
Turkey

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**FACULTY OF SCIENCE**
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## CONTENTS

**HACETTEPE JOURNAL OF BIOLOGY AND CHEMISTRY**

(Formally, the Hacettepe Bulletin of Natural Sciences and Engineeering, Series A)

## PREFACE

With this volume the Hacettepe Bulletin of Natural Sciences and Engineering, Series A, continues publication under a new title. This represents more than just a change of name. It continues the philosophy of permitting our publications to develop along lines appropriate to their content and purpose, and will bring in its wake various changes in editorial policy.

Certainly we consider it important that our journal should continue to provide an outlet for research originating in Turkey. Howewer, a journal is useful only to the extent that it can bring this research to a wide international audience, and this in turn depends on it being able to attract good material from abroad. One important aspect of this process, that will continue over the coming year, is to attract internationally well known scientists to our editorial board to advise on policy and help in the promotion of our journal. It gives us great pleasure to welcome those who have agreed to join us, and to thank them for giving their valuable time.

The ability to publish articles quickly is increasingly important, and we hope to build on the well earned reputation of the Hacettepe Bulletin in this respect. Here we owe a deep dept of gratitude to our referees, without who's staunch support this would be impossible. With an increase in international content the role of the internet will undoubtedly increase, and we cannot emphasize too strongly the importance of the electronic submission of articles. For some years now, papers on Biology and Chemistry have been published using the WORD typesetting system. We can assure authours who submit a WORD version of their paper by e-mail that their paper will be processed with the greatest possible speed.

Finally it gives us the greatest pleasure to announce that, thanks to the good officers of our Rector Prof. Dr. Tunçalp Özgen, we will not need to make any page charges for the foreseeable future. On behalf of the Faculty of Science we wish the Hacettepe Journal of Biology and Chemistry every success in the future,

Prof. Dr. Ali Kalaycıoğlu (Dean)

# BIOLOGY

**Hacettepe Journal of Biology and Chemistry**
**Volume 31 (2002), 1-8**

# DETERMINATION OF THE CONSERVATION STATUS OF NON–PASSERINE BIRDS IN NALLIHAN BIRD PARADISE, CENTRAL ANATOLIA, TURKEY[1]

**Utku PERKTAŞ[2,3] and Zafer AYAŞ[2]**

Received 11.10.2002

**Abstract**

This study was conducted to determine breeding and wintering non–passerine bird species in Nallıhan Bird Paradise (Nallıhan–Ankara) based on different conservation conventions and European Threat Status. In study period (August 2000–July 2001), according to Red Data Book for Turkey, Nallıhan Bird Paradise was less important breeding area for non-passerine birds, but it was detected during the study period that the area was an important wintering area for non-passerine bird species. Based on data from the same period, accordig to European Threat Status, Nallıhan Bird Paradise was more important as breeding area than as wintering area. All non–passerine bird species which are important level according to Bern Convention were recorded between August 2000 and July 2001.

**Keywords:** Conservation Status, Non-Passerine Bird Species, Nallıhan Bird Paradise, Central Anatolia, Turkey

## Introduction

Turkey has one of the richest bird faunas in the Middle East (1). For the avifauna of Turkey, our information had been more obvious, during particularly last fifty years (2). By both the long term studies and the publications qualifying as reports, these data are being strengthened (3-13).

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[1]This study was part of the requirements for the MSc degree submited to Hacettepe University on 17 February 2002.

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In Turkey, 453 bird species are found of which 263 (58%) bird species are non – passerines (14). Of these non-passerine birds, 122 species regularly breed in Turkey (14) and, 24 of these 122 bird species also regularly breed in Europe and large declines in population size of these bird species during 1970 – 1990 in Turkey and Europe have been shown (15).

Although avifauna of Turkey has a lot of bird species including has unfavorable conservation status, only one red data book has been prepared by Kiziroğlu (1989) in a national level for Turkey birds. Except this determination, some international conservation conventions which were signed by European countries includes Turkey. In these conventions, Turkey is represented with insufficient known for bird species (15).

This paper were designed to determine: *(1)* In Nallıhan Bird Paradise (NBP), which breeding and wintering non–passerine species which were under the conservation according to different conservation conventions and European Threat Status in NBP and *(2)* to consider the importance of NBP as a protected area between August 2000 and July 2001 for the under conservation breeding and wintering non-passerine bird species.

## Methods

### Study Area

Study area includes NBP and north of Sarıyar Dam Lake and NBP ($40^0$ 06' N, $31^0$ 36' E) is situated on the north side of the Sarıyar Dam Lake and northwest of Central Anatolia (Figure 1). It covers approximately 900 ha and is characterized by seasonal wetland.

The Nallıhan Bird Paradise (425 ha) was declared as an Important Bird Area and it was also declared protected area in 1994 (16). The important habitats of area include seasonal mudflats, standing freshwaters, streaming freshwaters, grasslands, wet grasslands, rocky areas, farmlands and settling areas.

Vegetation structure of the NBP and study area was declared as steppe and salt marsh (17). But, some places of NBP almost devoided vegatation structure during the study period.

Details on the climate data of study area are only available for Nallıhan, approximately 30 km to the northwest of Nallıhan Bird Paradise. During the study period (August 2000-July 2001), the total annual rainfall was 305,4 mm at Nallıhan, the annual mean temparature $13,5^0$C. According to average climate data of 25 years (1976-2000) for Nallıhan,

the total annual rainfall is 277,1 mm at Nallıhan, the annual mean temparature 12,2$^0$C. Therefore, approximately six months in one year is determined as an arid period in Nallıhan and its environs.

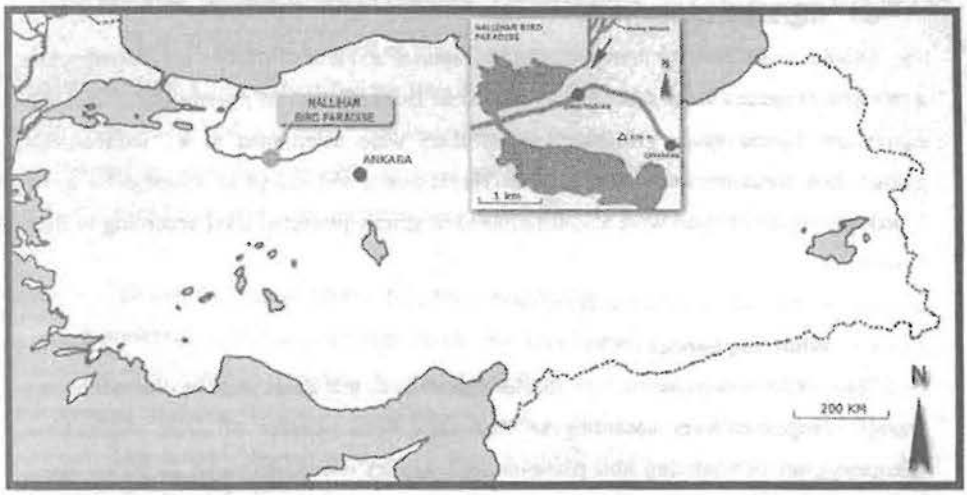


Figure 1. Location of the Nallıhan Bird Paradise

**Field Study**

Observations with regular intervals have been made for each month from August 2000 to July 2001 for non-passerine bird species. For the identification of different birds, we used telescope (40 X 60) and binoculars (16 X 24) in the course of the observation period. Conservation status of existing non–passerine bird species in the study period was determined according to SPEC category (15), European Threat Status (ETS) (15), Bern Convention (18) and Red Data Book (RDB) for Turkey (19). The possible status of these species for this area are given as breeding species - year birds - breeds regularly - resident breeding (R), breeding species - only summer birds - breeds regularly or irregularly - migrant breeding (MB) and winter visitor (WV) (19, 20).

