near the village of Fener in Bafra (41° 41' 16" N, 35° 53' 53" E). *Juncus littoralis* C. A. Mey., and *Alopecurus pratensis* L. are the dominant taxa of this association in Turkey. Their flowering time is between April and June. *Juncus littoralis* C. A. Mey., *Alopecurus pratensis* L., *Juncus acutus* L., *Galium verum* L. subsp., *verum* and *Vicia laxiflora* Boiss., *Calamagrostis arundinaceae* (L.) Roth, *Catabrosa aquatica* (L.) P. Beauv., *Iris pseudacorus* L., *Galium elongatum* C.Presl, *Scutellaria galericulata* L., *Mentha pulegium* L., *Torilis nodosa* (L.), and Gaertn. and *Spergularia marina* (L.) Besser were also represented as diagnostic species of this association. The mean of height of the association was 1 m and average percentage of cover was 95 %. The life form spectra

Table 2. *Alopecuro pratensis-Juncetum littoralis* Yalçın et al. 2013 Holotype: Relevé 331.

*Life Form	Relevé No	127	28	129	330	331	332	333	334	33	36	337	52	Presence
	Size of relevé (m²)	25	25	25	25	25	25	25	25	25	25	25	25	
	Height of herb layer (cm)	100	100	100	120	100	100	100	100	100	100	100	100	
	Coverage of herb layer (%)	95	90	90	85	95	100	95	90	95	100	95	95	
	Altitude (m)	3	4	6	6	5	5	5	4	3	4	5	5	
	Number of Plants	13	9	17	18	20	18	15	14	18	19	17	13	
	Differential and characteristic species of the association													
Ch	<i>Juncus littoralis</i>	3	2	1	2	2	2	2	2	2	2	1	1	V
H	<i>Alopecurus pratensis</i>	1	2	1	1	1	+	.	+	+	1	1	1	V
Ch	<i>Juncus acutus</i>	1	1	1	1	+	1	+	1	1	1	1	1	V
H	<i>Galium verum</i> subsp. <i>verum</i>	+	+	.	1	1	+	+	r	+	+	+	+	V
H	<i>Vicia laxiflora</i>	+	.	+	+	+	+	+	+	+	+	r	.	V
	Characteristic species of <i>Molinio-Arrhenatheretea</i> *, <i>Trifolio fragiferi-Cynodontion</i> **, <i>Cynosurion cristati</i> ***, <i>Holoschoenetalia vulgaris</i> ****, <i>Gaudinio-Hordeion bulbosi</i> *****													
H	<i>Oenanthe pimpinelloides</i> ****	+	+	+	+	.	+	+	r	+	r	.	+	V
H	<i>Bellis perennis</i> ***	.	.	.	+	r	.	r	.	+	r	r	.	III
H	<i>Lotus corniculatus</i> var. <i>tenuifolius</i> *	.	.	.	.	+	+	+	+	+	+	r	.	III
G	<i>Hordeum bulbosum</i> *****	.	.	+	+	+	.	.	.	.	.	.	+	II
H	<i>Carex divisa</i> **	.	.	.	+	.	.	.	.	.	.	r	.	I
	Characteristic species of <i>Phragmito-Magnocaricetea</i> *, <i>Phragmitetalia</i> **, <i>Magnocaricetalia</i> ***, <i>Magnocaricion elatae</i> ****													
H	<i>Catabrosa aquatica</i> *	1	1	+	+	.	+	1	1	1	+	+	+	V
G	<i>Iris pseudocorus</i> **	+	r	r	r	+	r	r	.	r	r	r	+	V
H	<i>Galium elongatum</i> ***	1	+	1	+	1	.	+	.	r	r	+	.	IV
H	<i>Scutellaria galericulata</i>	+	+	+	.	+	r	.	.	.	.	.	.	III
Ch	<i>Euphorbia palustris</i> ****	.	.	.	.	.	+	+	+	.	+	.	+	II
	Characteristic species of <i>Isoeto-Nanojuncetea</i>													
H	<i>Mentha pulegium</i>	+	+	+	1	+	+	+	+	+	+	+	+	V
	Characteristic species of <i>Calamagrostion arundinaceae</i>													
H	<i>Calamagrostis arundinaceae</i>	.	.	.	.	.	1	1	+	+	.	.	1	III
	Characteristic species of <i>Sedo-Scleranthetea</i>													
H	<i>Rumex acetosella</i>	+	+	r	.	r	.	.	.	.	.	.	.	II
	Characteristic species of <i>Bidentateae tripartitae</i>													
H	<i>Alopecurus aequalis</i>	+	r	.	r	r	r	+	r	.	+	r	+	V
	Characteristic species of <i>Cardamino-Geranietea purpurei</i>													
H	<i>Torilis nodosa</i>	1	1	+	1	+	1	1	+	+	+	+	1	V
	Characteristic species of <i>Saginetea maritimae</i>													
T	<i>Spergularia marina</i>	+	+	+	+	+	+	+	+	r	+	+	+	V
	Companions													
H	<i>Apium graveolens</i>	.	.	.	.	.	+	+	+	1	r	+	.	III
H	<i>Artemisia santonicum</i>	r	.	r	r	r	+	.	.	.	+	r	.	III
H	<i>Trifolium hybridum</i> var. <i>anatolicum</i>	+	+	+	+	r	.	.	.	r	.	.	.	III
H	<i>Centaurea urvillei</i> subsp. <i>armata</i>	+	.	r	.	.	.	.	+	.	.	.	.	II
T	<i>Lathyrus annuus</i>	.	.	r	.	+	.	.	.	+	.	r	.	II
T	<i>Lathyrus aphaca</i> var. <i>biflorus</i>	r	.	+	.	+	.	.	.	.	.	.	.	II
T	<i>Medicago lupulina</i>	.	.	.	.	r	r	.	.	.	r	.	.	II
H	<i>Trifolium physodes</i> var. <i>physodes</i>	.	.	.	+	.	.	.	.	+	.	.	.	I
H	<i>Convolvulus arvensis</i>	.	.	.	.	r	.	.	.	.	.	.	.	I
H	<i>Helminthotheca echioides</i>	.	.	.	.	.	.	.	.	.	r	.	.	I

