Pak. J. Bot., 39(4): 1055-1070, 2007.

AN INVESTIGATION ON THE DIVERSITY, DISTRIBUTION AND CONSERVATION OF *POACEAE* SPECIES GROWING NATURALLY IN ESKIŞEHIR PROVINCE (CENTRAL ANATOLIA–TURKEY)

CENGİZ TÜRE* AND HARUN BÖCÜK

Department of Biology, Faculty of Science, Anadolu University, Eskişehir, Turkey
**Author for Correspondence (e-mail: cture@anadolu.edu.tr, fax: +90 222 320 49 10)*

Abstract

Turkey is located in the region when natural forms of important cultivated plant species show genetic diversity. In the present study, plant distribution and conservation strategies of *Poaceae* (*Gramineae*) species distributing naturally on steppe vegetation, getting important contributions to the plant diversity under antropogenic effects were studied. During the study, 125 plant taxa belonging to 57 genera were determined. The research area is situated in the B3 square according to Davis' grid system. Total number of species of the larger genera in the study area are as follows: *Bromus* L. 10, *Poa* L. 9, *Aegilops* L. 8, *Phleum* L., *Stipa* L. and *Hordeum* L. 6, *Avena* L. 5, *Elymus* L., *Eremopyrum* (Ledeb.) Jaub. & Spach, *Lolium* L., *Alopecurus* L., *Melica* L. and *Secale* L. 3. The phytogeographic elements represented in the research area are as follows: Euro-Siberian 20 (16.0%), Irano-Turanian 12 (9.6%), Mediterranean 6 (4.8%) and East Mediterranean 3 (2.4%). When the risk categories of the plant taxa are considered, it can be seen that 1 taxon is in VU (*Vulnerable*), 1 taxa in DD (*Data Deficient*) and 3 in LC (*Least Concern*) categories. Four (3.2%) species are endemic for Turkey.

Introduction

Turkey is located at the intersection of two important gene centers like Mediterranean and Near East and in the ninth order among all continental countries in terms of biodiversity. Natural races of most cereals cultivated as human food grow on steppe ecosystems (Vavilov, 1951; Anon., 2001a). The *Poaceae* (*Gramineae*), an important part of steppe ecosystems, is one of the largest families of flowering plants, with approximately 600 genera and 10.000 species in the World. The members of the family are widespread in all climates and regions. Grasslands, which make up 20% of the world's vegetational cover, are composed of *Poaceae* members (Arabacı & Yıldız, 2004). The family has been mostly studied systematically, ecologically and genetically (Hubbard, 1948).

It is important to search the *Poaceae* members specially used in agricultural activities. Because the gene center of the most members of *Poaceae* family is Southwest Asia including Turkey (Davis, 1985). The main starch source of both human and animals except potato *(Solanum tuberosum)* is plant taxa belonging to *Poaceae*. Of the *Poaceae* genera mostly used in agricultural activities now, *Triticum*, *Hordeum*, *Panicum* and *Avena,* sown 7000 years ago in Central and East Anatolia (Harlon & Zohary, 1966; Türe, 2003), in the same regions where sowing of the plants belonging to the genera *Oryza*, *Zea* and *Secale* was started much more later (Charles, 1984). Although the species number belonging to *Poaceae* used in agricultural activities seems to be low, it comes in the first order among the plants used in agricultural activities.

Besides the nourishment values in ecosystems, some *Poaceae* taxa have also ecologically important functions like carrying out the most of the primer productivity, preserving the soil against erosion and getting the soil richer in terms of organic matters. These plants distribute in different habitats from subalpinic and xerophyte areas to aquatic ecosystems (Clayton & Renvoize, 1986).

Poaceae members distributing naturally are used as a gene source for their close relatives phylogenetically to achieve new and economically advanced characteristics (Mennan *et al*., 2003). Hybrid forms getting from natural populations of *Hordeum vulgare* L., *Aegilops* sp., *Agropyrum elongatum* (Host) Beauv., because of their rich protein contents (Reitz, 1976; Olson *et al*., 1987), *Triticum, Elymus, Avena, Alopecurus, Agropyrum, Haynaldia, Scale, Eromopyrum* are used because of their tolerance to the environmental conditions (Mennan *et al*., 2003). Specially, *Elymus* sp., *Agropyrum elongatum* L., have a wide tolerance to salinity and *Triticum turgidum* L., *Aegilops squarrosa* L.*, Agropyrum intermedium* (Host) P. Beauv.*, Lophopyrum elongatum* (Host) A. Love show resistance to drought (Farooq *et al*., 1994; Wynjones *et al*., 1984, Ebrahemzadeh *et al*., 2000) and *Catapodium rigidum* (L.) C.E. Hubbard ex Dony subsp. *rigidum* var. *rigidum* shows resistance to boron toxicity (Türe & Bell, 2004).

Except some *Poaceae* taxa used in perfume sector (Clayton & Renvoize, 1986), some *Lolium* taxa are also used to produce paper, flavor, fibers and board (MDF) (Anon., 2002). Poaceae taxa could be used for their genetic characteristics like *Aegilops umbellulata* Zhuk*, Aegilops bicornis* (Forsskal) Jaub. & Spach*, Agropyrum elongatum, Agropyrum intermedium*, *Triticum diccocum* Schrank*, Triticum monococum* L.*, Triticum timopheevi* Zhuk.*, Agropyrum glaucum* (Desf. ex DC.) Roemer & Schultes. showing quite resistance to rust and diseases (Anon., 1972; Parlevliet, 1981; Zitelli, 1974).

Genetically modified 96 different wheat races have been used in agricultural areas for the last 30 years in Turkey. But *Tritium monococcum* and *Triticum dicoccum*, natural race of the region, is about to be extinct because of not being used in agriculture any longer (Anon., 2001a).

Because of increased industrial activities, urbanization, tourism activities, creating new agricultural areas, mining activities, using agricultural methods and overgrazing, the natural structures of steppe ecosystems have been getting destroyed. So, development of *Poaceae* members is obstructed and the natural distribution areas of them are getting limited day by day (Mishra & Rawat, 1998; Ghazanfar, 1998; Ojeda *et al*., 2000; Victor & Dold, 2003; Türkmen *et al*., 2004).

The aim of the study was to determine the plant diversity, natural distribution and conservation characteristics of *Poaceae* family in Eskişehir region which could be used in different areas in future except the known characteristics.

Study area: Eskişehir, northwest of Central Anatolia, lies down between 29^{o} 58' and 32^{o} 04' east longitudes and 39^{o} 06' and 40^{o} 09' north latitudes and covers about 13.652 square kilometer. This province is with Black Sea region on the north, Marmara region on the northwest, Aegean region on the southwest. It is bordered by Bozdağ and Sündiken mountains on the north, Emirdağ mountain on the south, Sakarya valley on the east and Türkmen mountain on the west (Fig. 1) (Anon., 1981-1984; Türe, 2000a, Erdir & Türe, 2003).

Major soil groups: Agricultural activities are carried out nearly 42% of soils in Eskişehir. All types of major soil groups are available in the province. Specially, alluvial and colluvial soils covering about 100.000 ha lie down the level lands along the rivers. Agricultural activities can be mostly seen in these kind of areas (Türe & Bell, 2004; Türe & Köse, 2000).

