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Research article/Araştırma makalesi

Urban vascular flora and ecological characteristics of Mamak District (Ankara/Turkey)

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Abstract

In this research, the urban flora of Mamak district in Ankara was studied and the negative consequences of unplanned urbanization ignoring ecological conditions were analysed in the context of urban ecology. For inventorying the species, primarily, plant specimens were collected from green areas such as parks, gardens, etc. within the district in vegetation periods. Then, the specimens were preserved in GAZI Herbarium. In this study, totally 233 plant taxa were determined; 118 of them were indigenous and 115 taxa were exotic and cultivated. Besides, archaeophyte and neophyte, endemic, urbanophile-urbanoneutral-urbanophobe taxa, and hemeroby scale of the study area were mentioned. In addition, the precautions to be taken against the negative consequences of unplanned urbanization were also emphasized in this paper. Finally, the importance of urban ecological and floristic studies for Mamak district in Ankara were presented with this study.

Key words: Ankara, Mamak, urban ecology, urban ecosystem, urban flora

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Mamak İlçesinin (Ankara/ Türkiye) kentsel vasküler florası ve ekolojik özellikleri

Özet

Bu araştırmada, Mamak ilçesinin kentsel florası araştırılmış ve ekolojik koşullar göz ardı edilerek gerçekleştirilen plansız kentleşmenin olumsuz sonuçları kentsel ekoloji bağlamında analiz edilmiştir. Türlerin envanteri çıkarılırken öncelikle, vejetasyon döneminde ilçedeki park, bahçe vb. yeşil alanlardan bitki örnekleri toplanmıştır. Toplanan örnekler, GAZI herbaryumunda muhafaza edilmektedir. Çalışmada toplam 233 takson tespit edilmiştir; bunlardan 118'i doğal, 115'i ise egzotik ve kültürdür. Bununla beraber, arkeofit ve neofit, endemik, urbanofil ve urbanofob bitkiler ile çalışma alanın hemerobi basamaklarından bahsedilmiştir. Bu çalışmada ayrıca plansız kentleşmenin olumsuz sonuçlarına karşı alınması gereken önlemler üzerinde de durulmuştur. Son olarak, bu çalışmayla Ankara'nın Mamak ilçesi için kent ekolojisi ve florası çalışmalarının önemi ortaya konulmuştur.

Anahtar kelimeler: Ankara, Mamak, kentsel ekoloji, kent ekosistemi, şehir florası

1. Introduction

Cities are the most important naturally and/or anthropogenically influenced ecosystems in which millions of people live (Antipina, 2003). Urban ecosystems and the composition of urban flora and fauna are greatly dependent on human activities (Sukopp, 2004) and human impact has been the most important influence especially on the composition of the flora and vegetation for about the last 50 centuries (Shaltout and El-Sheikh, 2002; Wheater, 2002). Because of human impacts, species are estimated to go extinct all around the world at a rate of 0.5% per year due to habitat loss and fragmentation (Van der Veken et al., 2004). Flora and vegetation are very important components and elements of urban ecosystems. The urban flora, basically, consists of plants that naturally grow there (Antipina, 2003).

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Species occur in urban areas which are directly linked to the ecological structure, city planning strategies, politics, topography, economic and cultural life of cities (Maurer et al., 2000).

There are many studies on urban flora in the world. Studies in cities of Mumbai/India (Graham, 1839), Los Angeles/United States (Abrams, 1917), Buenos Aires/Argentina (Guaglianone, 1980), London/England (Burton, 1983), Mexico City/Mexico (Rapoport et al., 1983), Plzen/Czech Republic (Pyšek and Pyšek, 1988), Berlin/Germany (Böcker et al., 1991), Beijing/China (He, 1992), Melbourne/Australia (Jones and Jones, 1999), Sousse/Tunisia (Brandes, 2001) are main urban floristic researches in the world. On the other hand, studies on urban flora in Turkey are fairly limited. Studies in cities of Antalya (Göktürk and Sümbül, 1997), Ankara (Akaydın and Erik, 2002), Bursa (Daşkın and Kaynak, 2006), Muğla (Kaya et al., 2008), Adana (Karakuş and Türkmen, 2011), İstanbul (Altay et al., 2012), Denizli (Gürcan and Düşen, 2015) and studies in districts of Kadıköy (Osma et al., 2010), Kartal (Altay et al., 2010), Beykoz (Tarakçı et al., 2012), Pendik (Eskin et al., 2012) are urban floristic researches in Turkey.

Mamak is one of the extremely active districts of Ankara, where urbanization is constantly growing and unplanned slum areas emerge. As a result, there are old settlements that have suffered a lot of destruction in the district. The reason of choosing this area is to reveal the negative effects and pressures of urbanization on nature and the environment. This study aims to reveal the negative consequences of unplanned urbanization and industrialization ignoring ecological conditions and the precautions to be taken in this context.

In this study, the urban flora and ecological characteristics of Mamak district was presented. Moreover, indigenous and exotic-cultivated plants that exist in urban habitats were mentioned.