* Ch: chamaephytes; H: hemicryptophytes; G: geophytes; T: therophytes.

of the association, consists of hemicryptophytes (74.19%), therophytes (12.90%), chamaephytes (9.67%), and geophytes (3.24%), respectively. Dominant life form of the association is hemicryptophytes. However, *Juncus acutus* L., and *Juncus littoralis* C. A. Mey., are chamaephytes. There was a little grazing pressure on this association

because *J. acutus* and *J. littoralis* are cushion-forming forbs and they are not palatable species. *Alopecurus pratensis* is a very tall graminoid and grazed by cattle. The economic value of these meadows is low, as their forage is neither abundant nor of high quality.

Although it mostly dominated by hemicryptophytes, chamaephytes is represented by the

Table 3. The mean soil values of the associations described in the study area (n= 10, $\pm$ Standart Error, C : Clay, P<0.05).

	<i>Alopecuro pratensis-Juncetum littoralis</i>	<i>Polypogono monspeliensis-Hordetum geniculati</i>	<i>Ranunculo ophioglossifolii-Paspaleum distichi</i>
Clay (%)	44.40 $\pm$ 0.82 b	44.35 $\pm$ 0.51 b	50.30 $\pm$ 0.73 a
Sand (%)	21.40 $\pm$ 0.20 a	20.15 $\pm$.036 a	16.79 $\pm$ 0.71 b
Silt (%)	35.01 $\pm$ 0.21 a	35.49 $\pm$ 0.65 a	32.99 $\pm$ 0.63 b
Texture	C	C	C
N (%)	0.34 $\pm$ 0.026 a	0.33 $\pm$ 0.013 a	0.31 $\pm$ 0.025 a
CaCO ₃ (%)	5.00 $\pm$ 0.50 a	1.10 $\pm$ 0.10 b	0.38 $\pm$ 0.008 b
pH	7.43 $\pm$ 0.082 a	7.34 $\pm$ 0.088 a	5.79 $\pm$ 0.054 b
Organic Matter (%)	5.96 $\pm$ 0.30 b	5.71 $\pm$ 0.32 b	7.72 $\pm$ 0.28 a
P (ppm)	39.68 $\pm$ 4.44 a	20.65 $\pm$ 1.66 b	6.13 $\pm$ 0.47 c
K (ppm)	633.61 $\pm$ 40.89 a	702.36 $\pm$ 29.19 a	226.78 $\pm$ 21.14 b
Total Salinity (%)	0.14 $\pm$ 0.007 a	0.11 $\pm$ 0.001 b	0.091 $\pm$ 0.003 c

Table 4. Species diversity and Evenness values of plant association (n= 10, $\pm$ Standart Deviation).

Plant Association	Species Diversity (H')	Evenness (J)	H _{max}
<i>Polypogono monspeliensis-Hordetum geniculati</i>	1.18 $\pm$ 0.3	0.97 $\pm$ 0.1	1.21 $\pm$ 0.4
<i>Alopecuro pratensis-Juncetum littoralis</i>	1.10 $\pm$ 0.2	0.97 $\pm$ 0.05	1.13 $\pm$ 0.5
<i>Ranunculo ophioglossifolii-Paspaleum distichi</i>	1.09 $\pm$ 0.2	0.95 $\pm$ 0.05	1.14 $\pm$ 0.5

characteristic species of the association, such as *Juncus acutus* and *Juncus littoralis*. Geophytes and therophytes are also available in low proportion.