Table 1. Some analysis values belonging to major soil groups in Eskişehir province.

Major soil type	pH	Salt (%)	Calcerous (%)	Organic matter	P_2O_5 (kg/d)	K_2O (kg/d)
Alluvial	7,77	0,079	11,73	2,31	9,36	198,6
Brown soil	7,86	0,069	13,61	1,93	6,47	161,1
Non-calcerous brown forest	7,42	0,049	12,2	2,33	6,79	130,5
Brown Forest	7,14	0,056	10,05	2,1	6,8	134,2
Non-calcerous brown	6,58	0,078	11,29	1,54	5,85	76,1
Hydromorphic alluvial	7,77	0,112	16,23	2,4	11	207,5
Red brown	7,66	0,047	19	1,59	5,13	123,4
Colluvial	7,71	0,083	18,34	1,56	7,06	160,6

Table 2. Bioclimate zone of the study area according to Emberger formula (1952).

Station	Altitude	P	PE	M	m	S	Q	Bioclimate zone
Eskişehir	801 m	379,2	59,52	28,7	-3,7	2,1	40,9	Semi-dry Medit.

(**P**: Annual average precipitation (mm/m^2), **PE**: Annual summer precipitation mm/m^2), **M**: Average temperature of the hottest month (0C), **m**: Average temperature of the coldest month (^{0}C), **S**: Value of dry season (PE/M), **Q**: Comparison of temperature-precipitation (2000.P.(M+m+546,4) . (M-m))

Table 3. Annual mean precipitation according to seasons and precipitation regime types according to data obtained from Eskişehir Meteorology Station (mm).

	Spring (Sp)	Summer (S)	Fall (F)	Winter (W)	Annual	Precipitation regime
Eskişehir	120,68	59,52	74,31	124,67	379,2	W.Sp.F.S.

Natural and common plant associations of brown soils in the area are short and middle meadow herbs. Brown forest soils are covered by deciduous trees and shrubs. Natural plants of noncalcareous brown forest soils of the area are deciduous forest trees. No specific climate type or plant taxa are available for alluvial soils. Usually, noncalcareous brown soils are covered by herbs and shrubs. Natural plants of red brown soils are short and middle meadow herbs (Anon., 1984). Some chemical and physical analyses of the major soil groups in the area are given in Table 1.

Climate: Although it seems to be a transition zone between the West and Central Anatolian climates, the climate of Eskişehir is hard and terrestrial. The altitudes of some areas like Porsuk and upper Sakarya plains can reach to 800-1000 m. The city is surrounded by mountains from south and north, and high plateaus from west. Because of this situation, the effects of Black Sea and Mediterranean climates on the city are blocked, but the west Anatolian climate can reach into the Eskişehir (Anon., 1981-1984).

The annual mean temperature of the city is 10.9^{0}C. December is the most rainy month, annual mean precipitation is determined as 386,6 mm. When the area is evaluated according to precipitation regime, it shows the characteristics of East Mediterranean Precipitation Regime Type 1 (WSpFS). When the meteorologic data is considered according to Emberger formula, it can be seen that the study area is in semi-dry Mediterranean bioclimate zone (Table 2 & 3) (Akman, 1990; Anon., 2000).

The dry period of Eskişehir is between June-September period according to Walter method (Fig. 2).

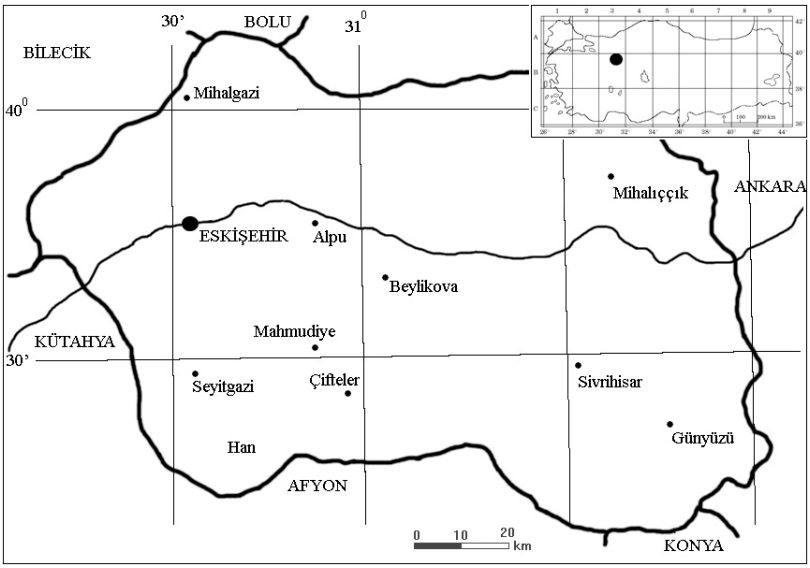


Fig. 1. Location of Eskişehir province

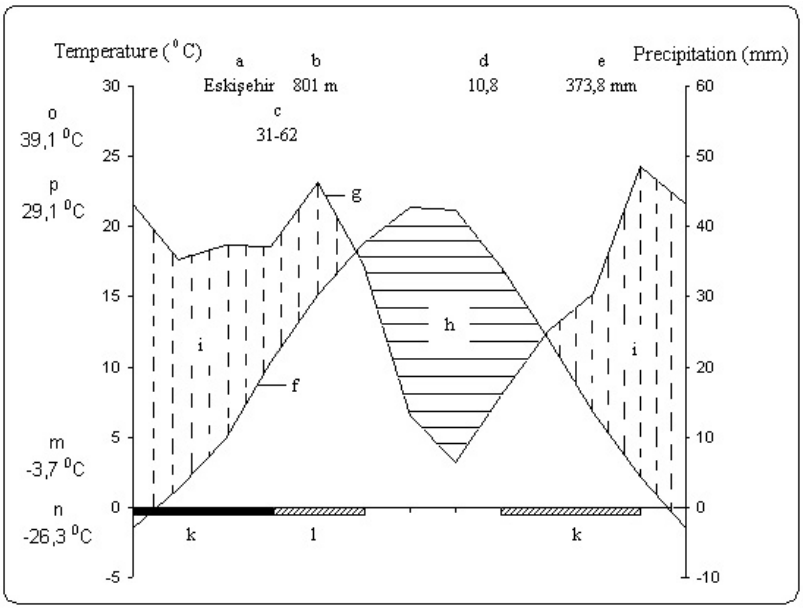
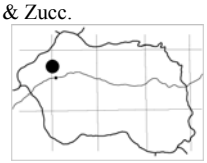


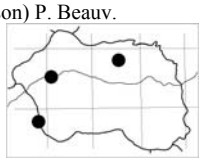
Fig. 2. Ombrothermic diagram of Eskişehir province
(**a:** City name, **b:** Altitude, **c:** Temperature and observation year number **d:** Mean annual temperature, **e:** Mean annual precipitation, **f:** Mean monthly temperature curve, **g:** Mean monthly precipitation curve, **h:** Dry period, **i:** Rainy period, **k:** Minumum temperature of the coldest month, **l:** Annual absolute minumum temperature, **m:** Absolute maximum temperature, **n:** Maximum temperature of the hottest month)

***Poaceae (Graminae)* list of Eskişehir province**

1. *Phyllostachys bambusoides* Sieb. & Zucc.