**Results**

During the study period, it was recorded 17 non – passerine bird species which was breeding 13 non–passerine bird species which was wintering in Nallıhan Bird Paradise. These species and posible status of them was given in Appendix 1 with SPEC Category, ETS, Bern Convention and Red Data Book for Turkey.

**a. Resident Breeders (R)**

This status included eight non–passerine bird species. According to Red Data Book, except of *Larus ridibundus* (Black-headed Gull), *Columba livia* (Rock Dove) and *Streptopelia decaocto* (Collared Dove), all non-passerine bird species had different dangerous status.

According to European Threat Status, only two species (*Tadorna ferruginea* and *Buteo rufinus*) were determined in a dangerous level. All of the bird species were also determined strictly protected level according to Bern Convention.

**b. Migrant Breders (MB)**

This status included 10 non–passerine bird species and four of which were determined as a strongly dangerous level according to Red Data Book. Except of *Egretta garzetta* (Little Egret) and *Upupa epops* (Hoopoe), all of them were determined as a unfavourable conservation status according to European Threat Status and except of *Streptopelia turtur* (Turtle Dove), all of them were also determined in strictly protected level according to Bern Convention.

**c. Wintering Species (WV)**

Three of 13 non–passerine bird species appearing in this status were as determined as a strongly dangerous level according to Red Data Book. Except of *Anas querquedula* (Garganey), all of wintering non passerine bird species were determined as secure status according to European Threat Status and except of *Fulica atra* (Coot), four non passerine bird species were determined in strictly protected level and eight non-passerine bird species were determined in protected level according to Bern Convention.

**Discussion**

According to Red Data Book for Turkey (19), considering both of the resident breeder and the migrant breeders non–passerine bird species, Nallıhan Bird Paradise migt be less important breeding area during the study period. Considering winter visitor bird species in Nallıhan Bird Paradise, however, this site may be more important as a wintering area than as a breeding area. Because, a lots of non-passerine bird species which has severely endangered (A.2) status according to Red Data Book appeared in wintor period (Appendix 1). Also, in Red Data Book for Turkey, debatable informations have been offered. For example, *Larus ridibundus* (Black–headed Gull) has been determined as a migrant non-breeding species for Turkey (19), but it was recorded in Nallıhan Bird Paradise as a resident breeeding. Thus, the red data book for Turkey should be rearrangement with considering new data.

According to European Threat Status (15), only two species was appeared in unfavourable conseration status for resident breeder non–passerine bird species. However, eight of 10 migrant breeder non-passerine bird species is also appeared in European Threat Status (15). Therefore, Nallıhan Bird Paradise may be a more important area for migrant breeders, especially *Ciconia nigra* (Black Stork), *Merops apiaster* (Bee-eater), *Coracias garrulus* (Roller). As a wintering area, Nallıhan Bird Paradise had only two species (*Anas*

*querquedula*-Garganey and *Buteo rufinus*- Long – legged Buzzard) in important level for Europe includes Turkey in the study period. Other species were placed in secure status as in Tucker and Heath (1994). Thus, in wintering period (November 2000 – March 2001), Nallıhan Bird Paradise was a less important are than in breeding period.

Member states of Council of Europe and invited non–member states in Europe and North and West Africa had ratified the Bern Convention (18-21). All of the resident breeding, migrant breeding and wintering non–passerine bird species in Nallıhan Bird Paradise were determined in important conservation level by Bern Convention (Appendix 1). Therefore, Nallıhan Bird Paradise was an important area in study period according to Bern Convention.

During the August 2000 – July 2001, Nallıhan Bird Paradise as a wildlife protected area, represented different important levels for breeding and wintering areas for non–passerine bird species, according to Red Data Book, European Threat Status and Bern Convention. However, excepting some species, such as *Ciconia nigra* (Black Stork), *Merops apiaster* (Bee-eater), *Coracias garrulus* (Roller), Nallıhan Bird Paradise has been determined as a less important breeding and wintering area in the study period.

In addition to, less importance as a breeding area of Nallıhan Bird Paradise may be related to aridity and vegetation structure. Birds are strongly affected by change in vegetation structure (22) and this kind of affect has been supported by some related studies (20, 23, 24). According to climatic data, it has been also determined that Nallıhan Bird Paradise passed a extreme one year between August 2000 and July 2001 (13).

**Acknowledgements**

We are especially grateful to Hacettepe University Research Foundation for their supports (Project Number: 00.01.601.001). We also thank to Atıl Barış ALBAYRAK for his helps during the study, and to Çağatay TAVŞANOĞLU and Dr. Levent Mert GÜNAY for checking the English language of the manuscript.

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**Appendix 1.** Recording non – passerine bird species in Nallıhan Bird Paradise is given as different conservation concerns and European Threat Status.

| | Status for Nallıhan Bird Paradise | SPEC | European Threat Status (ETS) | Red Data Book | BERN Convention |
|---|---|---|---|---|---|
| Little Greebe - *Tachybaptus ruficollis* | WV | - | S | A.3 | App. II |
| Great Crested Grebe - *Podiceps cristatus* | WV | - | S | A.2 | App. III |
| Great Cormonant - *Phalacrocorax carbo* | WV | - | S | A.2 | App. III |
| Black–crowned Night Heron - *Nycticorax nycticorax* | MB | 3 | D | A.3 | App. II |
| Squaco Heron - *Ardeola ralloides* | MB | 3 | V | A.3 | App. II |
| Little Egret - *Egretta garzetta* | MB | - | S | A.2 | App. II |
| Great Heron - *Egretta alba* | WV | - | S | A.2 | App. II |
| Grey Heron - *Ardea cinerea* | R | - | S | A.3 | App. III |
| Black Stork - *Ciconia nigra* | MB | 3 | R | A.2 | App. II |
| White Stork - *Ciconia ciconia* | MB | 2 | V | A.3 | App. II |
| Ruddy Shelduck - *Tadorna ferruginea* | R | 3 | V | A.2 | App. II |
| Eurasian Wiegon - *Anas penelope* | WV | - | S | A.4 | App. III |
| Common Teal - *Anas crecca* | WV | - | S | A.4 | App. III |
| Mallard - *Anas platyrhynchos* | R | - | S | A.4 | App. III |
| Garganey - *Anas querquedula* | WV | 3 | V | A.3 | App. III |
| Northern Shoveler - *Anas clypeata* | WV | - | S | A.3 | App. III |
| Common Pochard - *Aythya ferina* | WV | 4 | S | A.4 | App. III |
| Black Kite - *Milvus migrans* | MB | 3 | V | A.4 | App. II |
| Egyptian Vulture - *Neophron percnopterus* | MB | 3 | E | A.3 | App. II |
| Common Buzzard - *Buteo buteo* | WV | - | S | A.3 | App. II |
| Long – legged Buzzard - *Buteo rufinus* | R | 3 | (E) | A.2 | App. II |
| Eurasian Coot - *Fulica atra* | WV | - | S | - | App. III |
| Green Sandpiper - *Tringa ochropus* | WV | - | (S) | B.2 | App. II |
| Black – headed Gull - *Larus ridibundus* | R | - | S | B.3 | App. III |
| Rock Dove - *Columba livia* | R | - | S | - | - |
| Eurasian Collored Dove - *Streptopelia decaocto* | R | - | (S) | - | - |
| European Bee-eater - *Merops apiaster* | MB | 3 | D | A.4 | App. II |
| European Roller - *Coracias garrulus* | MB | 2 | (D) | A.2 | App. II |
| European Hoopoe - *Upupa epops* | MB | - | S | A.2 | App. II |
| Syrian Woodpecker - *Dendrocopus syriacus* | R | 4 | (S) | A.3 | App. II |

**Explanation for Appendix 1**

**SPEC category (Tucker and Heath, 1994):**

SPEC 1: Species of global conservation concern, i.e. clssified as Globally Threatened, Conservation Dependent or Data Deficient (from Tucker and Evans, 1997 as a Collar et al., 1994).