The soil texture is clay and the concentrations of N, P, K, and CaCO₃ concentrations and salinity is very high. The pH is 7.43 and the soil is slightly alkaline (Table 3). Species diversity (H') and Evenness (J) were 1.10, and 0.97, respectively (Table 4).

***Polypogono monspeliensis-Hordetum geniculati*, Yalçın et al. 2013, ass. nova (Holotypus: Table 5, releve 341)**

This association was seen in the western part of the study area near the village of Fener in Bafra (41° 41' 16" N, 35° 53' 53" E). *Hordeum geniculatum* All. is the dominant and one of the characteristic species of this association spreads in Northern Turkey. It is a Euro-Siberian element and its flowering time is between June and July. Diagnostic species of this association include *Hordeum geniculatum* All., *Polypogon monspeliensis* (L.) Desf., *Centaureum pulchellum* (Sw.) Druce, and *Romulea ramiflora* Ten. subsp. *ramiflora*. The association is also represented by *Cynodon dactylon* (L.) Pers. var. *dactylon*, *Lotus corniculatus* L. var. *tenuifolius* L., *Bellis perennis* L., *Plantago lanceolata* L., *Lolium perenne* L., *Trifolium physodes* M.Bieb. var. *physodes*, and *Medicago disciformis* DC. The diagnostic species are widespread in the

arid environments. The mean height of the association is 20 cm and average cover is 90%. This association is overgrazed and flooded in early spring.

The most common life form in the association is hemicryptophytes and their ratio is 75.00% in the biological spectrum of this association. The therophytes are the second life forms and their ratio is 16.66% whilst geophytes are the smallest group and they represent 8.34% in this association. Geophytes are represented as *Romulea ramiflora* subsp. *Ramiflora*, and *Iris pseudacorus*. *Hordeum geniculatum* and *Centaureum pulchellum* are the most abundant therophytes. No chamaephytes are present in the life form spectra.

The soil of the association is very rich in organic matter (%), nitrogen (%), phosphorus (ppm), and potassium (ppm). The soil texture is clay, and soil reaction is slightly alkaline (Table 3). The species diversity (H') and Evenness (J) were found to be 1.18 and 0.97, respectively (Table 4).

***Ranunculo ophioglossifolii-Paspaleum distichi*, Yalçın et al. 2013, ass. nova (Holotypus: Table 6, releve 365)**

The *Ranunculo ophioglossifolii-Paspaleum distichi* was found in the eastern part of the study area near the village of Ahmetbey in Terme (41° 11' 26" N, 36° 59' 58" E). *Paspalum distichum* L., the dominant taxon of this association, spreads on the wet and trampling

Table 5. *Polygono monspeliensis-Hordetum geniculati* Yalçın et al. 2013 Holotypus: Relevé 341.