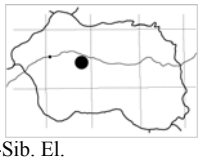


2. *Brachypodium sylvaticum* (Hudson) P. Beauv.



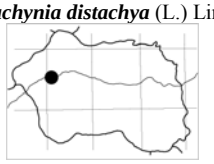
Euro.-Sib. El.

3. *Brachypodium pinnatum* (L.) P. Beauv.



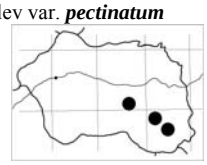
Euro.-Sib. El.

4. *Trachynia distachya* (L.) Link

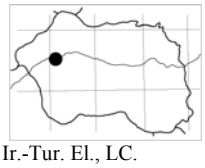


E. Medit. El.

5. *Agropyron cristatum* (L.) Gaertner subsp. ***pectinatum*** (Bieb.) Tzvelev var. ***pectinatum***



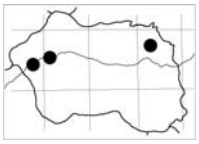
6. *Elymus lazicus* (Boiss.) Melderis subsp. ***divaricatus*** (Boiss. & Bal.) Melderis



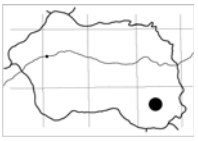
End., Ir.-Tur. El., LC.

7. *Elymus hispidus* (Opiz) Melderis subsp. ***barbulatus*** (Schur) Melderis

8. *Elymus farctus* (Viv.) Runemark ex Melderis subsp. ***farctus*** var. ***bessarabicus*** (Savul & Rayss) Melderis

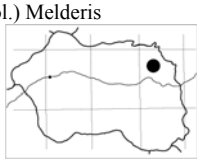


9. *Eremopyrum bonaepartis* (Sprengel) Nevski subsp. ***bonaepartis***

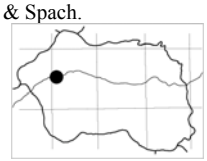


Ir.-Tur. El.

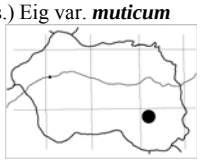
10. *Eremopyrum bonaepartis* (Sprengel) Nevski subsp. ***hirsutum*** (Bertol.) Melderis



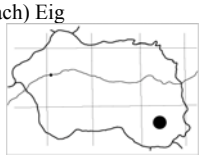
11. *Eremopyrum orientale* (L.) Jaub. & Spach.



12. *Ambylopyrum muticum* (Boiss.) Eig var. ***muticum***

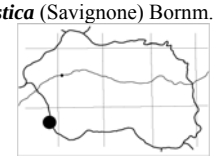


13. *Ambylopyrum muticum* (Boiss.) Eig var. ***loliaceum*** (Jaub. & Spach) Eig

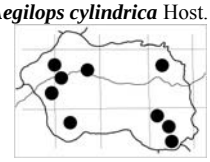


End., LC.

14. *Aegilops speltoides* Tausch var. ***ligustica*** (Savignone) Bornm.

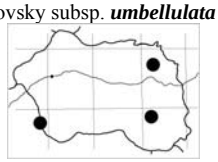


15. *Aegilops cylindrica* Host.

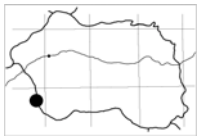


Ir.-Tur. El.

16. *Aegilops umbellulata* Zhukovsky subsp. ***umbellulata***

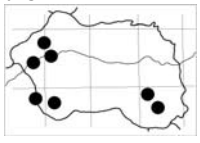


17. *Aegilops peregrina* (Hackel) Maire & Weiller

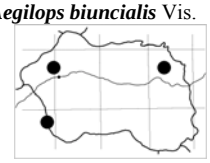


DD.

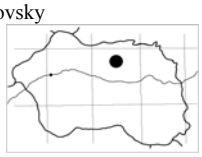
18. *Aegilops triuncialis* L. subsp. ***triuncialis***



19. *Aegilops biuncialis* Vis.

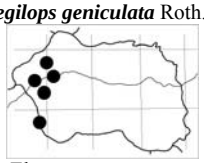


20. ***Aegilops columnaris*** Zhukovsky



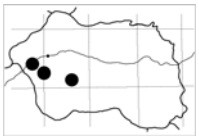
Ir.-Tur. El.

21. ***Aegilops geniculata*** Roth.

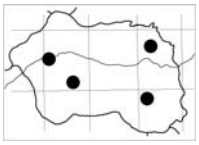


Medit. El.

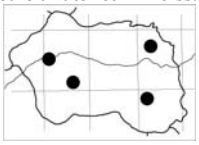
22. ***Triticum baeoticum*** Boiss. subsp. ***baeoticum***



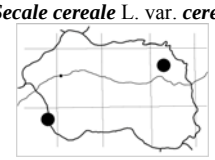
23. ***Triticum aestivum*** L.



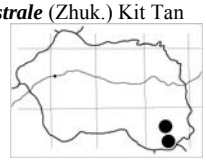
24. ***Secale anatolicum*** Boiss.



25. ***Secale cereale*** L. var. ***cereale***

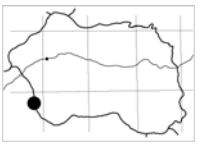


26. ***Secale cereale*** L. var. ***ancestrale*** (Zhuk.) Kit Tan



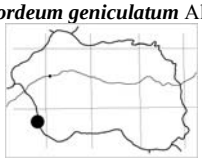
End., VU.

27. ***Hordeum violaceum*** Boiss. & Huet



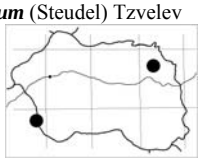
Ir.-Tur. El.

28. ***Hordeum geniculatum*** All.

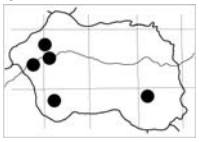


Euro.-Sib. El.

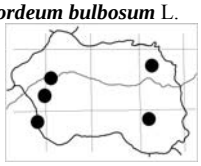
29. ***Hordeum murinum*** L. subsp. ***glaucum*** (Steudel) Tzvelev



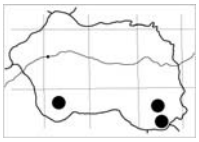
30. ***Hordeum murinum*** L. subsp. ***leporinum*** (Link) Arc. var. ***leporinum***



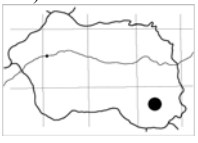
31. ***Hordeum bulbosum*** L.



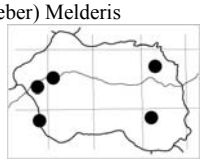
32. ***Hordeum distichon*** L.



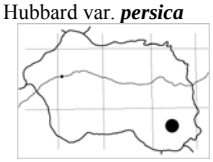
33. ***Taeniatherum caput-medusae*** (L.) Nevski subsp. a***sper*** (Simonkai) Melderis



34. ***Taeniatherum caput-medusae*** (L.) Nevski subsp. ***crinitum*** (Schreber) Melderis

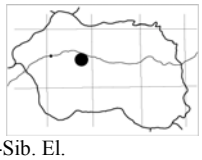


35. ***Henrardia persica*** (Boiss.) C.E. Hubbard var. ***persica***



Ir.-Tur. El.