2. Materials and methods

The Mamak district is located at the eastern part of Ankara, which is the capital city of Turkey (32°55'23" E and 39°56'31" N). Neighboring districts are Elmadağ (in the east), Altındağ (in the north-northwest), Çankaya (in the south-southwest-west) (Figure 1). Total land area is 342 km^2 which also covers some rural areas (Governorship of Ankara, 2016).

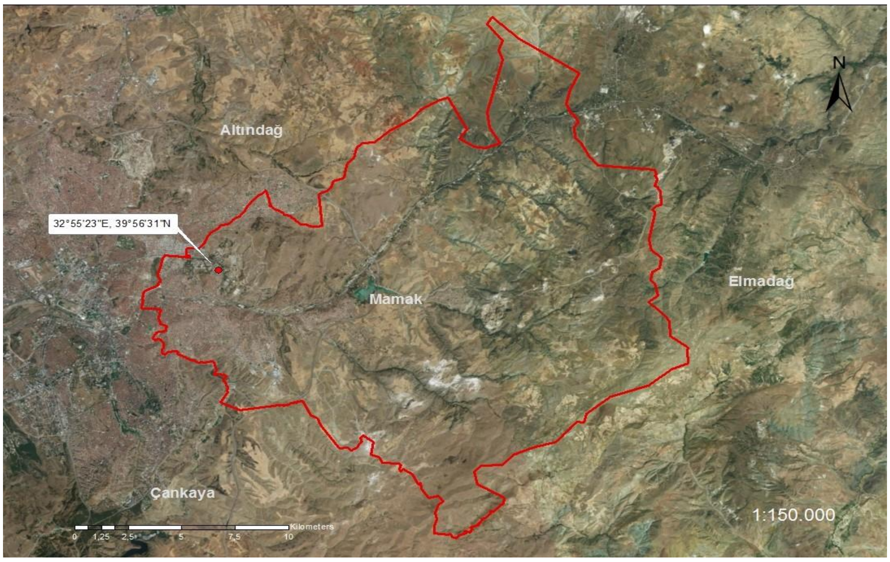

Figure 1. The satellite view of Mamak district (Google Earth Pro, 2016)

The basement rocks in the Mamak district consist of impermeable rocks of Emir Formation of Triassic age. It is unconformably overlain by semipermeable units of Keçikaya, Ortaköy and Elmadağ Formations which are also of Triassic in age. Besides, Gölbaşı Formation of Late Pliocene is unconformably overlies the formations beneath and of permeable character. The uppermost part of the stratigraphic column consists of permeable units of talus and alluvium (Çelik et al., 2007). Elmadağ Formation consists of limestone, metasandstone, agglomerate, calcarenite, metaconglomerate, sandstone and sandy limestone. Ortaköy Formation comprises agglomerate, calcarenite, tuff, splite and diabasis. Keçikaya Formation consists of only limestone and finally, Gölbaşı Formation is composed of mudstone, conglomerate and sandstone (Akyürek et al., 1997).

In the district, a total area of 34245.6 hectares, 7 soil types were determined. Soil types were identified in the district respectively are as follows; brown soils (20375.6 ha, 59.5%), brown forest soils without lime (2473.39 ha, 7.22%), brown soils without lime (2296.01 ha, 6.70%), reddish brown soils (2094.64 ha, 6.12%), brown forest soils (808.628 ha, 2.36%), alluvial soils (356.757 ha, 1.04%), colluvial soils (261.891 ha, 0.76%). Mamak's 5578.71 hectares (16.29%) is covered with other land types and settlements (Ministry of Food, Agriculture and Livestock, 2015).

Mediterranean Region's continental climate is dominant in the study area. Climate data were taken from the Ankara Meteorological Station. January is the coldest month (mean low –1.9°C) while July is the warmest month (mean high 31.4°C). Annual precipitation is about 425.7 mm per year; the most precipitation occurs in spring. For the period of 1996 - 2015 (20 years), the mean annual temperature is 12.8°C and the mean annual precipitation is 35.5 mm. Extreme winter cold (< 0°C) is usual and the late frost danger is generally present in the area. In relation to the Mediterranean bioclimatic divisions, the area adjacent to the slightly humid zone with semi-arid cold winter (Turkish State Meteorological Service, 2016).

Green areas in the Mamak district can be classified in 5 groups based on their functions; (1) parks, gardens and playgrounds, (2) meadows, tree nurseries and forests, (3) visual green spaces, medians and squares, (4) cemeteries, (5) public buildings with green spaces. The changes in green space per capita of Mamak district between 2011 - 2015 years are as follows; 7.28 m^2 (in 2011), 7.51 m^2 (in 2012), 8.18 m^2 (in 2013), 8.43 m^2 (in 2014), 8.68 m^2 (in 2015) (Mamak Municipality, 2016).