SPEC 2: Concenterated in Europe and with an Unfavourable Conservation Status.

SPEC 3: Not conentrated in Europe but with an Unfavourable Conservation Status.

SPEC 4: Concentrated in Europe and with a Favourable Conservation Status.

\- : Non - SPEC

**European Threat Status (Tucker and Heath, 1994):**

| | | | |
|---|---|---|---|
| **E :** | Endangered | **L :** | Localized |
| **V :** | Vulnerable | **Ins. :** | Insufficienty Known |
| **R :** | Rare | **S :** | Secure |
| **D :** | Declining | **( ) :** | Status provisional |

**Bern Convention (Tucker and Heath, 1994):**

All animal species under conservation according to Bern Convention related to Appendix II and Appendix III in Bern Convention.

**Appendix II** : Indicates that Strictly Protected Fauna Species

**Appendix III** : Indicates protected fauna species.

**Red Data Book (Kiziroğlu, 1989):**

This publication was prepared for Turkey Bird's Species. Including categories:

**A.1.1.** : Extinct,

**A.1.2.** : Threatened with extinction,

**A.2.** : Severely endangered,

**A.3.** : Endangered,

**A.4.** : Potentially endangered.

**B.2. and B.3.** : Endangered migrants, winter visitors and non – breeder species.

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# HUMAN PLACENTAL CELL CULTURING ON COLLAGEN AND FIBRONECTIN COATED SURFACES AND FIBROBLAST FEEDER-LAYER

**AYLİN GÜRPINAR*, M. ALİ ONUR*, S. İSMET GÜRHAN**, AŞKIN TÜMER***

Received 25.10.2002

**Abstract**

In this study, systems were established and tested for growing human placental trophoblasts on various surfaces. For this purpose, in the first step, trophoblastic cell were isolated from the first trimester human placentas. Trophoblastic cells were cultured on collagen and fibronectin coated surfaces and 3T3 fibroblast feeder-layer. To prepare collagen coated surfaces, six-well polystirene (PS) dishes weri modified by using collagen-glutaraldehyde (GTA) mixture. Fibronectin coated surfaces were prepared with the same method. Fibroblast feeder-layer was prepared by using 3T3 mouse fibroblasts. Syncytia formation capacity of trophoblastic cells were investigated on these surfaces and the results were compared with the conventional techniques. The results showed that trophoblasts adhered neither to the normal nor to the modified surfaces. But adhering and growing were observed on the fibroblast feeder-layer.

**Key words:** cell culture, feeder layer, polymeric surfaces, trophoblast.

## Introduction

Human placental syncytial trophoblasts play the major role in gas and nutrient exchange between mother and fetus. All nutrients necesarry for fetal growth are transported

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from maternal circulation across the placenta to the fetus. Fetal metabolic waste products are "discharged" from fetal blood into maternal circulation through the placenta (1, 2). Placenta also have an endocrine function and secrete several hormones like chorionic gonadotropin, estrogens and progesterone (3). Playing such crucial roles during pregnancy, trophoblasts deserve a special attention. But, it is hard to study about functions of human placentas, because making experiments on pregnant women may have some diffucilties on mother and baby. The only way for making *in vivo* experiments is to measure blood pressure both mother and baby on birth. There isn't an animal model which is fit to human placental function.

Therefore the human placenta which was obtained after birth was used for all experiments. For starting *in vivo* perfusion studies, firstly the whole placenta was perfused (4, 5). Later on only the cotiledone could be perfused and we may have said that this cotiledone represented the whole placenta (6, 7). In these systems time is very important. Placentas should be used immediateley after they were obtained.

Considering the limitations in *in vivo* studies with humans, cell-culture techniques seem to be the only remaning possible way for studying human placental cells. The avaibilty of an *in vitro* purified trophoblast system would facilitate studies on several aspects of trophoblast function, transport of nutrients between maternal and fetal circulations, secretion of steroid and protein hormones, transport of immunoglobulins from mother to fetus (1). Attempts have been made to grow these cells in culture media.

However it turns out that human trophoblasts are extremely selective in adhering to various surfaces and adhering is possible only if the surfaces are modified (8). We established three different sytems and tested them for growing human placental trophoblasts on different polymeric surfaces. The aim is to define an appropiate adhering and growing surface for trophoblasts. This will enable both culturing of these cells and therefore detailed studies on them. Therefore, it will be invesigated placental function, placental transfer of nutrients, drugs and some chemicals in culture medium. For this purpose trophoblastic cells were cultured on collagen and fibronectin coated surfaces and 3T3 mouse fibroblasts as a feeder-layer. Syncytia formation capacity of these cells also was investigated and compared the results conventional technique. It can be also tested placental fibroblasts as a feeder-layer and placental transfer mechasims can be investigated with this system. Our study about placental fibroblasts are undergoing. Therefore, in our study, we used a new technique to prepare *in vitro* perfusion system in cell culture conditions.

**Material and Methods**

Primary culture

Trophoblast cells were isolated by means of chorionic villus sampling (CVS) (9) and curattage at the first trimester of human placenta. Chorionic villi tissue was dissected

under sterile conditions. Placenta was obtained from Hacettepe University, Faculty of Medicine, Department of Obstetrics and Gynecology.

In the first step, tissue fragments were rinsed with Phosphate Buffered Saline (PBS) containing 0.1% antibiotic mixture (penicillin, streptomycin and neomycin) (Sigma, Germany). Then tissues were trypsinized for 12 hours and trophoblast cells were isolated.

Finally, trophoblasts were cultured in RPMI-1640 Medium containing 20% fetal calf serum, 0.1% antibiotic mixture (penicillin, streptomycin, neomycin) and 200 mM L-Glutamine (Sigma, Germany). Cells were plated in 24-well polystirene culture dishes and incubated in humidified (5% $CO_2$- 95 % $O_2$) air at 37 °C.

Cell Culturing on Collagen-Coated Surfaces

For this, the method improved by Borstien and Murray in 1958 was used (10). In this method, collagen-coated six-well polystirene dishes were used and the following steps were followed:

1. One milliliter of collagen-glutaraldehyde mixture was placed in each well of six-well culture dishes,

2. To remove glutaraldehyde and bind collagen, culture wells were incubated at 37 °C for five hours,

3. After glutaraldehyde removal, culture dishes were washed three times by bidistilled water,

4. Culture dishes were dried at room temperature,

5. Dishes were sterilized for one hour under UV light.

Baby Hamster Kidney cells (BHK) and trophoblasts were plated into seperate three-well dishes. Cells were incubated in humidified (5% $CO_2$- 95% $O_2$ ) air at 37°C. BHK cells were used as controls (11, 12).

Cell Culturing on Fibronectin-Coated Surfaces

Fibronectin-coated surfaces were prepared as described above replacing collagen with fibronectin. Again, BHK and trophoblast cells were plated into six-well polystirene culture dishes.

Cell Culturing on a Fibroblast Feeder-Layer

To prepare the feeder-layer, 3T3 fibroblast cells which are known to adhere to culture plates easily, were used. After 3T3 fibroblasts adhered to and spread on the culture plates $2x10^5$ 3T3 cells/ml and $5x10^5$ cells/ml), their proliferation was blocked by g irradiation (10). For this, 6 MRad irradiation dosage was applied to the cell suspension for 15 minutes.