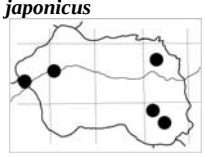
36. ***Bromus racemosus*** L.



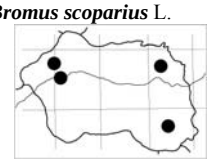
Euro.-Sib. El.

37. ***Bromus intermedius*** Guss.

38. ***Bromus japonicus*** Thunb. subsp ***japonicus***

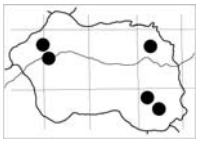


39. ***Bromus scoparius*** L.

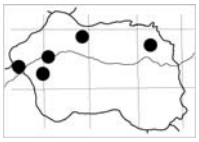


40. ***Bromus danthoniae*** Trin.

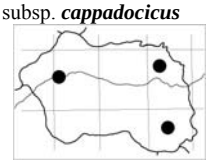
41. *Bromus tectorum* L.



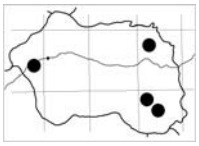
42. *Bromus sterilis* L.



43. *Bromus cappadocicus* Boiss. & Ball. subsp. ***cappadocicus***



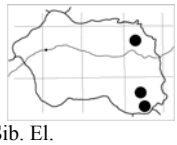
44. *Bromus tomentollus* Boiss.



Ir.-Tur. El.

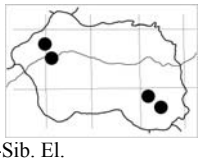
45. *Bromus benekenii* (Lange) Trimen

46. *Avena clauda* Durieu



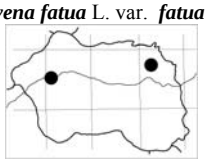
Euro.-Sib. El.

47. *Avena barbata* Pott ex Link subsp. ***barbata***



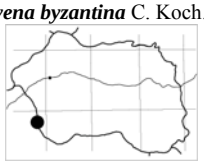
Euro.-Sib. El.

48. *Avena fatua* L. var. ***fatua***

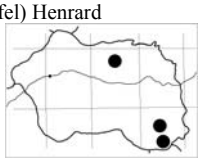


49. *Avena sativa* L.

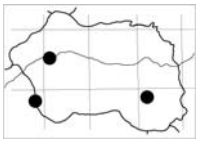
50. *Avena byzantina* C. Koch.



51. *Helicrotrichon compressum* (Heuffel) Henrard

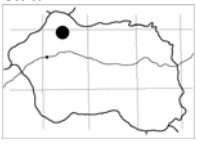


52. *Arrhenatherum elatius* (L.) P. Beauv. ex J. & C. Presl. subsp. ***elatius***



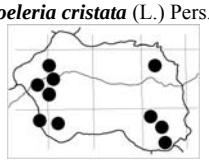
53. *Ventanata dubia* (Leers) Cosson

54. *Rostarira cristata* (L.) Tzvelev var. ***cristata***



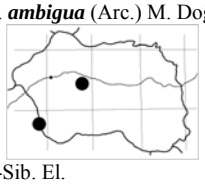
55. *Koeleria brevis* Steven

56. *Koeleria cristata* (L.) Pers.



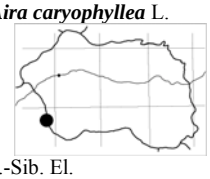
57. *Deschampsia caespitosa* (L.) P. Beauv.

58. *Aira elegantitissima* Schur subsp. ***ambigua*** (Arc.) M. Doğan



Euro.-Sib. El.

59. *Aira caryophyllea* L.



Euro.-Sib. El.

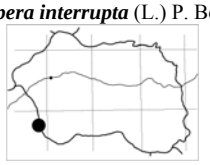
60. *Calamogrostis pseudophragmites* (Haller fil.) Koeler

Euro.-Sib. El.

61. *Apera spica-venti* (L.) P. Beauv.

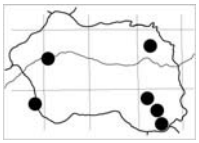
Euro.-Sib. El.

62. ***Apera interrupta*** (L.) P. Beauv.

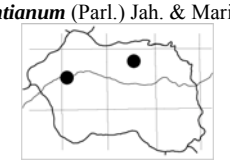


Euro.-Sib. El.

63. ***Polypogon mospeliensis*** (L.) Desf.

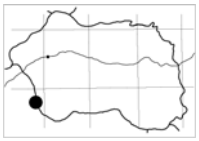


64. ***Milium vernale*** Bieb. subsp. ***montianum*** (Parl.) Jah. & Marie



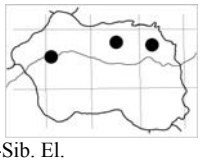
65. ***Zingeria pisidica*** (Boiss.) Tutin

66. ***Anthoxanthum odoratum*** L. subsp. ***alpinum*** (A.&D.Löve) B.Jones & Melderis



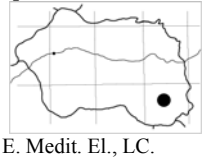
Euro.-Sib. El.

67. ***Alopecurus arundinaceus*** Poiret



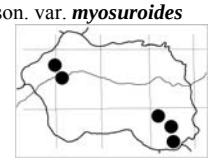
Euro.-Sib. El.

68. ***Alopecurus lanatus*** Sm.



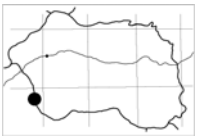
End., E. Medit. El., LC.

69. ***Alopecurus myosuroides*** Hudson. var. ***myosuroides***

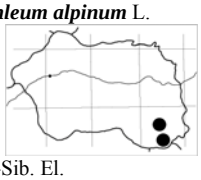


Euro.-Sib. El.

70. ***Beckmannia eruciformis*** (L.) Host.

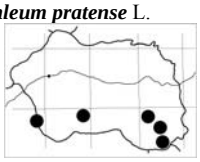


71. ***Phleum alpinum*** L.



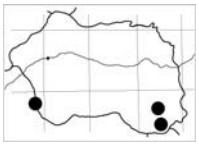
Euro.-Sib. El.

72. ***Phleum pratense*** L.

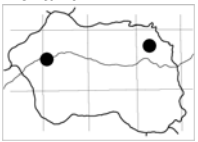


Euro.-Sib. El.

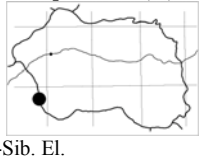
73. ***Phleum bertolonii*** DC.



74. ***Phleum montanum*** C. Koch. subsp. ***montanum***

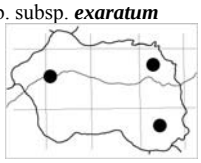


75. ***Phleum phleoides*** (L.) Karsten.

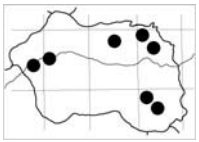


Euro.-Sib. El.