The plant specimens were gathered from green areas (parks, gardens, etc.) and other urban habitats. The inventory of the flora was conducted in the vegetation period of 2012 - 2017. Specimens were dried according to herbarium methods and were identified by using "*Flora of Turkey and the East Aegean Islands*" (Davis, 1965 – 1985; Davis et al., 1988; Güner et al., 2000) and "Manual of Cultivated Plants" (Bailey, 1949). The specimens were preserved in GAZI Herbarium (GAZI). The identified taxa were first classified as Gymnosperm and Angiosperm. The taxa beneath them were arranged in alphabetical order respectively; family, genus, species, subspecies and varieties. For such information like current names and authors of taxa and their phytogeographical region, "*Türkiye Bitkileri Listesi (Damarlı Bitkiler) [Turkish Plant List (Vascular Plants)]" (*Güner et al., 2012) and "www.theplantlist.org" (The Plant List, 2017) were used. Life forms of taxa (phanerophytes, chaemaphytes, hemicryptophytes, therophytes, geophytes and helophytes) were determined based on Raunkier system (Akman and Ketenoğlu, 1987). The categories and criteria of the rare and endangered species were assessed and determined according to "IUCN 2017-1" (The IUCN Red List of Threatened Species, 2017). Life cycles of taxa (annual, biennial, perennial) were also determined according to "*Flora of Turkey and the East Aegean Islands"* (Davis, 1965 – 1985; Davis et al., 1988; Güner et al., 2000) and "Manual of Cultivated Plants" (Bailey, 1949). Archaeophyte and neophyte plants were also emphasized in this research. Besides that, urbanophile, urbanoneutral and urbanophobe plants for 118 native taxa were determined and presented according to Wittig et al. (1985). Finally, study area was also determined according to hemeroby scale of Sukopp and Weiller (1988).

Abbreviations

VU: Vulnerable, NT: Near Threatened, Ch: Chamaephyte, G: Geophyte, He: Helophyte, H: Hemicryptophyte, Ph: Phanerophyte, Th: Therophyte, C-W: Cosmopolitan or Widespread, E-S: Euro-Siberian element, I-T: Irano-Turanian element, M: Mediterranean element, A: Annual, B: Biennial, P: Perennial, Arc: Archaeophyte, Neo: Neophyte, *: Urbanophobe, **: Urbanoneutral.

3. Results

List of Native Plants
Angiospermae
Amaranthaceae
Amaranthus retroflexus L., C-W, Th, A, Neo, *
Chenopodium album L. subsp. *album* var. *album*, C-W, Th, A, Arc, *
Amaryllidaceae
Allium sp., C-W, G, P, **
Apiaceae
Bifora radians M.Bieb., C-W, Th, A, **
Caucalis platycarpos L., C-W, Th, A, *
Torilis arvensis subsp. *neglecta* (Spreng.) Thell., C-W, Th, A, *
Apocynaceae
Cynanchum acutum L. subsp. *acutum*, C-W, H, P, *
Araliaceae
Hedera helix L., C-W, Ph, P, *
Asparagaceae
Hyacinthella micrantha (Boiss.) Chouard, Endemic, VU, C-W, G, P, **
Muscari neglectum Guss. ex Ten., C-W, G, P, *
Asteraceae
Carduus nutans L. subsp. *nutans*, C-W, H, B, *
C. pycnocephalus subsp. *albidus* (M.Bieb.) Kazmi, C-W, Th, A, **
Centaurea iberica Trev. ex Sprengel, C-W, Th, A-B, *
C. solstitialis L. subsp. *solstitialis*, C-W, Th, A, *
C. urvillei subsp. *steppos*a Wagenitz, C-W, H, P, *
C. virgata Lam., I-T, H, P, *
Cichorium intybus L., C-W, H, P, Arc, *
Cirsium arvense (L.) Scop., C-W, H, P, Arc, *
C. vulgare (Savi) Ten., C-W, H, B, *
Conyza canadensis (L.) Cronquist, C-W, Th, A, Neo, *
Cota austriaca (Jacq.) Sch.Bip., C-W, Th, A, **
Crepis alpina L., C-W, Th, A, **
C. foetida subsp. *rhoeadifolia* (M.Bieb.) Čelak., C-W, Th, A, Neo, *
Crupina crupinastrum (Moris) Vis., C-W, Th, A, *
Cyanus depressus (M.Bieb.) Soják, C-W, Th, A, **
Echinops pungens Trautv. var. *pungens*, I-T, H, P, **
Lactuca serriola L., C-W, H, B, Arc, *
Onopordum tauricum Willd., E-S, H, B, *
Senecio vernalis Waldst. & Kit., C-W, Th, A, **
S. vulgaris L., C-W, Th, A, Arc, *
Sonchus asper subsp. *glaucescens* (Jord.) Ball, C-W, Th, A-B, *
Tragopogon dubius Scop., C-W, H, B, *
Tripleurospermum oreades (Boiss.) Rech.f. var. *oreades*, C-W, H, P, *
T. parviflorum (Willd.) Pobed., C-W, Th, A, *
Xeranthemum annuum L., C-W, Th, A, *
Boraginaceae
Alkanna orientalis (L.) Boiss. var. *orientalis*, I-T, H, P, *
Anchusa azurea Mill. var. *azurea*, C-W, H, P, *
A. hybrida Ten., M, H, B-P, *