*Life Form	Relevé No	139	140	341	142	143	344	45	346	347	348	349	350	351	Presence
	Size of relevé (m²)	20	20	20	20	20	20	20	20	20	20	20	20	20	
	Height of herb layer (cm)	20	20	20	25	20	20	20	20	20	15	20	15	15	
	Coverage of herb layer (%)	95	80	90	95	95	90	90	95	85	95	95	90	90	
	Altitude (m)	5	5	6	7	5	5	6	5	5	5	5	5	8	
	Number of Plants	13	15	14	13	14	14	10	13	13	13	13	12	15	
	Differential and characteristic species of the association														
T	<i>Hordeum geniculatum</i>	2	+	1	2	+	1	1	1	1	3	2	2	1	V
T	<i>Centaureum pulchellum</i>	.	1	+	+	+	+	+	1	+	1	1	.	1	V
H	<i>Polygogon monspeliensis</i>	1	3	2	.	3	2	3	2	1	.	.	r	1	IV
G	<i>Romulea ramiflora</i> subsp. <i>ramiflora</i>	.	.	.	r	+	r	.	r	r	.	r	r	.	III
	Characteristic species of <i>Molinio-Arrhenatheretea</i> *, <i>Plantaginietalia majoris</i> **, <i>Trifolio fragiferi-Cynodotion</i> ***, <i>Cynosurion cristati</i> ****														
H	<i>Cynodon dactylon</i> var. <i>dactylon</i> ***	1	2	+	1	+	+	+	+	+	+	1	+	+	V
H	<i>Lolium perenne</i> **	+	1	+	+	+	+	+	+	.	+	+	+	1	V
H	<i>Lotus corniculatus</i> var. <i>tenuifolius</i> *	+	+	+	+	.	+	+	r	+	+	+	+	+	V
H	<i>Bellis perennis</i> ****	+	+	r	+	r	+	+	r	.	.	.	r	r	IV
H	<i>Plantago lanceolata</i> *	+	.	.	.	.	+	.	.	+	+	+	.	r	III
H	<i>Carex divisa</i> ***	.	.	.	.	.	.	.	.	.	+	+	.	+	II
	Characteristic species of <i>Polygono-Poetea annuae</i> , <i>Polygono arenastri-Poetalia annuae</i> **														
H	<i>Plantago coronopus</i> subsp. <i>coronopus</i> **	+	1	1	1	+	+	.	+	1	1	.	1	1	V
T	<i>Poa annua</i> **	.	+	r	.	r	.	.	.	.	.	.	.	r	II
	Characteristic species of <i>Isoeto-Nanojuncetea</i>														
H	<i>Mentha pulegium</i>	+	+	+	+	r	.	+	.	.	.	.	.	.	III
	Characteristic species of <i>Phragmito-Magnocaricetea</i> , <i>Phragmitetalia</i>														
G	<i>Iris pseudocorus</i>	.	r	r	.	.	r	.	r	+	r	1	r	.	IV
	Characteristic species of <i>Saginetea maritima</i>														
T	<i>Spergularia marina</i>	.	.	.	+	r	+	.	r	+	.	r	+	.	IV
	Companions														
H	<i>Trifolium physodes</i> var. <i>physodes</i>	+	1	+	+	+	+	+	+	+	+	+	+	+	V
H	<i>Ranunculus neapolitanus</i>	+	+	+	.	+	r	+	r	+	.	.	.	.	IV
H	<i>Agropogon littoralis</i>	+	1	+	+	+	.	.	.	+	.	.	.	.	III
H	<i>Euphorbia stricta</i>	r	+	.	r	.	.	.	.	.	.	.	.	.	II
H	<i>Tragopogon pusillus</i>	.	.	.	.	.	.	.	.	.	+	.	+	+	II
H	<i>Medicago disciformis</i>	.	.	.	.	.	.	.	.	.	+	+	.	+	II
H	<i>Centaurea urvillei</i> subsp. <i>armata</i>	.	.	.	.	.	.	.	.	.	r	.	r	.	I
H	<i>Helminthotheca echioides</i>	.	.	.	.	.	.	.	.	.	.	.	r	.	I
H	<i>Taraxacum bessarabicum</i> subsp. <i>bessarabicum</i>	.	.	.	.	.	.	.	.	.	.	.	r	.	I

* Ch: chamaephytes; H: hemicryptophytes; G: geophytes; T: therophytes.

habitats of Northern Turkey and locally is referred to as iron grass and its flowering time is between June and August. *Ranunculus ophioglossifolius* Vill. and *Myosotis sicula* Guss, are the second abundant or are solely present in the ungrazed parts. The diagnostic species are *Paspalum distichum* L., *Ranunculus ophioglossifolius* Vill, and *Myosotis sicula* Guss. The association is also represented by *Trifolium repens* L. var. *repens*, *Lolium perenne*, *Cynodon dactylon* var. *dactylon*, *Plantago lanceolata*, *Potentilla reptans* L., and *Rumex acetosella* L. The most abundant life form in the association is the hemicryptophytes and their ratio is 94.00% in the biological spectrum of this association. There is only the *Poa annua* L. as a therophyte and their ratio is 6.00% in this

association. Neither chamaephytes and nor geophytes are present in the association. The mean height of the species was 20 cm, and average percentage of cover is 90%.

The pH of the soil is 5.79 and the soil is slightly acidic. The pH was comparatively low, while soil clay content was higher as compared to other associations. The organic matter and nitrogen concentrations of the soil were high (Table 3). Flooding occurred in the winter and ceased in the summer and then the soil dries up. But, the water table of the soil is also high and the vegetation was not completely dried during the summer months. The species diversity (H') and Evenness (J) were 1.09 and 0.95, respectively (Table 4).

Table 6. *Ranunculo ophioglossifolii-Paspaleum distichi* Yalçın et al. 2013 Holotypus: Relevé 365