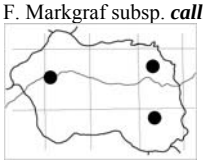
76. ***Phleum exaratum*** Hochst. ex Griseb. subsp. ***exaratum***



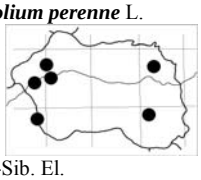
77. ***Festuca valesiaca*** Schleicher ex Gaudin



78. ***Festuca callieri*** (Hackel ex St-Yves) F. Markgraf subsp. ***callieri***



79. ***Lolium perenne*** L.

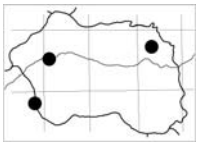


Euro.-Sib. El.

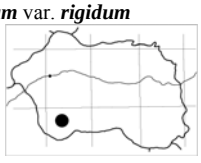
80. ***Lolium persicum*** Boiss. & Hohen

Ir.-Tur. El.

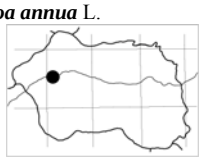
81. ***Lolium rigidum*** Gaudin var. ***rigidum***



82. ***Catapodium rigidum*** subsp. ***rigidum*** var. ***rigidum***

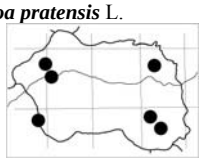


83. *Poa annua* L.

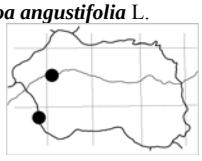


84. *Poa trivialis* L.

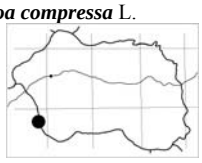
85. *Poa pratensis* L.



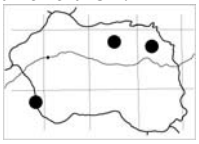
86. *Poa angustifolia* L.



87. *Poa compressa* L.



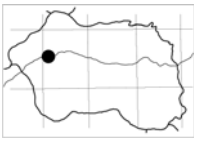
88. *Poa nemoralis* L.



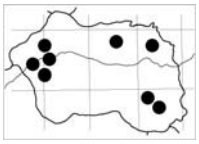
89. *Poa sterilis* Bieb.

90. *Poa alpina* L. subsp. ***fallax*** F. Hermann

91. *Poa timeolontis* Heldr. ex. Boiss.

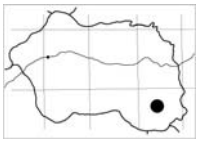


92. *Poa bulbosa* L.

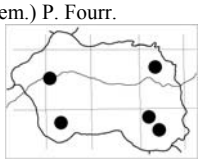


93. *Catabrosa aquatica* (L.) P. Beauv.

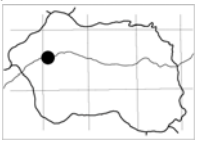
94. *Puccinella distans* (Jacq.) Parl. subsp. ***distans***



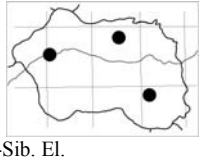
95. *Puccinella convoluta* (Hornem.) P. Fourr.



96. *Sclerochloa dura* (L.) P. Beauv.

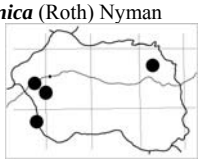


97. *Dactylis glomerata* L. sunsp. ***glomerata***

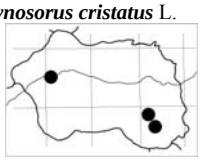


Euro.-Sib. El.

98. *Dactylis glomerata* L. sunsp. ***hispanica*** (Roth) Nyman

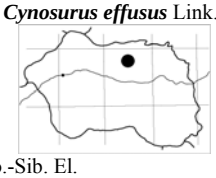


99. *Cynosorus cristatus* L.



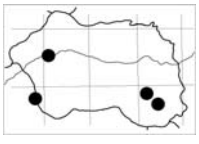
Euro.-Sib. El.

100. *Cynosurus effusus* Link.

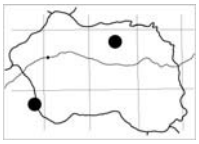


Euro.-Sib. El.

101. *Briza media* L.



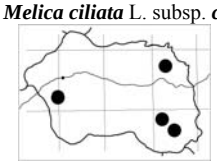
102. *Briza humulis* Bieb.



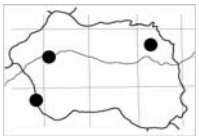
103. *Melica uniflora* Retz.

Euro.-Sib. El.

104. *Melica ciliata* L. subsp. ***ciliata***

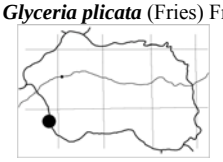


105. ***Melica persica*** Kunth subsp. ***jacquemontii*** (Decne. ex Jacquem.) P.H.Davis

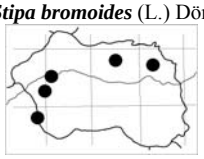


Ir.-Tur. El.

106. ***Glyceria plicata*** (Fries) Fries

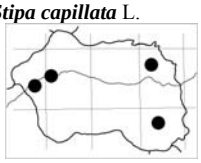


107. ***Stipa bromoides*** (L.) Dörfler



Euro.-Sib. El.

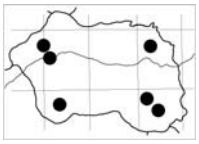
108. ***Stipa capillata*** L.



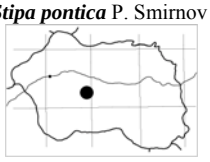
109. ***Stipa arabica*** Trin. & Rupr.

Ir.-Tur. El.

110. ***Stipa lessingiana*** Trin. & Rupr.

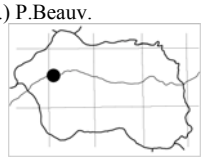


111. ***Stipa pontica*** P. Smirnov

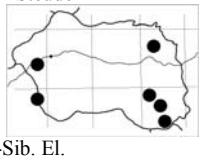


112. ***Stipa pulcherrima*** C. Koch. subsp. ***crassiculmis*** (P. Smirnov) Tzvelev

113. ***Piptatherum coerulescens*** (Desf.) P.Beauv.

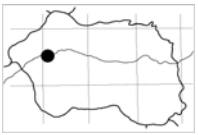


114. ***Phragmites australis*** (Cav.) Trin ex Steudel

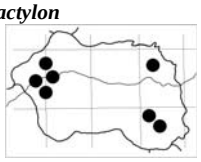


Euro.-Sib. El.

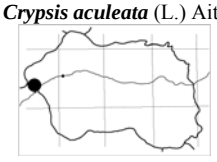
115. ***Aeluropus littoralis*** (Gouan) Parl.



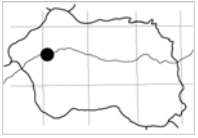
116. ***Cynodon dactylon*** (L.) Pers. var. ***dactylon***



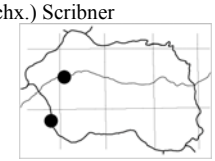
117. ***Crypsis aculeata*** (L.) Aiton



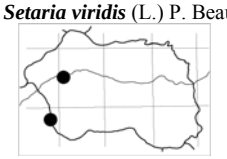
118. ***Echinochloa crus-galli*** (L.) P. Beauv.