A. leptophylla Roem. & Schult. subsp. *leptophylla*, C-W, H, B-P, **
A. pusilla Guşul., C-W, Th, A, **
Echium italicum L., M, H, B, *
Heliotropium europaeum L., I-T, Th, A, *
Brassicaceae
Alyssum desertorum Stapf., C-W, Th, A, *
Brassica elongata Ehrh., C-W, H, B-P, *
Calepina irregularis (Asso) Thell., C-W, Th, A, *
Capsella bursa-pastoris (L.) Medik., C-W, H, B, Arc, *
Descurainia sophia (L.) Webb ex Prantl, C-W, Th, A-B, *
Diplotaxis tenuifolia (L.) DC., C-W, H, P, Neo, **
Eruca vesicaria (L.) Cav., C-W, Th, A, *
Lepidium draba L., C-W, H, P, Neo, *
L. latifolium L., C-W, H, P, *
L. perfoliatum L., C-W, Th, A-B, *
Microthlaspi perfoliatum (L.) F.K.Mey., C-W, Th, A, **
Sinapis arvensis L., C-W, Th, A, Arc, **
Sisymbrium altissimum L., C-W, Th, A-B, *
S. loeselii L., C-W, Th-H, A-B-P, Neo, *
Caprifoliaceae
Scabiosa rotata M.Bieb., I-T, Th, A, *
Caryophyllaceae
Silene conoidea L., C-W, Th, A, *
Stellaria media (L.) Vill., C-W, Th, A, Arc, *
S. pallida (Dumort.) Piré, C-W, Th, A, *
Colchicaceae
Colchicum triphyllum Kunze, M, G, P, **
Convolvulaceae
Convolvulus arvensis L., C-W, H, P, Arc, **
C. galaticus Rost. ex Choisy, I-T, H, P, *
Crassulaceae
Phedimus spurius (M.Bieb.) t Hart, E-S, H, P, *
Euphorbiaceae
Euphorbia helioscopia L., C-W, Th, A, Arc, **
Fabaceae
Lotus corniculatus L. var. *corniculatus*, C-W, H, P, *
Medicago sativa L. subsp. *sativa*, C-W, H, P, *
Medicago x varia Martyn, C-W, H, P, *
Melilotus albus Desr., C-W, Th, A-B, Arc, *
M. officinalis (L.) Desr., C-W, Th, A-B, Arc, *
Trifolium pratense L. var. *pratense*, C-W, H, P, Arc, *
T. repens L. var. *repens*, C-W, H, P, Arc, *
T. resupinatum L. var. *resupinatum*, C-W, Th, A, *
Trigonella capitata Boiss., C-W, Th, A, *
T. spruneriana Boiss., C-W, Th, A, **
Vicia cracca subsp. *stenophylla* Vel., C-W, H, P, *
Geraniaceae
Erodium cicutarium (L.) L Hér. subsp. *cicutarium*, C-W, Th, A, Arc, **
Hypericaceae
Hypericum perforatum subsp. *veronense* (Schrank) H.Linb., C-W, H, P, *
Iridaceae
Crocus danfordiae Maw subsp. *danfordiae*, Endemic, VU, C-W, G, P, **
Lamiaceae
Ajuga chamaepitys subsp. *chia* (Schreb.) Arcang., C-W, Th-H, A-B-P, **
Ballota nigra subsp. *anatolica* P.H.Davis, I-T, H, P, Arc, *
Lamium orientale (Fisch. & C.A.Mey.) E.H.L.Krause, I-T, Th, A, **
L. purpureum L. var. *purpureum*, E-S, Th, A, Arc, *
Marrubium globosum Montbret & Aucher ex Benth. subsp. *globosum*, Endemic, NT, I-T, H, P, **
M. parviflorum Fisch. & C.A.Mey. subsp. *parviflorum*, I-T, H, P, *
Salvia frigida Boiss., I-T, H, P, **
Liliaceae
Gagea peduncularis (C.Presl) Pascher, M, G, P, **
Malvaceae
Alcea biennis Winterl, C-W, H, P, *
Malva neglecta Wallr., C-W, Th, A, *
M. sylvestris L., C-W, H, B-P, Arc, *
Orobanchaceae
Orobanche ramosa L., C-W, Th, A, **
Papaveraceae
Fumaria asepala Boiss, I-T, Th, A, *
F. officinalis L., C-W, Th, A, Arc, *
Glaucium grandiflorum Boiss. & A.Huet subsp. *grandiflorum* var. *grandiflorum*, I-T, H, P, *
G. grandiflorum subsp. *refractum* (Nábelek) Mory var. *refractum*, I-T, H, P, *
Papaver lacerum Popov, C-W, Th, A, *
P. rhoeas L., C-W, Th, A, Arc, *
Plantaginaceae
Plantago major subsp. *intermedia* (Gilib.) Lange, C-W, H, P, *
Veronica persica Poir., C-W, H, P, Neo, **
V. polita Fr., C-W, Th, A, *
V. triphyllos L., C-W, Th, A, **
Poaceae
Dactylis glomerata subsp. *hispanica* (Roth) Nyman, C-W, H, P, Arc, *
Hordeum murinum subsp. *leporinum* (Link) Arcang., I-T, Th, A, Arc, *
Lolium perenne L., E-S, H, P, Arc, *
Phragmites australis (Cav.) Trin. ex Steud., E-S, He, P, **
Poa annua L., C-W, Th, A, Arc, *
P. bulbosa L., C-W, H, P, *
Polygonaceae
Rumex crispus L., C-W, H, P, *
R. obtusifolius subsp. *subalpinus* (Schur) Celak., C-W, H, P, *
Ranunculaceae
Adonis aestivalis L. subsp. *aestivalis*, C-W, Th, A, **
Consolida orientalis (J.Gay) Schrödinger, C-W, Th, A, **
Ranunculus marginatus d'Urv., C-W, Th, A, **
Resedaceae
Reseda lutea L. var. *lutea*, C-W, Th-H, A-B-P, Neo, *
Rubiaceae
Galium spurium L. subsp. *spurium*, E-S, Th, A, Arc, *
Scrophulariaceae
Verbascum cheiranthifolium Boiss. var. *cheiranthifolium*, C-W, H, P, **
Urticaceae
Urtica dioica L. subsp. *dioica*, E-S, H, P, Arc, *
Verbenaceae
Verbena officinalis L., C-W, Ch, P, *
Zygophyllaceae
Tribulus terrestris L., C-W, Th, A, *
List of Exotic and Cultivated Plants
Gymnospermae
Cupressaceae
Cupressus arizonica Greene, Ph, P
C. macrocarpa Hartw., Ph, P