Placental trophoblastic cells were incubated on the 3T3 fibroblast layer which consisted of survival but nonproliferating cells.

**Results and Discussion**

Primary Culture

The morphological and functional differentiation of human trophoblast cells ends with the formation of terminally differentiated multinucleated syncytial trophoblast. (13).

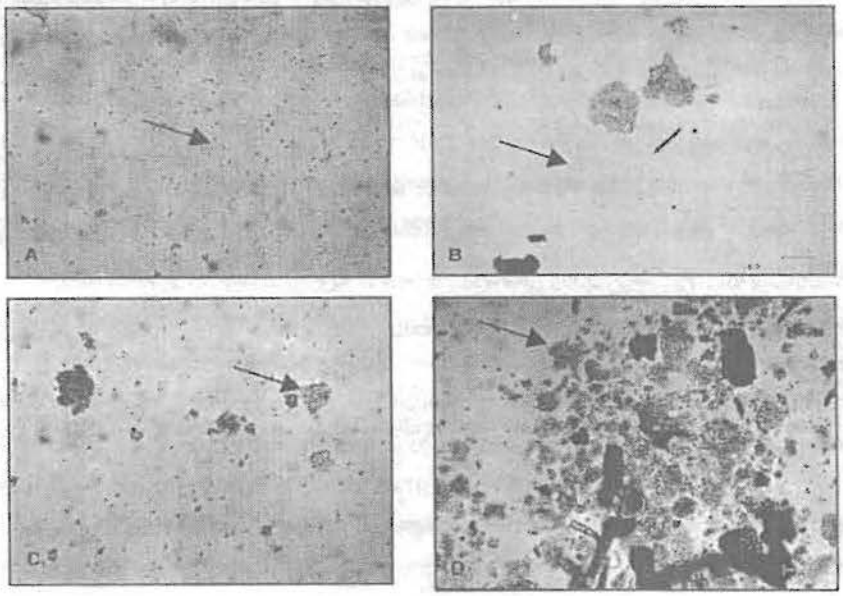


**Figure 1A-D:** A. Trophoblast cells at the beginning of culture. There are single cells in the culture medium; B. Syncytium after 24 h; C. Syncytium after 48 h; D. Syncytium after 72 h. Trophoblastic cells differentiated into the multinucleated syncytial trophoblasts after 24 h of culture period. Number of syncytia was increased in time and the higest number was seen at 72 h (bar 100 μm).

In Figure 1 (A, B, C, D), differentiated syncytiums are shown. After incubating for 24 hours, trophoblasts differentiated into syncytiotrophoblasts. These photographs indicate an increase in the syncytium formation. These results are in good accordance with the previous studies (3).

Cell Culturing on Collagen and Fibronectin-Coated Surfaces

Cell matrix adhesion molecules mediate cell function, growth, migration and differentiation. Collagen and fibronectin are extracelluler matrix components. Therefore, collagen gels and fibronectin-containing surfaces that mimic *in vivo* three-dimensional

microenviroment (14). It is reported that modification of the surface of PS culture plates by cell adhesive proteins, such as collagen and fibronectin, increase cell adhesion (15). Collagen and fibronectin have $NH_2$ groups giving the surface a positive charge and such surfaces are suitable for cell adhesion (9). In order to improve the cell attachment, collagen and fibronectin have also been immobilized onto PHEMA microcarriers (17). Collagen adsorbtion on poly ethylene terephtalate regulates human urothelial cell adhesion and proliferation (18). Haruo et al investigated bovine trophoblastic cell differentiation on collagen substrate. In ruminants the differentiation of trophectoderm is marked by appearance of binucleate cells in cytotrophoblasts. In this study bovine trophoblastic cell line (BT-1) established from *in vitro* fertilized blastocysts differentiated into binucleated cells on collagen gel. BT-1 had cytotrophoblastic epithelial characteristics and spontaneously formed multicellular spherical vesicles in the culture medium. When these vesicles were cultured on type I collagen substrate, most vesicles attached to the collagen substrate, and exhibited cell outgrowth and proliferation (19). In our study, BHK cells adhered to these surfaces, but trophoblast cells neither adhered to the normal nor to the modified surfaces.Cell Culturing on Fibroblast Feeder-layer

Culturing mouse embryonic fibroblasts or other cells have been used for many years to enhance cell growth. Feeder layers grown as a confluent monolayer may make the surface suitable for attachment for other cells (10). For this purpose, a number of cells cultured on fibroblast feeder layers. A new engraftment technique to resurface the wounds with Integra and composite biocompatible epidermal graft (CBEG) has been successfully applied to three patients for elective reconstructive procedures. For this purpose a small skin biopsy was taken from the normal edge of the lesion for keratinocytes and dermal fibroblast cultures 2 weeks before surgery. When sufficient cells were grown, the patient was admitted for the excision of the lesions or scars. The wounds of the patients, ranging from 125 to 250 $cm^2$, were covered with Integra. When the neodermis of the Integra was fully vascularized, the silicone membrane of the Integra was removed and replaced with the CBEG, which consisted of autologous keratinocytes cultivated on a hyaluronate-derived membrane using human dermal fibroblasts as a feeder layer. This engraftment technique has several advantages. The CBEG is much easier to handle than the conventional cultured epidermal autograft. It eliminates the invasive second procedure for skin harvesting, with resulting pain and scarring. (20). Currently, embriyonic stem cells were also cultured on fibroblast feeder layer for many purposes (21). Embriyonic stem cell lines are derived from human blastocysts. Totipotent cells of the early mammalian embryo are capable of unlimited and undifferentiated proliferation *in vitro*. H9 is an embryonic stem cell line (22). It was showed that this inner cell mass-derived cells attached to mouse embriyonic fibroblast feeder layer after 8 days of culture. After H9 cells were allowed to differentiate for 2 weeks, both α-fetoprotein and

human chorionic gonadotropin were dedected in conditioned culture medium, indicating endoderm and trophoblast differentiation.

Our study showed that trophoblasts and syncytia adhered to the feeder-layer within 24-48 h. This was the case which was not observed with the standart culture plates. When the cell number was increased, more syncytia adhered to the layer of 3T3 fibroblasts. These results are shown in Figure 2 (A, B, C).

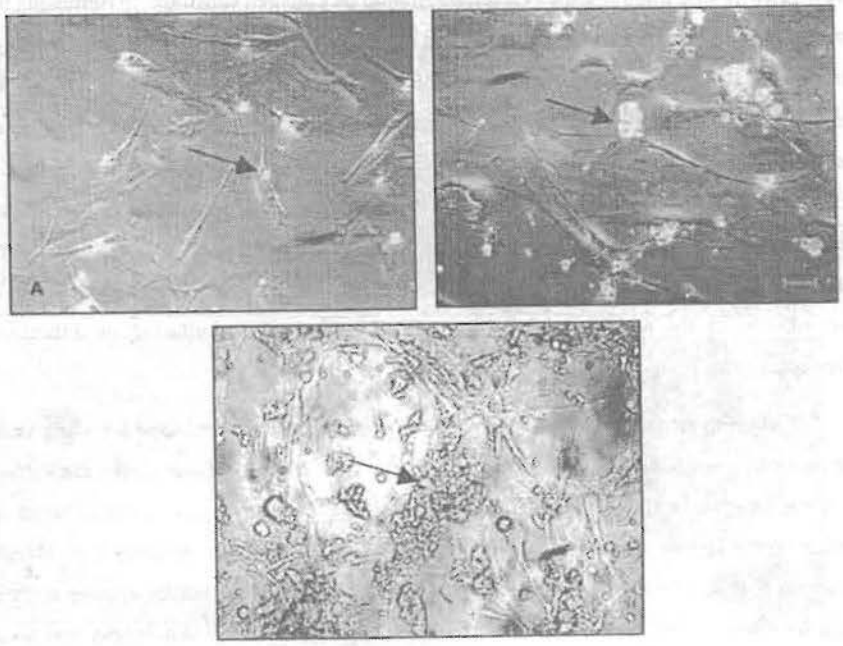


**Figure 2. A-C:** A. 3T3 fibroblasts. Their proliferation was blocked by γ irradiation; B. Syncytium which adhered to the feeder-layer ($2x10^5$ 3T3cells/ml); C. Syncytium which adhered to the feeder-layer ($5x10^5$ 3T3 cells/ml) When the 3T3 fibroblast cell number increased, adhesion of syncytia on fibroblast feeder-layer enhanced (bar 100 μm).