119. ***Paspalum paspolodes*** (Michx.) Scribner



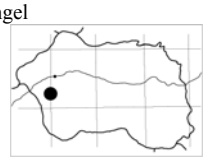
120. ***Setaria viridis*** (L.) P. Beauv.



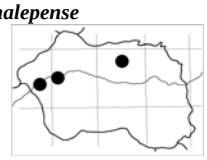
121. ***Pennisetum orientale*** L.C.M. Richard

Ir.-Tur. El.

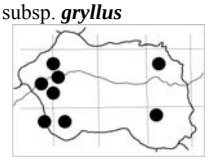
122. ***Saccharum strictum*** (Host.) Sprengel



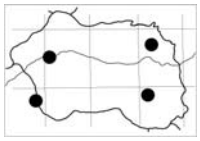
123. ***Sorghum halepense*** (L.) Pers. var. ***halepense***



124. ***Chrysopogon gryllus*** (L.) Trin. subsp. ***gryllus***



125. ***Botriochloa ischaemum*** (L.) Keng.



General vegetation structure: The province is between the West Anatolia forest region and Central Anatolia steps (Atalay, 1994). The dominant plant taxa in Dursunbey region on east, the part of the city located in west Anatolia, is *Pinus nigra* forests. The same plant cover cannot be seen on the plateaus of Kütahya, Afyonkarahisar and Eskişehir. In the mountainous areas among the plateaus, plant cover can be rich with increasing humidity (Türe, 2003). This restricted plant cover is completely disappeared in the border of Central Anatolia steppe. The part in the West Anatolia of the city is rich in terms of forests. The areas, taking more and periodic precipitation during the year are Bozdağ-Sündiken mountains and their extensions on the north and Türkmen mountains and their extensions on the west. In these areas, the forests has the needle leaved plants like *Pinus sylvestris* L.*, Pinus nigra* Arnold.*, Pinus brutia* Ten. and *Juniperus* sp. The needle leaved forests are surrounded by forests consisting of *Quercus* sp., and other decidous plants (Çetik, 1985).

Most of the upper Sakarya river basin, locating on the south of Eskişehir, is in the Central Anatolia steppe region. In this region, precipitations are low and non-periodic. Forests in the border of Sakarya river basin is damaged because of being destroyed. Foots of the river basins are changed to steppy areas because of hard grazing. Dominant plant taxa of steppe are *Astragalus* sp., *Capsella* sp., *Peganum* sp., and *Cirsium* sp., (Atalay, 1994; Akman, 1993; Akman, 1995).

The present reports gives an account on the diversity distribution and conservation of *Poaceae* species growing naturally in Eskisehir province in Central Anatolia, Turkey.

Material and Methods

The materials of the present study are the plant taxa belonging to *Poaceae* collected during the field studies carried out during the vegetation periods in different years and other studies carried out in the region until now (Davis, 1985; Davis, 1988; Ekim, 1977; Ekim, 1978; Ekim & Akman, 1991; Türe *et al*., 1999; Türe, 2000a; Türe *et al*., 1996; Erdir & Türe, 2003; Ocak & Türe, 2001; Türe & Köse, 2000; Türe & Böcük, 2001; Böcük, 2002; Uryan, 2000; Türe & Bell, 2004).

The herbaria of Middle East Technical University, Ankara University and Gazi University were used for checking and identification of the plant materials. The flora of Turkey and other resources were used for identification (Davis, 1985, Güner *et al*., 2000; Heywood, 1963-1980; Doğan, 1991; Doğan, 1999). The *Poaceae* species were either identified or checked by Prof. Dr. Musa Dogan from the Middle East Technical University. The author names of the plants were checked according to Brummitt & Powell (1992). Except the plant scientific names phylogenetically, phytogeographic areas, endemism and risk categories were also given under the coordinated distribution map in the plant list. Besides, the distribution of the plant taxa determined in the area are shown on a map. Abbreviations were used to indicate the phytogeographic regions of taxa if known, Irano-Turanian as Ir.-Tur., Euro-Siberian as Euro.-Sib., Mediterranean as Medit., East Mediterranean as E. Medit., endemic as End. And risk categories if known, *Vulnerable* as VU, *Data Deficient* as DD, *Least concern* as LC (Anon., 2001b; Ekim *et al*., 2000).

Results and Discussion

Most of the plant taxa in the study area between the Anatolia forest region and Central Anatolia steppies are composed by the plant taxa belonging to *Poaceae* (Çetik, 1985; Atalay, 1994). So, it is therefore important to know the *Poaceae* diversity when the general plant diversity and ecological structure of the area is determined.

Over 130 *Poaceae* genera in Turkey are available and 634 *Poaceae* taxa are distributed in Turkey (Davis, 1985; Davis *et al*., 1988; Güner *et al*., 2000; Seçmen et al., 1986). Eleven genera and 29 species are cultivated (Arabacı & Yıldız, 2004).

In Eskişehir province and its environs, 57 *Poaceae* genera were determined when the genera revisions related to *Poaceae* in the Flora of Turkey were considered (Table 4) (Davis 1985). These data show that Eskişehir region has 42.5% of all *Poaceae* genera in Turkey. This ratio is quite important if the borders of the study area are considered.

At the end of the studies, 125 plant taxa were determined in the study area. According to these data, 19.7% of *Poaceae* taxa in Turkey distributed in Eskişehir province.

The phytogeographical distribution of the plant taxa determined in the study area are given in Table 5. It can be seen that Euro-Siberian Elements have the most number of plant taxa in the study area and it is followed by Irano-Turanian and Mediterranean Elements, respectively. Although the study area is in the Irano-Turanian phytogeographic region, it is really remarkable that Euro-Siberian elements have the greater number of plant taxa.

Nearly 14% of Poaceae species and 30% of total plant taxa are also endemic for Turkey (Davis, 1985). *Poaceae* family thus contributes about 2% to the endemism ratio of Turkey. When the relationship between the endemism ratio and phytogeographical region in Turkey is checked, it can be seen that Irano-Turanian phtogeographic region have the most number of plant taxa. And it is followed by Mediterranean and Euro-Siberian Elements, respectively. This situation can be explained by the change during the geological ages and topographic structure of the country (Seçmen, 1986; Türe, 2000b; Türker & Güner, 2003; Türe *et al*., 2004). Four (3.2%) endemic Poaceae taxa were determined for Eskişehir region. Although the study area is in the Irano-Turanian phtogeographical region, the number of endemic plant taxa are quite low. It is thought that low endemism ratio of *Poaceae* taxa in the study area is because of the contribution of Euro-Siberian elements to the flora (Seçmen, 1986; Türe & Tokur, 2000).

Risk categories of the determined plant taxa were considered in plant list (Table 6) according to Red Data Book of Turkish plants (Anon., 2001b**;** Ekim *et al*., 2000). It is determined that 3 plant taxa were in LC (*least concern*), 1 was in VU (*vulnerable*) and 1 in DD (*data deficient*) risk categories. Monitoring of these taxa are quite important for preserving the biological diversity. Currently, a lot of plant taxa become extinct and lost their distributing areas because of both antropogenic and natural causes (Çepel, 1997; Stohlgren *et al*., 2000; Stohlgren *et al*., 1997, Türkmen *et al*., 2004). About 28% of Turkey's total area is covered by steppe ecosystems. But some of these steppe ecosystems is changed into agricultural areas, the rest (about 90% of total steppe ecosystems) is getting destroyed and barren as a result of overgrazing (Anon., 2001a).