	Relevé No	152	153	35	55	356	13	14	59	360	361	362	363	364	365	66	Presence
	Size of relevé (m²)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	
	Height of herb layer (cm)	25	20	25	25	25	20	20	25	20	20	25	25	25	25	25	
	Coverage of herb layer (%)	95	90	95	95	90	95	95	90	95	95	95	90	95	90	95	
	Altitude (m)	5	5	4	4	5	5	4	5	4	5	5	4	5	4	5	
	Number of Plants	14	11	12	13	12	12	12	12	12	11	12	13	12	13	12	
	Differential and characteristic species of the association																
H	<i>Paspalum distichum</i>	3	3	2	3	3	3	3	3	3	2	3	2	2	3	2	V
T	<i>Ranunculus ophioglossifolius</i>	+	+	1	1	1	+	+	+	+	1	+	1	1	1	1	V
T	<i>Myosotis sicula</i>	.	+	.	1	1	+	.	+	+	.	+	.	.	+	.	IV
	Characteristic species of <i>Molinio-Arrhenatheretea</i> *, <i>Plantaginietalia majoris</i> **, <i>Trifolio fragiferi-Cynodontion</i> ***, <i>Cynosurion cristati</i> ****																
H	<i>Trifolium repens</i> var. <i>repens</i> ****	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	V
H	<i>Lolium perenne</i> **	+	+	+	+	r	.	+	.	+	+	+	+	+	+	+	V
H	<i>Cynodon dactylon</i> var. <i>dactylon</i> ***	.	+	.	.	r	.	+	r	.	+	.	r	r	r	r	IV
H	<i>Plantago lanceolata</i> *	+	r	.	+	r	.	+	.	+	.	+	r	r	r	r	IV
H	<i>Potentilla reptans</i> **	+	.	.	+	.	+	+	+	+	.	+	.	r	.	r	II
	Characteristic species of <i>Phragmito-Magnocaricetea</i> *, <i>Magnocaricetalia</i> , <i>Magnocaricion elatae</i> **																
H	<i>Polygonum salicifolium</i> **	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	V
H	<i>Alisma plantago-aquatica</i> *	+	.	r	.	+	+	.	+	.	r	+	r	.	r	r	IV
H	<i>Veronica anagallis-aquatica</i> *	+	.	.	r	.	+	+	.	.	+	.	r	.	r	.	III
	Characteristic species of <i>Sedo-Scleranthetea</i>																
H	<i>Rumex acetosella</i>	+	+	+	+	.	+	.	+	+	.	+	+	+	+	.	IV
	Characteristic species of <i>Polygono-Poetea annuae</i> , <i>Polygono arenastri-Poetalia annuae</i>																
T	<i>Poa annua</i> **	+	.	r	r	.	r	.	+	+	+	+	r	r	r	r	III
	Characteristic species of <i>Isoeto-Nanojuncetea</i>																
H	<i>Mentha pulegium</i>	r	.	r	+	.	r	.	+	.	+	.	r	.	r	.	III
	Characteristic species of <i>Holoschoenetalia vulgaris</i>																
H	<i>Oenanthe pimpinelloides</i>	.	r	r	.	r	.	+	r	.	+	.	.	.	.	r	III
	Companions																
H	<i>Centaurea urvillei</i> subsp. <i>armata</i>	1	1	1	1	+	.	+	.	+	+	.	1	1	.	1	IV
H	<i>Trifolium physodes</i> var. <i>physodes</i>	+	.	+	.	+	+	+	.	+	.	+	.	+	.	+	II

* Ch: chamaephytes; H: hemicryptophytes; G: geophytes; T: therophytes.

DISCUSSION

There are only a few studies about meadow vegetation in Turkey (Vural 1996, Karaömerlioğlu 2007, Korkmaz et al. 2012). Most of them are related to the alpinic, subalpinic, and coastal dune habitats. They are very different from the meadow vegetation floristically and ecologically. For this reason, it is very difficult to compare the floristic similarity of the associations described in the study area to similar studies. The study area is near sea level and the soil water table is high. Flooding was observed in the study area during the rainy season and even in the dry seasons. The formation of some associations is subject to flooding. The soils were rich in soil nutrients in the study area (Table 3). The associations that are described in this study significantly differ with respect to soil traits except for the nitrogen concentrations (Table 7). *Alopecuro pratensis-Juncetum littoralis* had usually the highest soil N concentration, CaCO₃, and sand content. Total

salinity was also high. This association occupied more saline soils as compared to other associations; therefore, *Alopecuro pratensis-Juncetum littoralis* should be classified as sub-halophytic grassland. This difference may be explained by the fact that the major vegetation gradient corresponding to salinity level also coincides with climate. The most salt-rich grasslands usually develop under a maritime climate (Eliás et al. 2013). However, *Ranunculo ophioglossifolii-Paspaleum distichi* had the lowest CaCO₃ content and P and K concentrations. *Alopecuro pratensis-Juncetum littoralis* and *Polypogono monspeliensis-Hordetum geniculati* grow on slightly alkaline soils, while *Ranunculo ophioglossifolii-Paspaleum distichi* grows on slightly acidic soils (Kacar 2009). Trampling and increased nitrification in coastal systems entries, favour the spread of *Trifolio-Cynodontion ruderal* communities (Campos et al. 2004).

Plant associations were affected not only by soil

nutrients but also by other ecological traits such as the annual precipitation regime, grazing pressure, and the duration of flooding (Jarolimek et al. 2000, Dodd et al. 2002, Hillerislambers et al. 2002) in the study area. For example, annual precipitation has increased about 250 mm per year from the western to the eastern part of the study area. In addition to these factors, overgrazing is very effective on floristic composition of meadow vegetation.