It is concluded that trophoblast cells are highly selective for surfaces they adhere to. They adhered neither to unmodified PS surfaces nor to PS surfaces modified by collagen and fibronectin. As our results indicate, covering the surface with another cell layer as a feeder, helps trophoblasts to adhere. In our case, this feeder-layer is a fibroblast (3T3) layer. Being a novel technique, using a feeder-layer seems to be very promising as an alternative way for trophoblast culturing. Such a this study is the first step to prepare plancental perfusion culture systems. Some other cell lines such as placental fibroblasts also should be tried. Therefore it

can be prepared placental perfusion system and placental function, transport of drugs and chemicals can be tested in such a culture system.

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# NEW FLORISTIC RECORDS FROM VARIOUS SQUARES IN FLORA OF TURKEY

Received 26.11.2002

Birol Mutlu[1]

**Abstract**

In this paper 28 species are reported as new records from A2, A3, A4, B3, B4, B5, B6, B8, C3, C4, C5, C9 and C10 squares in Turkish Flora.

**Key words**: New floristic records, Plant distribution, Flora, Turkey.

## Introduction

Biocographic data rapidly increased about plant of Turkey. Collected plant with floristic and revision research or other floristic excursions based on main material of this increase. These records were obtained from mainly revision of the genus *Arabis* L. in Turkey (1) and other floristic excursions on Ankara, Antalya, Bursa, Çankırı, Erzurum, Eskişehir, Hakkari, Isparta, Kayseri, Kırşehir, Muğla, Sivas, Şırnak and Yozgat province between 1998 and 2002.

## Material and Methods

During the difference fieldwork, plant materials have been collected between 1997-2000 from Turkey. These materials were identified according to *The Flora of Turkey and The East Aegean Islands* (2, 3, 4). After checking up carefully from the relevant papers about the district (6-22), 28 species have been found as new records for the A2, A3, A4, B3, B4, B5,

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B6, B8, C3, C4, C5, C9 and C10 squares in Turkish Flora. These species are given in the same arrangement, as it is followed alphabetical order. Phytogeograpical regions and endemism of the taxa were evaluated according to Davis (2, 3). Red Data Categories are given in the end of species locality as status (5). Abbreviations used in the text are as follows: Ir.-Tur.: Irano-Turanian, Medit.: Mediterranean, E. Medit.: East Mediterrancan, EN: Endangered; LR (lc): Lower Risk (least concern). Plant specimens are deposited at the Herbarium of Hacettepe University (HUB), Ankara.

## Results

**Apiaceae**

*Oenanthe silaifolia* Bieb.

**B4** Ankara: Gölbaşı, Mogan Lake, Gölova stream, N: 39.43.52.3-E: 32.46.59.3, 1000 m, 30/5/2001, **B. Mutlu** 7867.

**Asteraceae**

*Cnicus benedictus* L. var. *benedictus*

**C3** Antalya: Shore of Olimpos National Park, Adrasan Bay, before 2 km to Çavuş Village, 200 m, 24/5/2000, **B. Mutlu** 5737.

*Leontodon crispus* Vill. ssp. *asper* (Waldst. & Kit) Rohl. var. *setulosus* (Hal.) Kupicha

**B3** Eskişehir: Between Alpu-Özdenk villages, 840 m, 4/7/1999, **B. Mutlu** 5127.

**Brassicaceae**

*Arabis glabra* (L.) Bernhardi

**B8** Erzurum: Palandöken Mountain opposite side of Polat Otel, afforestation of *Pinus sylvestris,* 2100 m, 7/6/1999, **B. Mutlu** 4864.

This species name accepted as *Turritis glabra* L. in Flora of Turkey (Davis, 1965). But this name rejected in revision of *Arabis* (Mutlu, 2002)..

*Arabis hirsuta* (L.) Scop.

**B6** Sivas: Yolkaya, Kevgirbaba Hill, around of Karakale village, 1400 m, 9/6/1999, **B. Mutlu** 4894.

*Arabis nova* Vill.

**A2** Bursa: Gemlik, mixed forest of *Pinus. pinea* and *Quercus. coccifera*, rocky slopes, 550 m, 2/5/1999, **B. Mutlu** 4699.

*Arabis montbretiana* Boiss.

**C3** Antalya: Shore of Olimpos National Park, between Yaylakuzdere-Tahtalı, 1000 m, *Pinus brutia* forest, 11/6/2000, **B. Mutlu** 5948.

**C4** Antalya: Alanya, between Mahmutlar-Sarıveliler, *Pinus brutia* forest, road side, N: 36.31.44.9-E: 32.14.01.3, 1200 m, 4/4/2001, **B. Mutlu** 6501.

**C9** Sırnak: Entrance of Uludere, rocky slopes, N: 37.26.21.9-E: 42.53.07.9, 1365 m, 29/5/2002, **B. Mutlu** 7966-A.A.Dönmez.

**C10** Hakkari: Between Şemdinli-Şapatan passageway,2. km from Şemdinli, rocky slopes, N: 37.19.70.8-E: 44.33.50.8, 1556 m, 30/5/2002, **B. Mutlu** 7968-*A.A.Dönmez.*

*Arabis aucheri* Boiss.

**A4** Ankara: Güdül, around of İnönü Caves, 800 m, 10/4/2001, **B. Mutlu** 6248-*S. Erik-B.Tarıkahya.*

*Capsella rubella* Reuter

**B5** Kırşehir: Lake side of Seyfe, 650 m, 18/4/1998, **B. Mutlu** 2122. Medit. element.

*Conringia persica* Boiss.

**B8** Erzurum: Palandöken Mountain opposite side of Polat Otel, afforestation of *P. sylvestris*, 2100 m, 7/6/1999, **B. Mutlu** 4868.

*Erophila verna* (L.) ssp. *spathulata* (Lang.)Walters

**B5** Kayseri: Lakeside of Palas, 600 m, 18/4/1998, **B. Mutlu** 2175.

*Erysimum leptophyllum* (Bieb.) Andrz.

**B5** Yozgat: Pine grove of Yozgat, *Pinus nigra* forest, 1600 m, 9/6/1999, **B. Mutlu** 4886.

*Erysimum pallidum* Boiss.

**C3** Antalya: Saklıkent, Bakır Mountain, alpinic steppe, 2525 m, 3/8/2001, **B. Mutlu** 7741. Endemic. Status: EN.

*Neslia apiculata* Fisch

**B3** Isparta: Lake side of Eğirdir, 950 m, 25/5/1998, **B. Mutlu** 3417.

*Thlaspi kotschyanum* Boiss. & Hohen.

**B8** Erzurum: Palandöken Mountain opposite side of Polat Otel, afforestation of *P. sylvestris*, 2100 m, 7/6/1999, **B. Mutlu** 4873.