To prevent this situation and reacquire the biological sources, it must be secured that land owners in the area should be in rehabilitation projects related to conservation from planning stage to application. Advanced rehabilitation-restoration studies and new conservation strategies is needed to be developed by considering potential effects on ecosystems and species under the light of scientific researches.

The plant taxa distributed naturally in the study area are shown on a coordinated map with the information related to phytogeographical characteristics, endemism and risc categories to know the distributing localities and monitor the taxa easily.

Table 4. Species' totals and percentages of the larger genera in the study area.

Genus	Number	%
Bromus	10	8
Poa	9	7,2
Aegilops	8	6,4
Hordeum	6	4,8
Phleum	6	4,8
Stipa	6	4,8
Avena	5	4
Alopecurus	3	2,4
Elymus	3	2,4
Eremopyrum	3	2,4
Lolium	3	2,4
Melica	3	2,4
Secale	3	2,4

Table 5. The phytogeographical distribution and endemism of the plant taxa determined in the study area.

	Number	%
Euro-Siberian	20	16
Irano-Turanian	12	9,6
Mediterranean	6	4,8
East Mediterranean	3	2,4
Endemic	4	3,2

Table 6. The risk categories of the plant taxa.

Plant taxa	Risk Category
Aegilops peregrina (Hackel) Maire & Weiller	DD
Alopecurus lanatus Sm.	LC
Amblyopyrum muticum (Boiss.) Eig var. *loliaceum* (Jaub. & Spach) Eig	LC
Elymus lazicus (Boiss. & Bal.) Melderis subsp. *divaricatus* (Boiss. & Bal.) Melderis	LC
Secale cereale L. var. *ancestrale* (Zhuk.) Kit Tan	VU

In this study *Poaceae* diversity and distribution which should be known because of their economic and ecological values in Eskişehir province were determined. Monitoring opportunity of the species with the help of the coordinated maps will be able to help to know the biological diversity and preserve the gene sources.

Acknowledgement

We want to thank to Prof. Dr Musa Doğan of the Middle East Technical University, Ankara, Turkey for his encouragement and support.

References

Akman, Y. 1990. *İklim ve Biyoiklim*, Palme Yayınları, No: 103, Ankara.
Akman, Y. 1993. *Biyocoğrafya*, Palme Yayınları, Ankara.
Akman, Y. 1995. *Türkiye Orman Vejetasyonu*, Ankara Üniv. Fen Fak. Botanik Anabilim Dalı, Ankara.
Anonymous. 1972. *Genetic Vulnerability of Major Crops*, National Academy of Science, Washington D.C., p 307.
Anonymous. 1981-1984. *Yurt Ansiklopedisi*, Anadolu Yayıncılık, 2814-2825, İstanbul.
Anonymous. 1984. *Eskişehir ili verimlilik envanteri ve gübre ihtiyaç raporu*, TOVEP yayın., No: 22, Genel yayın no: 754, Ankara.
Anonymous. 2000. Eskişehir Meteoroloji Bölge Müdürlüğü Verileri, Eskişehir.
Anonymous. 2001a. *Türkiye Ulusal Biyolojik Çeşitlilik Stratejisi Eylem Planı* (Turkish National Biological Diersity Application Plan).
Anonymous. 2001b. Species Survival Commission. *IUCN Red List Categories, approved by the 51st meeting of the IUCN Council*. Gland, Switzerland.
Anonymous. 2002. *Hasad*, 18, No 207.
Arabacı, T. and B. Yıldız. 2004. A floristical study on *Poaceae* spp., growing naturally in Malatya Province, *Turk. J. Bot*., 28: 361-368.
Atalay, İ. 1994. *Türkiye Vejetasyon Coğrafyası*, Dokuz Eylül Üniversitesi, Buca Eğitim Fak., İzmir.
Böcük, H. 2002. *Sivrihisar Dağları'nın (Eskişehir) Ekolojik ve Floristik Yönden İncelenmesi*, Anadolu Üniv., Fen Bilimleri Enst., Yüksek Lisans Tezi, Eskişehir.
Brummitt, R.K. and C.E. Powell. 1992. *Authors of Plant Names*, Royal Botanic Gardens, Kew.
Çepel, N. 1997. *Biyoçeşitlilik Önemi ve Korunması*, TEMA Vakfı Yayınları, No: 15, İstanbul.
Çetik, R. 1985. *Türkiye Vejetasyonu-I: İç Anadolu'nun Vejetasyonu ve Ekolojisi*, Selçuk Üniv. Yay No: 7, Fen-Edeb. Fak. Yay. 1, Konya.
Charles, M.P. 1984. Introductory Remarks on the Cereals. *Bulletin on Sumerian Agriculture*, I: 17-31.
Clayton, W.D. and S.A. Renvoize. 1986. *Genera Graminum. Grasses of the World.* Kew Bull. Add. Series XII. (H.M. Stationery Office: London).
Davis, P.H. 1985. *Flora of Turkey and the East Aegean Islands*, Vol. 9, Edinburgh Univ. Press., Edinburgh.
Davis, P.H. 1988. *Flora of Turkey and the East Aegean Islands*, Vol. 10, Edinburgh Univ. Press., Edinburgh.
Doğan, M. 1991. Taxonomic significance of vegetative and Flora l morphologies in the genus *Alopecurus* L. (Gramineae). *Turk. J. Bot*., 15: 124-132.
Doğan, M. 1999. A concise taxonomic revision of the genus *Alopecurus* L. (Gramineae). *Turk. J. Bot*., 23: 245-262.
Ebrahimzadeh, H., F. Meighany and H. Rahimian. 2000. *Role of mineral ions in salt tolerance of two wheat (Triticum aestivum L.) cultivars*, Vol. 32(2).
Ekim, T. 1977. *Eskişehir İli Sündiken Dağları Vejetasyonunun Sosyolojik ve Ekolojik Yönden Araştırılması*, Doçentlik Tezi, Ankara.
Ekim, T. 1978. *Orta Anadolu (Eskişehir) Türkmen Dağı'ının Floristik Çalışması*, TBAG-258, Ankara.
Ekim, T. and Y. Akman. 1991. Eskişehir İli Sündiken Dağlarındaki Orman Vejetasyonunun Bitki Sosyolojisi Bakımından Araştırılması. *Doğa. Türk. Bot. Derg*., 15: 28-40.
Ekim, T., M. Koyuncu, M. Vural, H. Duman, Z. Aytaç and N. Adıgüzel. 2000. Türkiye Bitkileri Kırmızı Kitabı (Eğrelti ve Tohumlu Bitkiler). *Red Data Book of Turkish Plants (Pteridophyta and Spermatophyta-updated version)*, Türkiye Tabiatını Koruma Derneği-Van Yüzüncü Yıl Ünv. Yayınları, Ankara.

Erdir, M. and C. Türe. 2003. Plant diversity and general ecological characteristics of protected area of Musaözü Dam and its environment (Eskişehir, Turkey) Anadolu Üniv. *Journal of Science and Technology*, 4(2): 301-322.