C. sempervirens L., Ph, P
Cupressus × *leylandii* A.B.Jacks. & Dallim., Ph, P
Juniperus sabina L., Ph, P
J. squamata Buch.-Ham. ex D.Don, Ch, P
J. virginiana L., Ph, P
Platycladus orientalis (L.) Franco, Ph, P
Thuja occidentalis L., Ph, P, Neo
Ginkgoaceae
Ginkgo biloba L., Ph, P
Pinaceae
Abies alba Mill., Ph, P
Cedrus atlantica (Endl.) Manetti ex Carrière, Ph, P
C. deodara (Roxb. ex D.Don) G.Don, Ph, P
C. libani A.Rich., Ph, P
Picea abies (L.) H.Karst., Ph, P
P. glauca (Moench) Voss, Ph, P
P. orientalis (L.) Peterm., Ph, P
P. pungens Engelm., Ph, P
Pinus nigra J.F.Arnold, Ph, P
P. pinea L., Ph, P
P. sylvestris var. *hamata* Steven, Ph, P
Taxaceae
Taxus baccata L., Ph, P
Angiospermae
Adoxaceae
Sambucus nigra L., Ph, P
Viburnum opulus L., Ph, P
V. tinus L., Ph, P
Anacardiaceae
Cotinus coggygria Scop., Ph, P
Asparagaceae
Yucca filamentosa L., He, P
Asteraceae
Calendula officinalis L., Th, A, Neo
Taraxacum campylodes G.E.Haglund, H, P
Berberidaceae
Berberis aquifolium Pursh, Ph, P, Neo
B. thunbergii DC., Ph, P, Neo
B. vulgaris L., Ph, P
Betulaceae
Betula pendula Roth, Ph, P, Arc
Bignoniaceae
Catalpa bignonioides Walter, Ph, P, Neo
Buxaceae
Buxus sempervirens L. subsp. *sempervirens*, Ph, P, Neo
Caprifoliaceae
Lonicera japonica Thunb., Ph, P
L. ligustrina var. *yunnanensis* Franch., Ph, P
Symphoricarpos × *chenaultii* Rehder, Ph, P, Neo
Caryophyllaceae
Cerastium tomentosum L., H, P
Silene pendula L., Th, A
Celastraceae
Euonymus japonicus Thunb., Ph, P
Convolvulaceae
Ipomoea purpurea (L.) Roth, Th-H, A-P
Cucurbitaceae
Cucurbita pepo L., Th, A
Elaeagnaceae
Elaeagnus angustifolia L., Ph, P
Euphorbiaceae
Ricinus communis L., Ph, P
Fabaceae
Anagyris foetida L., Ph, P
Cercis siliquastrum L. subsp. *siliquastrum*, Ph, P
Gleditsia triacanthos L., Ph, P
Robinia hispida L., Ph, P
R. pseudoacacia L., Ph, P, Neo
Styphnolobium japonicum (L.) Schott, Ph, P, Neo
Quercus pubescens Willd., Ph, P
Q. robur L. subsp. *robur*, Ph, P
Grossulariaceae
Ribes aureum Pursh, Ph, P
Hydrangeaceae
Philadelphus coronarius L., Ph, P, Neo
Juglandaceae
Juglans regia L., Ph, P
Lamiaceae
Lavandula angustifolia Mill. subsp. *angustifolia*, Ch, P
Malvaceae
Hibiscus syriacus L., Ph, P
Tilia cordata Mill., Ph, P
T. tomentosa Moench, Ph, P
Moraceae
Ficus carica L. subsp. *carica*, Ph, P
Morus alba L., Ph, P, Neo
M. nigra L., Ph, P
Nyctaginaceae
Mirabilis jalapa L., H, P
Oleaceae
Forsythia × *intermedia* Zabel, Ph, P, Neo
Fraxinus angustifolia Vahl subsp. *angustifolia*, Ph, P
F. excelsior L., Ph, P
F. ornus L. subsp. *ornus*, Ph, P
Ligustrum japonicum Thunb., Ph, P
L. vulgare L., Ph, P
Syringa vulgaris L., Ph, P, Neo
Plantaginaceae
Antirrhinum majus L. subsp. *majus*, H, P
Platanaceae
Platanus orientalis L., Ph, P
Rosaceae
Amygdalus communis L., Ph, P
Armeniaca vulgaris Lam., Ph, P
Cerasus avium (L.) Moench, Ph, P
C. mahaleb (L.) Mill., Ph, P
C. vulgaris Mill., Ph, P
Cotoneaster dammeri C.K.Schneid., Ph, P
C. horizontalis Decne., Ph, P, Neo
C. salicifolius Franch., Ph, P, Neo
Crataegus laevigata (Poir.) DC., Ph, P
C. meyeri Pojark., Ph, P
C. monogyna Jacq., Ph, P
Cydonia oblonga Mill., Ph, P
Laurocerasus officinalis M.Roem., Ph, P
Malus floribunda Siebold ex Van Houtte, Ph, P
M. pumila Mill., Ph, P
Malus sp., Ph, P
Persica vulgaris Mill., Ph, P
Prunus divaricata var. *pissardi* Koch., Ph, P, Neo
Prunus sp., Ph, P
Prunus x domestica L., Ph, P
Pyracantha coccinea M.Roem., Ph, P
Pyrus elaeagnifolia Pall. subsp. *elaeagnifolia*, Ph, P
Pyrus sp., Ph, P
Rosa canina L., Ph, P
R. pulverulenta M.Bieb., Ph, P
Rosa sp., Ph, P