The Braun-Blanquet method and numerical methods exhibited similar results, and the three plant associations were distinguished. These methods are considered a good numerical approximation to Braun-Blanquet classification of plant communities as well (Mucina 1982, Jongman et al. 1995). The two main clusters are separated in the TWINSpan diagram (Fig. 2). Axis 1 in the DECORANA diagram represents the distance from the sea. *Alopecuro pratensis-Juncetum littoralis* occupied the sand dunes, while the other associations occur on the left of the axis. *Alopecuro pratensis-Juncetum littoralis* is different from the other associations with respect to floristic composition, and occurs on the right of axis 1 in the DECORANA diagram (Fig. 3). *Alopecuro pratensis-Juncetum littoralis* belongs to different syntaxonomical units. Axis 2 represented the moisture gradient and the *Ranunculo ophioglossifolii-Paspaleum distichi* which is subjected to flooding conditions. The results of the TWINSpan are in agree with the DECORANA.

Meadow vegetation in the Circumboreal phytogeographical region generally belongs to the *Molinio-Arrhenatheretea* class. Most of them are widespread on mesic or xero-mesic soils. *Molinio-Arrhenatheretea* meadows are widespread in the forest-steppe zone in many parts of the world (Ermakov et al. 1999, Rivas-Martinez et al. 2002b). *Molinio-Arrhenatheretea* includes meadow communities occupied from well-drained to rather wet soils, mostly influenced by man, by mowing/grazing and manuring; species living in both wet and dry conditions are relatively frequent (Pignatti et al. 1995).

Molinio-Arrhenatheretea has a wide distribution in the study area. The floristic composition of associations has been dramatically disturbed due to heavy grazing pressure (Yilmaz 2007). So, the syntaxonomical classification of meadow vegetation is troublesome in the study area. *Plantaginetalia majoris* is widespread in the trampled and grazed

meadows, and these meadows are temporally inundated, on moist to wet eutrophic soils rich in organic and mineral nutrient (Rivas-Martinez et al. 2002b). *Polypogono monspeliensis-Hordetum geniculati* (Table 5) and *Ranunculo ophioglossifolii-Paspaleum distichi* (Table 6) should be included in the *Plantaginetalia majoris*. *Polypogono monspeliensis-Hordetum geniculati* and *Ranunculo ophioglossifolii-Paspaleum distichi* should be included in the *Trifolio fragiferi-Cynodontion* due to their differential and characteristic species and their similar ecological conditions. Both of them are able to develop on loamy soils, to withstand a high degree of treading and represent the diagnostic species of *Trifolio fragiferi-Cynodontion* and *Plantaginetalia majoris*, respectively. As determined in this study, Ellenberg (1988) stated that on the banks of rivers and lakes, and also along the sea coast are found similar vegetation types growing under natural and seminatural condition in Europe. *Hordeum geniculatum* All., one of the characteristic species of *Polypogono monspeliensis-Hordetum geniculati* Yalçın et al. 2013 ass. nova spreads in the mesotrophic habitats in South (Kavgacı et al. 2010) and Central Turkey (Türe and Böcük 2007). Although *Hordeum geniculatum* All., is a Euro-Siberian element, it is seen widespread in different geographical areas of Turkey. These results show that the distribution of taxa is very complicated in Turkey once again. *Paspalum distichum* L. the dominant taxon of *Ranunculo ophioglossifolii-Paspaleum distichi* Yalçın et al. 2013 ass. nova is distributed on the wet and trampled habitats in Northern Turkey. *P. distichum* is the most important taxon of the wet meadows in the other countries (Sarika et al. 2005, Nishihiro et al. 2006). Van der Valk et al. (1993) reported that *P. distichum* is dominant in the natural meadow vegetations with regular flooding regimes that are able to withstand the grazing pressure by livestock.

Korkmaz et al. (2012) stated that *Samolo valerandi-Juncetum acuti* should be included in *Molinio-Arrhenatheretea*, *Plantaginetalia majoris*, and *Trifolio fragiferi-Cynodontion* in the Gölardı (Terme/Samsun) Wildlife Protected Area. The floristic similarity between *Samolo valerandi-Juncetum acuti* and *Alopecuro pratensis-Juncetum littoralis* ass., Nova was 4.65%. Therefore, we thought that *Alopecuro pratensis-Juncetum littoralis* Yalçın et al. 2013 ass. nova (Table 2) found in the study area should be treated as a new association. *Holoschoenetalia vulgaris*

Table 7. The evaluation of soil traits by one way ANOVA ($P < 0.05$)