**Capparaceae**

*Cleome ornithopoides* L.

**C1** Muğla: Datça, 25 km from Datça, stream side, 50 m, 19/9/2000, **B. Mutlu** 6159.

**Caryophyllaceae**

*Saponaria orientalis* L.

**C3** Antalya: Shore of Olimpos National Park, between Yaylakuzdere-Tahtalı, 1000 m, *P. brutia* forest, **B. Mutlu** 5686.

*Silene vulgaris* (Moench) Garcke var. *macrocarpa* (Turrill) Coode & Cullen

**C1** Muğla: Datça, Mırdalı Bay, 10 m, 21/1/2001, **B. Mutlu** 6204.

**Cyperaceae**

*Carex rostrata* Stokes apud With

**B4** Ankara: Gölbaşı, Mogan Lake, Karaoğlan Stream, N: 39.45.13.3 - E: 32.47.55.1, 950 m, 30/5/2001, **B. Mutlu** 6870.

**Fabaceae**

*Dorycnium rectum* (L.) Ser.

**C3** Antalya: Shore of Olimpos National Park, Kesmeboğazı, 400 m, *P. brutia* forest, **B. Mutlu** 6003. Medit. element.

*Hippocrepis unisiliquosa* L. ssp *unisiliquosa*

**A3** Ankara: Beypazarı, before 2 km to Acısu village, 550 m, 10/5/1999, **B. Mutlu** 4726.

*Trigonella orthoceras* Kar. & Kir.

**B4** Ankara: Gölbaşı, Mogan Lake, entrance from Mogan to Eymir, N: 39.47.43.8 - E: 32.48.00.8, 950 m, 30/5/2001, **B. Mutlu** 6962. Ir.-Tur. element.

*Trifolium bullatum* Boiss. & Hausskn.

**C3** Antalya: Shore of Olimpos National Park, between Yaylakuzdere-Gedelme, 510 m, *P. brutia* forest, **B. Mutlu** 5882.

**Iridaceae**

*Gladiolus italicus* Miller

**B4** Ankara: Gölbaşı, Mogan Lake, Aras farm, N: 39.44.21.2 - E: 32.48.20.7, 950 m, 30/5/2001, **B. Mutlu** 6910.

**Liliaceae**

*Bellevalia tauri* Feinbrun

**B4** Ankara: Gölbaşı, Mogan Lake, Hacılar district, N: 39.45.28.2 - E: 32.45.43.9, 950 m, 30/5/2001, **B. Mutlu** 7116. E. Medit. element. Endemic. Status: LR (lc).

*Ornithogalum pyrenaicum* L.

**B4** Ankara: Gölbaşı, Mogan Lake, Taşpınar district, N: 39.49.09.1 - E: 32.47.49.6, 950 m, 7/6/2001, **B. Mutlu** 7012.

**Linaceae**

*Linum bienne* Miller

**B4** Ankara: Gölbaşı, Mogan Lake, Hacılar district, N: 39.45.45.7 - E: 32.45.07.2, 950 m, 7/6/2001, **B. Mutlu** 7081.

**Scrophulariaceae**

*Veronica persica* Poiret

**B4** Ankara: Gölbaşı, corner of 112. Street, 950 m, N: 39.47.21.6 – E: 32.49.08.4, **B. Mutlu** 7282.

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# *Phragmites frutescens* H. Scholz (*Gramineae*), A New Record For The Flora of Turkey

Received 09.12.2002

B. Mutlu [1]

**Abstract**

*Phragmites frutescens* H. Scholz from southwest Anatolia are described as new records for Turkey.

**Key Words:** *Phragmites*, *Gramineae*, new record, Turkey

## Introduction

*Phragmites* L. is represented by one species from Turkey. This species is *Phragmites australis* (Cav.) Trin. ex Steud. During a botanical trip to SW Turkey, an unrecognised specimen of *Gramineae* was collected. It was identified from the Flora of Turkey (Davis, 1985) and checked from suplementums (Davis et Tan, 1988; Güner, et al. 2000). After checking these, I realized that the specimen was different from *Phragmites australis*. By using the species description of "*Phragmites* in Crete" (Scholz, 1996) and "*Phragmites frutescens* (*Gramineae*) re-visited. The discovery of an overlooked, woody grass in Greece, especially Crete" (Scholz, Böhling, 2000) the specimen was identified as *Phragmites frutescens* H. Scholz. Author abbreviations follow Brummit and Povel (1992). The specimens were deposited at the Herbarium of Hacettepe University, Department of Biology (HUB).

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**Results and Discussion**

*Phragmites frutescens* H. Scholz, in Taxon 45 (3): 522. 1996.

Perennial, phoenicoid habit. Stems 3-6 m, axillaries sterile shoots present, at base up to 3 cm in diameter. Ligula a dense fringe of hairs, 0.5-1 mm when young also with a row of erect hairs to 1 cm on dorsal surface. Leaf sheaths embracing internodes; both leaf sheaths and blades (laminae) being easily deciduous on older stems, so exposing the culm internodes; apical of leaf blades stiffy pointed. Panicles lax, (10-) 20-35 cm. Spikelets 4-6 flowered, 7-11 mm. Gluma unequal, glabrous, lower ovat, acute, (2-) 3-5 mm; upper ovate-lanceolate, acute, 3-6 mm. Lemma narrowly lanceolate, lower lemma 6-9 mm. Upper lemma 4-7 mm. Paleas 2-3 mm. Callus 0,5-0,7 mm, callus hairs 4-5 (-6) mm. Anthers 1,2-1,8 mm. Flowering; Nov.-Jan.

Type: Greece: Crete: Nomos Hania, Eparhia of Apokoronos, between Jeorhioupolis and Litsardha, in ditches, 24 Apr. 1996. (HT: B).

General distribution: Mediterranean element. Greece, Crete, Rhodes and SW Anatolia.

Specimen seen: C1 Muğla: Datça-Bozburun road, turn to Bozburun, road side, 10 m, 22/11/2001, B. Mutlu 7868 (Fig.1).

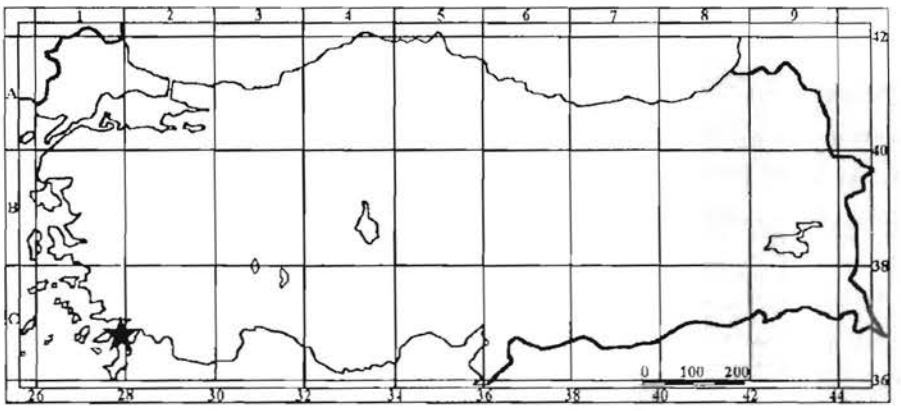


**Figure 1.** The distribution of *Phragmites frutescens* in Turkey

**Identification key to *Phragmites* species in Turkey;**

1-Lateral shoots usually absent. Leaf blade and tips soft, leaf sheaths tightly enclosing stem. Panicles dense, panicle base often enclosed in uppermost leaf sheath, lower branches with spikelets to the base. Floret per spikelets (3-) 4-12; spikelets 10-18 mm. Upper glume 5-12 mm, upper lemma (7-) 9-12 mm. Callus 1-1.5 mm, callus hairs (6-) 8-10 mm; anthers 2-4 mm. Flowering time August to October **australis**

1-Axillary sterile shoots present. Leaf blade coarse, tips pungent, leaf sheaths loosely enclosing stem. Panicles lax, panicle base usually free, lower branches without spikelets to the base. Floret per spikelets 4-6; spikelets 7-11 mm. Upper glume 3-6 mm, upper lemma 4-7 mm. Callus 0,5-0,7 mm, callus hairs 4-5-(6) mm. Anthers 1,2-1,8 mm. Flowering time November to January **frutescens**

The sylleptic and next-year(s)-branching of the culms, the "phoenicoid" habit (resembling the leaves of the *Phoenix* palm) of unbranched shoots and abscission of the leaves are the most practical features to recognize *P. frutescens* in field. Flowering period (November to January) and woody culms after flowering are other distinguishing features of *P. frutescens*.