Spiraea vanhouttei (Briot) Carrière, Ph, P
Salicaceae
Populus canescens (Aiton) Sm., Ph, P
P. nigra L. subsp. *nigra*, Ph, P
Salix alba L. subsp. *alba*, Ph, P
S. babylonica L., Ph, P
Salix sp., Ph, P
Sapindaceae
Acer negundo L., Ph, P, Neo
A. pseudoplatanus L., Ph, P, Arc
Aesculus hippocastanum L., Ph, P, Neo
Koelreuteria paniculata Laxm., Ph, P
Simaroubaceae
Ailanthus altissima (Mill.) Swingle, Ph, P, Neo
Tamaricaceae
Tamarix parviflora DC., Ph, P
T. tetrandra Pall. ex M.Bieb., Ph, P
Ulmaceae
Ulmus minor Mill., Ph, P
Violaceae
Viola tricolor L., Th, A
Vitaceae
Parthenocissus quinquefolia (L.) Planch., Ph, P, Neo

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4. Conclusions and discussion

In this study, totally 233 taxa (180 species, 36 subspecies and 17 varieties) were collected from the research area, belonged to 160 genera and 63 families. 118 taxa (50.64%) are indigenous (79 species, 25 subspecies and 14 varieties), belong to 87 genera and 34 families and 115 taxa (49.36%) are exotic and cultivated (101 species, 11 subspecies and 3 varieties), belong to 74 genera and 39 families. It was determined that 106 indigenous taxa (89.83%) belong to dicots, while 12 (10.17%) to monocots.

When the floristic results of this study were compared with other studies, it was revealed that this study has the lowest number of families, genera, species, taxa and endemic taxa because of the differences between the area studied in this research and others regarding climatic factors and the size (Table 1).

Table 1. Comparison in numbers with other urban floristic studies

Studies	**Number of families**	**Number of genera**	**Number of species**	**Number of taxa**	**Number of endemic taxa**
Mamak	63	160	180	233	3
Ankara (Akaydın and Erik, 2002)	76	385	995	1142	146
Antalya (Göktürk and Sümbül, 1997)	130	569	1023	1065	75
Bursa (Daşkın and Kaynak, 2006)	86	377	677	706	25
Denizli (Gürcan and Düşen, 2015)	113	438	667	675	12
Muğla (Kaya et al., 2008)	86	327	555	576	31

The first 5 families which have the most taxa in this study are: Rosaceae (27, 11.59%), Asteraceae (27, 11.59%), Fabaceae (17, 7.30%), Brassicaceae (14, 6.01%) and Pinaceae (11, 4.72%). When the richest families in our study were compared with the Ankara study by Akaydın and Erik (2002), it can be seen that the sorting in the current study does not resemble the other paper except for the listing for Asteraceae, Fabaceae, Brassicaceae. The cause of this difference is thought to be the size of the study areas, and habitat structures of these research (Table 2).