		Sum of Squares	df	Mean Square	F	Sig.
Sand (%)	Between Groups	156.74	2	78.37	21.72	0.001
	Within Groups	133.49	37	3.60		
	Total	290.23	39			
Clay (%)	Between Groups	329.40	2	164.70	25.02	0.001
	Within Groups	243.54	37	6.58		
	Total	572.95	39			
Silt (%)	Between Groups	49.80	2	24.90	5.80	0.006
	Within Groups	158.73	37	4.29		
	Total	208.54	39			
Total Salinity (%)	Between Groups	0.01	2	0.008	27.77	0.001
	Within Groups	0.01	37	0.00		
	Total	0.02	39			
Organic Matter (%)	Between Groups	33.72	2	16.86	13.47	0.001
	Within Groups	46.28	37	1.25		
	Total	80.00	39			
CaCO ₃ (%)	Between Groups	157.66	2	78.83	82.34	0.001
	Within Groups	35.42	37	0.95		
	Total	193.09	39			
pH	Between Groups	23.79	2	11.89	159.86	0.001
	Within Groups	2.75	37	0.07		
	Total	26.54	39			
P (ppm)	Between Groups	7506.34	2	3753.17	45.00	0.001
	Within Groups	3085.65	37	83.39		
	Total	10592.00	39			
K (ppm)	Between Groups	1865886.09	2	932943.04	77.11	0.001
	Within Groups	447626.67	37	12098.01		
	Total	2313512.77	39			
N (%)	Between Groups	0.008	2	0.004	0.60	0.550
	Within Groups	0.25	37	0.007		
	Total	0.26	39			

was a component of the Mediterranean summer-green pastures and grasslands, and growing on deep and damp soils (Rivas-Martinez et al. 2002b). *Holoschoenetalia vulgaris* and *Gaudinio-Hordeion bulbosi* also include terrestrial plants such as *Juncus littoralis* C.A. Mey., *Oenanthe pimpinelloides* L., *Hordeum bulbosum* L., *Pulicaria dysenterica* (L.) Gaertn., *Blackstonia perfoliata* (L.), and Huds., on the deep, moist, and sandy soil of the lowland meadows in the Mediterranean and Euro-Siberian areas (Tomaselli et al. 2011). *Alopecuro pratensis-Juncetum littoralis* should be included in *Molinio-Arrhenatheretea*, *Holoschoenetalia vulgaris*, and *Gaudinio-Hordeion bulbosi* because this association included many characteristic species of these synxonomical units and characteristic species of this association occurred in the summer-green pastures on temporary wet soils. But *Alopecuro pratensis-Juncetum littoralis* included only a few characteristic species of

Holoschoenetalia vulgaris and *Gaudinio-Hordeion bulbosi* because the successive development of this association was not completed owing to overgrazing and seasonal fluctuations in the flooding regime. However, in some places fragments of flood swards are interspersed with the grassland communities of the loamy river valleys in Central Europe according to Ellenberg (1988). The *Alopecuro pratensis-Juncetum littoralis* Yalçın et al. 2013 ass. nova has different syntaxonomical status than other syntaxa in the study area and shows a similar distribution with meadow communities as stressed by Ellenberg (1988) in Central Europe. *Alopecurus pratensis* L. the dominant and characteristic taxon of this association and in the mesotrophic floodplain meadows in Europe (Deak 2005, Velev et al. 2010). *J. littoralis* which is the other important taxon of this association exists on the saline habitats (Öztürk et al. 2011). But, Apaydin et al. (2009) reported that was

not related to the measured increase in soil salinity during winter, summer, and spring. The dense network of rhizomes of *J. littoralis* might facilitate the filtering of water and the removal of salts, so as to allow it to exist on the flooded and non-flooded soils (Alvarez-Rogel et al. 2007). Kılınç et al. (2011) reported that the soil organic matter is an important factor that regulates the distribution of *J. littoralis* and the growth of *J. littoralis* is associated with the soil organic matter concentrations making individual clumpings. These comments support the presences of *J. littoralis* in the meadow vegetation and, reveals why it is the indicator species in the TWINSPAN dendrogramme.

Karaömerlioğlu (2007) defined *Polypogono maritimi-Juncetum littoralis* in the Göksu delta (Silifke). But, there were many differences between *Alopecuro pratensis-Juncetum littoralis* and *Polypogono maritimi-Juncetum littoralis* with regard to floristic composition, ecological conditions, and syntaxonomical status.

Plant species and individuals can be grouped into different life-form classes based on structural and functional similarities (Mueller-Dombois and Ellenberg 2002). Van der Maarel (1988) synthesized that life-form and strategy are clearly related: short-lived hemicryptophytes mainly fall into two strategy categories, the related SR and CSR ones; the longer-lived into three: CSR, S, and CS; the geophytes have most of their representatives in the CSR and S types, the chamaephytes in the S, CSR, and CS types and, the stressed life form spectrum indicate the plant communities general environmental preference as reflected in the syntaxonomical position. Hemicryptophytes are the most widespread life form in the study area. According to Singh and Yadava (1974) meadows are rich in hemicryptophytes. *A. pratensis* is the longer lived hemicryptophytes and have CSR strategies according to Dunnett et al. (2001). Altay and Öztürk (2012) also assigned that *J. littoralis* as chamaephyte and hygrophalophytes in the Milleyha wetland ecosystem. Grime (2002) found that British *Juncus* (sedge) species adopted C/CS transient strategy due to their evergreen functional shoots.