Farooq, S., M. Asgbar, E. Askari and T.M. Shah. 1994. Production and evaluation of salt tolerant wheat germplasm derived through crosses between wheat (*Triticum aestivum* L.) and *Aegilops cylindrica*. I. Production of salt tolerant wheat germplasm, *Pak. J. Bot*., 26(2): 283-292.

Ghazanfar, S.A. 1998. Status of the Flora and Plant Conservation in the Sultanate of Oman. *Biological Conservation*, 85: 287-295.

Güner, A., N. Özhatay, T. Ekim and K.H.C. Başer. 2000. *Flora of Turkey and the East Aegean Islands (supplement),* vol. 11., Edinburgh Univ Press.

Harlon, J.R. and D. Zohary. 1966. Distribution of Cuild Coheats and Barley. *Science*, 153: 1074-80.

Heywood, V. H. and G.T. Tutin. 1963-1980. *Flora Europea*, Vol I-V, Cambridge.

Hubbard, G.E. 1948. *The Genera of British Grasses. In: Hutchingon, J. British Flowering Plants*, P.R. Gawthorn Ltd., London.

Mennan, H., M. Bozoğlu and D. Işık. 2003. Economic thresholds of *Avena* spp., and *Alopecurus myosuroides* in winter wheat fields. *Pak. J. Bot*., 35(2): 147-154.

Mishra, C. and G.S. Rawat. 1998. Livestock Grazing and Biodiversity Conservation: Comments on Saberwal. *Conservation Biology*, 12(3): 712-714.

Ocak, A. and C. Türe. 2002. The flora of the Meşelik campus of the Osmangazi University (Eskişehir-Turkey). *The Herb of Journal of Systematic Botany*, 8(2): 19-46.

Ojeda, F., T. Maranon and J. Arroyo. 2000. Plant diversity patterns in the Aljibe mountains (S.Spain): a comprehensive account. *Biodiversity and Conservation*, 9: 1323-1343.

Olson, R.A., K.J. Frey and R. Wheat. 1987. Nutritional qality of cereal grains: Genetic and Agronomic Improvement. *Agronomy*, Wisconsin, USA, pp. 133-182.

Parlevliet, J.E. 1981. Disease resistance in plants and it consequences for plant breeding. *Plant Breeding* II, (Ed.): K.J. Frey. The Lowa State Uni. Press., pp 309-347.

Reitz, L.P. 1976. Improving germplasm resources, agronomic research for food, ASA. Special Publication Number 26 (Ed.): F.L. Patterson. American Society of Agronomy, Wisconsin, USA, p 85-97.

Seçmen, Ö., Y. Gemici, E. Leblebici, G. Görk and L. Nekat. 1986. *Tohumlu Bitkiler Sistematiği*, Ege Üniv., Fen Fak., Kitaplar serisi No: 116, Bornova, İzmir.

Stohlgren, T.J., A.J. Owen and M. Lee. 2000. Monitoring shifts in plant diversity in response to climate change: a method for landscapes. *Biodiversity and Conservation*, 9(1): 65-86.

Stohlgren, T.J., G.W. Chong and M.A. Kalkhan. 1997. Rapid assessment of plant diversity patterns: a methodology for landscapes. *Environmental Monitoring and Assessment*, 48(1): 25-43.

Türe, C. 2000a. Floristic and Ecological Characters of Arayıt Mountain and Its Environs (Central Anatolia, Eskişehir-Turkey). *The Scientific and Pedagogical News of Odlar Yourdu University*, 4: 108-132, Baku.

Türe, C. 2000b. A description of the vegetation mosaic of the forests of yirce and muratdere (Bilecik-Bursa, Turkey) by satellite remote sensing. *Turkish Journal of Botany, Tübitak*, 25: 131-136.

Türe, C. 2003. *General Information about the Flora and Vegetation*, Our city Eskişehir, (Ed.): Melih Erdoğan, Eskişehir Chamber and Commerce Publication, No: 16, pp 58-64, Eskişehir.

Türe, C. and H. Böcük. 2001. The Flora of the Anadolu University Campus (Eskişehir-Turkey) Anadolu Univ. *Journal of Science and Technology*, 2(1): 83-95.

Türe, C. and R.W. Bell. 2004. Plant Distribution and its Relationship to Extractable Boron in Naturally-Occuring High Boron Soils Turkey. *Israel Journal of Plant Science*, (52): 125-132.

Türe, C. and S. Tokur. 2000. The Flora of the Forest Seriesof Yirce-Bürmece-Kömürsu and Muratdere (Bilecik-Bursa, Turkey). *Turkish Journal of Botany, Tübitak*, 24: 47-66.

Türe, C. and Y.B. Köse. 2000. Eskişehir ve Çevresindeki Bazı Tarım Alanlarında Yayılış Gösteren Yabancı Ot Florası Üzerinde Bir Araştırma. *Turkish Journal of Agriculture and Forestry, Tübitak*, 24: 327-331.

Türe, C., A. Ocak and H. Mısırdalı. 1996. *Balıkdamı'nın (Gökada) Florası*, Anadolu Üniv. Fen Fakültesi Dergisi, 2: 55-69.

Türe, C., A. Ocak and N.A. Bingöl. 1999. Gramineae of Eskişehir City Center and its vicinity. *1st International Symposium on Protection of Natural Environment and Ehrami Karaçam, 88-89, Kütahya, Turkey*.

Türe, C., N. Bingol Akanıl and B. Middleton. 2004. Characterization of the habitat of *Lythrum salicaria* L., in Floodplain Forests in Western Turkey – Effects on the Stem Height and Seed Production. *Wetlands*, 24(3): 711-716.

Türker, A.U. and A. Güner. 2003. Plant Diversity in Abant Nature Park (Bolu), Turkey. *Turk. J. Bot*., 27 (2003) 185-221, Tübitak, Ankara.

Türkmen, N., M. Aslan and A. Düzenli. 2004. Floristic Characteristics of the Karkami Dam Reservoir Area and its Surroundings (Gaziantep-Şanlıurfa: Turkey). *Biodiversity and Conservation* (in press).

Uryan, B. 2000. *Mihalıççık İlçesi'nin (Eskişehir) Florası*, Anadolu Üniv., Fen Bilimleri Enst., Yüksek Lisans Tezi, Eskişehir.

Vavilov, N.I. 1951. The origin, variation, immunity and breeding of cultivated plants. *The Chronica Botanica, Cambridge*, UK, pp. 293-350.

Victor, J.E. and A.P. Dold. 2003. Threatened Plants of the Albany Centre of Floristic Endemism, South Africa. *South African Journal of Science*, 99: 437-446.

WynJones, R.G., J. Gorham and E. McDonnell. 1984. Organic and inorganic solute contents as selection criteria for salt tolerance in the Tricaceae. In: *Salinity Tolerance in Plants, Strategies for Crop Improvement*. (Ed.): R.C. Staples, G.H. Toennissen, John Wiley and Sons, New York, pp 189-203.

Zitelli, G. 1974. Methods and Results of Breeding Durum Wheat for General and Specific Resistance to Rusts and Other Diseases. *Proceeding of 4th FAO Rockefeller Foundation Wheat Seminar, FAO, Rome*.

(Received for publication 15 May 2005