Table 2. Comparison of the richest families with the Ankara study

Mamak	**Ankara** (Akaydın and Erik, 2002)
Asteraceae - 27	Asteraceae – 130
Rosaceae - 27	Fabaceae – 99
Fabaceae - 17	Poaceae – 81
Brassicaceae - 14	Brassicaceae – 68
Pinaceae - 11	Lamiaceae – 63

The most common genera in the study area are *Anchusa* L., *Cupressus* L., *Centaurea* L. and *Picea* A.Dietr. with 4 taxa for each (1.72%), while *Cupressus* and *Picea* are represented with one native taxa in the flora of Turkey. The reason why *Picea* and *Cupressus* have the most taxa in this study is that the areas where these plants were collected lost their naturalness (Table 3).

Table 3. Comparison of the richest genera with the Ankara study

Mamak	**Ankara** (Akaydın and Erik, 2002)
Anchusa - 4	*Astragalus* - 23
Cupressus - 4	*Salvia* - 17
Centaurea - 4	*Alyssum* - 17
Picea - 4	*Ranunculus* - 16

In this study, determinations of life forms showed that the largest group was phanerophytes with 104 taxa (44.64%). The others were as follows: therophytes with 61 taxa (26.18%), hemicryptophytes with 53 taxa (22.75%), geophytes with 6 taxa (2.58%), therophytes-hemicryptophytes with 4 taxa (1.72%), chamaephytes with 3 taxa (1.29%) and helophytes with 2 taxa (0.86%). In addition, the life cycles of 233 taxa were as follows; 157 perennial (67.38%), 54 annual (23.18%), 7 biennial (3.00%), 7 annual-biennial (3.00%), 4 biennial-perennial (1.72%), 3 annual-biennial-perennial (1.29%) and 1 annual-perennial (0.43%). Especially, intensive use of woody plants in urban planting process around the district can be shown as the reason why the proportion of phanerophytes and perennials were that high.

The distribution of phytogeographical elements in the study area are as follows; Irano-Turanian (15 taxa, 12.71%), Euro-Siberian (7 taxa, 5.93%), Mediterranean (4 taxa, 3.39%) and cosmopolitan or widespread (92 taxa, 77.97%). In terms of phytogeographical elements, the first rank is occupied by cosmopolitan or widespread taxa, which is followed by Irano-Turanian elements in both studies (Table 4). This is because the areas studied in both studies were urban areas and study areas are in Irano-Turanian phytogeographic region.

Table 4. Comparison of the distribution of the phytogeographical elements with the Ankara study

Mamak	**Ankara** (Akaydın and Erik, 2002)
Irano-Turanian - 15	Irano-Turanian - 276
Euro-Siberian - 7	Mediterranean - 76
Mediterranean - 4	Euro-Siberian - 62
Cosmopolitan or widespread - 92	Cosmopolitan or widespread - 581

In the study, 3 taxa are endemic (2.54%), *Marrubium globosum* subsp. *globosum* (Lamiaceae), *Hyacinthella micrantha* (Asparagaceae), *Crocus danfordiae* subsp. *danfordiae* (Iridaceae).

While the most common native plant species were *Capsella bursa-pastoris*, *Trifolium pratense*, *Veronica persica* and *Senecio vernalis*; the most common exotic and cultivated plant species were *Platycladus orientalis, Robinia pseudoacacia*, *Pyracantha coccinea* and *Acer negundo* in the research area.

This study site was analyzed based on a hemeroby scale which was developed by Sukopp and Weiller (1998). In the boundaries of the study area, there are not HO, H1 and H2 classes. However, H3, H4, H5, H6, H7, H8 and H9 classes were presented as follows; H3 by the areas such as forests in and/or nearby villages (e.g. villages around Hüseyingazi Mountain); H4 memorial forests (e.g. Şehit Öğretmenler Memorial Forest); H5 hilly areas and old small village settlements (e.g. Hatip rivulet and surroundings); H6 small meadows (among the neighborhood and picnic areas) (e.g. Şehitlik Parkı); H7 agricultural fields, gardens and small-scale greenhouses; H8 agricultural areas where especially intensive agricultural spraying is applied; H9 main arteries of all the roads, railways and dump sites within the district.

Despite the fast-developing and continuously urbanizing nature of Mamak, it is fair to say that the district still has a rich flora. There are some factors which contribute to the richness of plant species in urban areas; such as wild-growing plant species (e.g. garden weeds and crops) and spontaneously occurring ornamental plants that escaped from original cultivations (Zerbe et al., 2003; Altay et al., 2010).