Tall grasses such as the giant reed (*Arundo donax* L.) and *Phragmites* species are difficult to collect and preserve for taxonomic studies. It may well be assumed that any sterile *Phragmites* population has been regarded as belonging to *P. australis* or, perhaps, *Arundo* L. Because of these reasons were given above, other taxonomists have not been noticed this species until this time.

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# INVESTIGATION OF HEMATOLOGICAL AND HISTOPATHOLOGICAL EFFECTS OF *Castanea sativa* PROPOLIS IN MALE RATS

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**Abstract**

Propolis is a multifunctional material used by bees in the construction and maintenance of their hives. It is a popular folk medicine possessing a broad spectrum of biological activities including anticancer, antioxidant, antiinflammatory, antibiotic and antihepatotoxic. In the present study, we investigated the hematological and histopathological effects of *Castanea sativa* propolis in male rats. The ethanol-propolis extract at a dose of 200 mg/kg body weight/day was given by gavage to male rats for 15 days. At the end of the treatment, hematological parameters and serum electrolytes were analysed and weights of liver, kidney, spleen, adrenal gland and testis were recorded. On hematological examination, increases in red blood cell count, hemoglobin and hematocrit, and a decrease in platelets were observed in alcohol and propolis groups when compared to the control group. There were increases also in serum sodium, potassium and chloride levels of rats in alcohol and propolis groups, but there was a decrease in serum calcium level of rats at the same groups. A decrease in adrenal weights and relative weights of adrenal of rats in alcohol and propolis groups was also observed. Histopathologically, congestion in portal veins and sinusoids, mononuclear cell infiltration and hydropic degeneration in liver, congestion in cortex and medulla, and tubular damages in the kidney of rats in alcohol and propolis groups were observed.

**Key Words**: Propolis, hematology, histopathology, rat

## Introduction

Use of propolis by humans has a long history, predated only by the discovery of honey. Propolis contains 50-70 % resins and 10 % essential oils coming from the trees, mixed with 30-50 % wax for proper consistency and 5-10 % pollen acquired from being

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transported in the bees'pollen baskets (1). The worker bees apply the resin to seal any cracks and fissures in the hive and they line their front door with it to prevent contamination . They use it as an antiseptic in brood cells, and they mix propolis with wax to distribute a fine varnish over every inch of the hive to protect it (2). So far, 150 compounds have been identified from propolis (3).

The main chemical classes found in propolis are flavanoids, phenolics, and various aromatic compounds. Furthermore propolis contains many of the B-complex vitamins, important minerals and trace elements. The chemical composition of propolis is highly variable because of the broad range of plants visited by honey bees while collecting the substance. On the other hand, occasionally the bees may bring hazardous substances into the material e.g. asphalt in the propolis from road construction sites (4). Similarly, metals such as iron, zinc, copper and magnesium were reported in Cuban propolis (5) and heavy metals such as lead were detected in Brazilian propolis (6).

Propolis is relatively non-toxic, with a no-effect level (NOEL) in a 90 days-mouse study of 1400 mg/kg body weight/day (2). Although there are reports about its antibacterial, antiinflammatory, antihepatotoxic, antitumour, antioxidative, and antifungal effects (7-9), there is limited report related with the toxicity of propolis. In order to determine the toxicity of propolis, we investigated hematological, histopathological and morphological effects of *Castanea sativa* propolis in male rats.

**Materials & Methods**

**Animals and Experimental Design**

In the animal experiment, 30 male Wistar swiss albino male rats 2-3 months of age and weighing 185-210 g were used. The rats were obtained from the Experimental Animals Production Centre, Hacettepe University in Ankara, Turkey. The rats were divided randomly into three groups. Each group were housed in separate cages, and laboratory conditions were at 22±2 °C and with 65±5 % relative humidity during the study. The first group served as the control. The second group received 20 % ethanol (alcohol-control group) and the third group received ethanol-propolis extract (propolis group), each having 10 animals. The rats were fed with standard rat pellet diet and tap water. Propolis was prepared in 95 % ethanol and then its alcohol degree was reduced to 20 %. This ethanol-propolis extract (in 20 % ethanol) at a dose of 200 mg/kg body weight/day was daily administered by gavage to male rats for 15 days. So, same volume of 20 % alcohol depending on body weight of rats was given to rats in alcohol-control group during 15 days.

Chemical content of *Castanea sativa* propolis used in this study are aliphatic acids (2.22 %), alcohols (1.71 %), aromatic acids (1.52 %), aromatic acid esters (13.1 %), flavanones and flavones (31.8 %), ketones (24.7 %), terpenoids (4.50 %) and others (20.4 %) (10). *Castanea sativa* propolis mainly contain the important flavanoids including galangin (9.13 %), quercetin (6.21 %), kaempferol (5.84 %), apigenin (4.57 %), pinobanksin (1.96 %), pinocembrin (0.82 %), pinostobin (0.58 %) and others (2.69 %) (10).

At the end of the experiment, blood samples were collected from the hearts of rats under ether anesthesia. Hematological parameters, such as the red blood cell count (RBC), hemoglobin concentration (Hb), hematocrit (Hct), white bood cell count (WBC), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV) and platelets count (PLT) were assessed with an automated hematology analyzer (Coulter STKS Counter model S Plus). In the serum, calcium (Ca), sodium (Na), potassium (K) and chloride (Cl) levels were measured.

On the other hand, liver, kidney, spleen, adrenal gland and testis were dissected out and organ weights were measured. Relative organ weights were calculated. The above-mentioned organs were fixed in Bouin solution for routine histopathological processing. After routine processing, paraffin sections were stained with hematoxylin and eosin and then examined at light microscopic level.

**Statistical analysis**

Data for hematology, organ weights and relative organ weights were analysed using one way analysis of variance (ANOVA) (SPSS package program, version 9.0). The results were presented as the mean ± standard deviation (SD) for each parameters. Comparisons were made between the controls and the experimental group. Values of $p \leq 0.05$ were regarded as statistically significant.

**Results**

The results of hematological and serum electrolytes analyses are presented in Table 1 and 2. Significant increases in RBC and Hct of rats in alcohol and propolis groups were observed. Platelets decreased significantly in rats in both alcohol and propolis groups. There was no statistically significant change in WBC, MCH and MCHC of rats in treatment groups.

Regarding serum electrolytes analysis, a marked decrease was observed in Ca level of rats in both alcohol and propolis groups when compared with the control. There were significant increases in serum Na, K and Cl levels of rats in both alcohol and propolis groups.