In this study, the high representation of hemicryptophytes may probably be due to the climatic conditions (i.e. precipitation and low soil permeability) and overgrazing. It has been reported that plants with their buds at or in the ground

(hemicryptophytes) are more resistant to trampling than that of the other life forms (Alhamad 2006). Particularly, the seasonal drought stress and unexpected flooding increased the proportion of hemicryptophytes in the lowland meadows (Yalçın et al. 2011). The frequency of the hemicryptophyte and therophyte among the plants of the study area shows how the effect of the two types of - mediterranean climate and cool temperature affected them (Yavari and Shahgolzari 2010). Plant life forms and various formations are the best indicators of general climate types (Böcük et al. 2009). Kavgaç (2007) reported that the proportion of therophytes is more than hemicryptophytes in the meadows behind sand dunes. The sand dune motion causes the low proportion of hemicryptophytes in meadows behind them. At lower altitudes, temperatures and length of growing-seasons are adequate, but soil moisture may not readily be available, which may be responsible for the development of annual species (Wang et al. 2002). In this study, therophytes exist in the described associations, but with no estimated dominance. If therophytes are dominant in meadow vegetation, this is a result of the extensive dry period in the summer (Christodoulakis 1996). Therophytes always predominate in Mediterranean coastal ecosystems (Sarika 2012). Occurrences of other life form patterns in the lowland meadows are less or rather more difficult to explain because the life form spectrum is an ambiguous interpretative tool (Naqinezhad et al. 2009).

It has been claimed that species richness is highest at intermediate levels of disturbance and productivity (Juttila 1997). Grazing declines due to cover and height of the meadow vegetation and light penetrating to the soil surface which provides opportunities for the germination of seedlings (Harkel et al. 1995). In the present study, *Alopecuro pratensis-Juncetum littoralis* has intermediate species diversity (Table 6). Some species were eliminated due to overgrazing and as a result of this, the realized amplitude of the distribution of the other species was narrowed. Finally, new species had the opportunity to arrive and grow there. Juttila (1997) stated that species richness decreased significantly with an increase in the height of vegetation. *Polypogono monspeliensis-Hordetum geniculati* had the highest Shannon index and evenness values. This association occurred in the western part of the study

area. The mean precipitation in western part of the study area was lower than the eastern part. This association includes the species which adapt themselves to more arid conditions. For example, flooding was not widespread in this part of the study area. Additionally, total height of vegetation was low as compared to the other associations. It has been found that as vegetation height becomes lower; evenness values reach maximum levels (Cingolani et al. 2003).

Jarolimek et al. (2000) addressed, that species richness has been decreased owing to flooding. As a result of long flooding periods, floristic composition of a particular association may be changed. In the present study, *Ranunculo ophioglossifolii-Paspaletum distichi* was flooded during the early spring, while being dried during the summer, so species richness of that association was the lowest (Table 4).

The CCA (Fig. 4, Table 1) indicated that soil traits (CaCO_3 , K, and N), as the main driving forces in the floristic composition of the associations in the study area. Zelnik and Carni (2008) reported that the same soil parameters (CaCO_3 , K, and N) were the best indicators of the floristic variation in the wet meadows. Similar results were obtained from the studies of Blackstock et al. (1998) and Ruggiero et al. (2002). McCrea et al. (2001) ascribed the effect to the dependence of many forbs, including many legumes, on high potassium levels to compete successfully with grasses. Kopeć et al. (2010) stated that the members of *Molinio-Arrhenatheretea* responded more strongly to better bioavailability of

soil nutrients than the other meadow species.

Finally, there was heavy grazing pressure on the meadow vegetation in the study area. As a result of this, the floristic composition was dramatically affected. Less palatable species (i.e. *Cynodon dactylon* var. *dactylon*) invaded such meadows as a result of the increased number of grazers in the study area. Overgrazing should be prevented over the growing period, and rotational grazing regimes should be practiced in such ecosystem types. The destroyed areas first should be fenced with suitable instruments, then, the rehabilitation studies should be applied. Quantitative information about grazing effects on vegetation is crucial for the planning of grazing regimes in order to achieve specific goals such as optimizing resource production for livestock and conserving local biodiversity. Optimal management strategy for the conservation of regional biodiversity in meadows would therefore include diversification of grazing intensity over the landscape (Carmel and Kadmon 1999). There are only a few studies and information about this type of vegetation in Turkey, so, these descriptions and typifications are very important according to us. But, these kinds of studies must increase and bring out the syntaxonomical status of the meadow vegetation in Turkey.

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