Although, floristic diversity could be rich in urban habitats, rapid urbanization may cause some problems for the survival of some species (Chocholoušková and Pyšek, 2003; Van der Veken et al., 2004). For example, while the number of therophytes increases, the number of endemic, rare and wasteland plant species decrease in urbanized areas (Maurer et al., 2000). A similar situation can be seen in the areas where the urbanization process continues rapidly just like in Mamak.

In this research, it was also observed that there is an increase of annuals, ruderals, non-native plants and cultivated species. As a result of increasing number of inhabitants in cities, increased traffic and trade cause an increase of the proportion of non-native species in the urban flora (Pyšek, 1998; Altay et al., 2010; Garcia-de-Lomas et al., 2010). These species can be imported to urban areas through human activity directly or indirectly and sometimes they can be more dominant than indigenous plants (Zerbe et al., 2003). *Cupressus arizonica*, *Acer negundo*, *Robinia pseudoacacia* , *Ailanthus altissima, Juglans regia* and *Morus nigra* are good examples for this situation in the district. Similarly, Kowarik (1992) mentioned that the most frequent non-native species on different habitats of Berlin/Germany were *Acer negundo*, *Robinia pseudoacacia* and *Prunus serotina* Ehrh.. Species such as *Acer negundo*, *Robinia pseudoacacia* and *Ailanthus altissima* were found and stated as some of the most frequent non-native species in some other studies as well (Altay et al., 2010; Osma et al., 2010; Eskin et al., 2012).

Introduction and establishment of non-native species to an area is always a big risk factor for inhabitants, native species and natural habitats. In this research, extremely increased snail (*Helix* L. sp.) populations were observed in some parks. This situation can be caused by the plantation of a cultivariety of a grass species (*Lolium* L. sp.) which is not native to these areas. Furthermore, the plantation of a limited variety of a non-native plant species could be harmful for urban ecosystem. In the future, a plant disease of a particular species could damage all the specimens or any other species. Moreover, one of the non-native species could replace or become dominant in the area by suppressing other species (Altay et al., 2010). Consequently, native species may go extinct or habitats may become monotypic, which result in destruction of ecosystem processes.

In urban planning, under the ecological perspective, one of the main principles is to protect natural habitats. Today we are witnessing wrong plantation practices with non-native or exotic plant species in many cities all over the world. These practices affect and change natural habitats in the end. For example, people, who migrate into big cities such as Ankara from rural areas, transport some of their rural area plants (e.g. fruit and vegetable plants). Consequently, although urban flora becomes richer, natural flora becomes affected negatively from these plants and eventually neutrality is lost. The following plant taxa can be given as good examples for this situation; *Platycladus orientalis*, *Eucalyptus* L'Hér. spp. *Ficus carica*, *Cucurbita* L. spp., *Robinia pseudoacacia*, *Juglans regia*. In some cases, this situation may be just the opposite; for instance, sometimes immigrants may consume some species in cities (e.g. *Hypericum perforatum*, *Euphorbia helioscopia*, *Chenopodium album*, etc.) for their ethnobotanical uses and ultimately this may cause a decrease of the population of these plants (Altay et al., 2010).

The concept of open-green space per capita is calculated by dividing the all green patches of the city into the total population of the city and it is expressed by "m^2". It is an important criterion for understanding how much of the green space demands of inhabitants are met. In developed countries, green space per capita varies based on the topography and different socioeconomic structures of the cities. Some of them are as follows; U.S.A. 100 m^2, Russia 60 m^2, England 70-80 m^2, France 60 m^2. In Turkey, on district scale it is designated as 10 m^2 by regulations (Regulation on the Construction of Spatial Plans, 2014). In this study area, green space per capita has been in an increasing trend over the years. Notwithstanding about 8 m^2 green space per capita, it does not match the values which are designated by regulations. Besides such values and numbers, the quality of green spaces is also very important. In the district, it was observed that suitability for use of green spaces is not functional. Urban transformation projects have been started in the city in the last few years and it still continues. It could be a big opportunity for the district to restore green spaces and gain functionality to these areas.

One of the reasons of urban heat islands is the surface area of buildings that absorb the heat. As it is known; vertical gardens and green roof practices prevent buildings from overheating. In the study area, although there were not so many examples, just a few of them were observed. The plantation on roofs and such kind of surfaces is an important issue. The determination of the species to be used for that purpose is another important matter as well. Species should be resistant to exhaust gases, drought and other stress factors. For this purpose, these species are good examples in the research area; *Berberis thunbergii*, *Hedera helix*, *Euonymus fortunei*, *Parthenocissus quinquefolia*.

This study clarifies the dramatic decrease of indigenous species, the increase of exotic and non-native species and the establishment of new ecotypes of the study area. As a result, the environment we live in must meet the needs of future generations as much as it meets the needs of people today. We must adopt sustainable policies and practices in order to leave a more livable environment for future generations as the protectors of the environment we live in.

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