**Table 1.** Hematological data of rats administered alcohol and propolis for 15 days.

| Parameters | Groups | | |
|---|---|---|---|
| | **Control** | **Alcohol** | **Propolis** |
| WBC ($x10^9$/l) | 4.86±0.61 | 3.44±0.33 | 4.21±0.30 |
| RBC ($x10^{12}$/l) | 6.73±0.07 | 7.33±0.11 [a] | 7.50±0.09 [a] |
| Hb (g/dl) | 13.7±0.30 | 14.6±0.13 | 14.6±0.15 |
| Hct (%) | 38.7±0.90 | 41.6±0.33 [a] | 41.5±0.52 [a] |
| MCH (pg) | 19.9±0.41 | 19.8±0.20 | 19.5±0.20 |
| MCHC (g/dl) | 34.7±0.24 | 34.9±0.14 | 35.2±0.18 |
| MCV (fl) | 56.7±0.84 | 56.8±0.49 | 55.2±0.47 |
| PLT ($x10^9$/l) | 891.8±28.7 | 700.0±18.1 [a] | 732.8±44.9 [a] |

Values are given as mean ± S.D.
[a] Significantly different from control group (P≤0.05)
[b] Significantly different from alcohol group (P≤0.05)

**Table 2.** Electrolytes levels in serum of rats administered alcohol and propolis for 15 days.

| Parameters | Groups | | |
|---|---|---|---|
| | **Control** | **Alcohol** | **Propolis** |
| Ca (mmol/l) | 2.79±0.03 | 2.50±0.01 [a] | 2.54±0.03 [a] |
| Na (mmol/l ) | 142.5±1.90 | 148.6±1.77 [a] | 152.7±1.12 [a] |
| K (mmol/l ) | 4.53±0.14 | 5.76±0.20 [a] | 5.98±0.21 [a] |
| Cl (mmol/l ) | 103.1±0.82 | 105.8±0.78 [a] | 109.3±0.77 [a, b] |

Values are given as mean ± S.D.
[a] Significantly different from control group (P≤0.05)
[b] Significantly different from alcohol group (P≤0.05)

Body weight, organ weight and relative organ weights are shown in Table 3. Body weight gain of rats in all groups showed a parallelizm. However, body weight gain of rats in alcohol group was high according to the control, although not statistically significant. There were increases in liver, kidney, testis and spleen weights of rats in alcohol and propolis groups, but only the increase in spleen weights was statistically significant. Adrenal weights of rats in alcohol group was significantly lower when compared to control and propolis groups. A significant decrease in the relative weights of kidney and adrenal of rats in alcohol group was also observed. There was no significant change in the relative weights of liver, spleen and testis of rats in both alcohol and propolis groups.

**Table 3.** Organ weights and relative organ weights of rats administered alcohol and propolis for 15 days.

| | Groups | | |
|---|---|---|---|
| | **Control** | **Alcohol** | **Propolis** |
| Initial weight (g) | 197.25±6.09 | 210.5±9.60 | 213.75±6.59 |
| Final weight (g) | 240.75±4.34 | 262.5±5.69 | 262.75±8.47 |
| Increase % | 22.0 | 24.7 | 22.9 |
| Organ weights (g) | | | |
| Liver | 9.69±0.25 | 10.26±0.50 | 10.17±0.40 |
| Kidney | 0.98±0.01 | 0.91±0.02 | 0.92±0.03 |
| Spleen | 0.53±0.04 | 0.63±0.06 | 0.71±0.05 [a] |
| Testis | 1.24±0.02 | 1.31±0.04 | 1.28±0.02 |
| Adrenal | 0.038±0.002 | 0.030±0.002 [a] | 0.040±0.003 [b] |
| Relative organ weights | | | |
| Liver ($10^{-3}$) | 40.8±0.89 | 38.8±1.20 | 38.5±0.61 |
| Kidney ($10^{-3}$) | 3.72±0.07 | 3.47±0.07 [a] | 3.51±0.08 |
| Spleen ($10^{-3}$) | 2.22±0.15 | 2.40±0.19 | 2.70±0.18 |
| Testis ($10^{-3}$) | 5.17±0.11 | 5.01±0.13 | 4.90±0.10 |
| Adrenal ($10^{-4}$) | 1.61±0.13 | 1.13±0.08 [a] | 1.51±0.12 [b] |

Values are given as mean ± S.D.
[a] Significantly different from control group (P≤0.05)
[b] Significantly different from alcohol group (P≤0.05)

The results of histopathological examination are summarized in Table 4. The congestion in portal veins and sinusoids, mononuclear cell infiltration and hidropic degeneration in hepatocytes in the liver of rats were observed in both alcohol and propolis groups. The congestion and tubular damage were observed in the kidney of rats in alcohol and propolis groups. There was no histopathological change in the spleen, adrenal gland and testis of treated rats.

**Table 4.** Incidence of observed histopathological changes in male rats administered alcohol and propolis for 15 days.

| | Groups | | |
|---|---|---|---|
| | **Control** | **Alcohol** | **Propolis** |
| **Liver** | | | |
| Congestion in veins and sinusoids | 0 | 7 | 7 |
| Hidropic degeneration | 0 | 7 | 7 |
| Mononuclear cell inflitration | 0 | 3 | 4 |
| **Kidney** | | | |
| Congestion in cortex | 0 | 10 | 10 |
| Congestion in medulla | 0 | 6 | 4 |
| Mononuclear cell infiltration | 0 | 6 | 6 |
| Tubular damage | 0 | 10 | 6 |

Numbers indicate the numbers of animals with observed histopathological changes in their tissues

**Discussion**

The plant species avaible in a geographic area determine the amounts of important compounds present in propolis (3). A recent study of New Zealand propolis revealed that the important dihydroflavonoids pinobanksin and pinocembrin made up approximately 70 % of the flavanoids in the samples analysed. A similar study of Brazilian, Uruguayan and Chinese samples showed dihydroflavonoids to comprise less than 10 % in all but one sample, which had 50 %. *Castanea sativa* propolis mainly contain the important flavanoids with a level of 31.8 % including galangin, quercetin, kaempferol, apigenin, pinobanksin, pinocembrin, and pinostobin (10). On the other hand, occasionally it may contain hazardous substances such as asphalt, metals, and heavy metals (4-6). In the present study, we investigated hematological, histopathological and morphological effects of propolis in male rats, as some of these compounds may cause toxic effects.

There was no statistically significant change in WBC, MCH and MCHC of rats in treatment groups. Significant increases in RBC and Hct of rats in both alcohol and propolis groups were observed. Platelets decreased significantly in rats in both alcohol and propolis groups. The decrease in platelets may be related to the hemorrhagic toxicity of alcohol. Congestion observed in the liver and kidney of rats in alcohol and propolis groups support this assumption.

When compared to the control group, a significant decrease was observed in the Ca levels of rats in both alcohol and propolis groups. There were significant increases in serum Na, K and Cl levels of rats in alcohol and propolis groups. Changes in serum electrolytes (Na, Ca and K) interact with each other; a decrease in one of them is frequently tied to an increase in one of the others (11). Serum electrolyte levels of rats in alcohol and propolis groups showed similar changes. Alcohol may have caused a change in the permeability of plasma membrane.

Body weight gain of rats in all groups showed a parallelizm. However, body weight gain of rats in alcohol group was higher than the control, but not statistically significant. There were increases in liver, kidney and spleen weights of rats in treatment groups, but only the increase in spleen weights was statistically significant. The increase in spleen weight may be related with the increase in RBC, Hb and Hct. Adrenal weights of rats in alcohol group was significantly decreased according to control and propolis groups. Also a significant decrease was observed in the relative kidney and adrenal weights of rats in alcohol group. There was no significant change in relative liver, spleen and testis weights of treated rats.

Regarding histopathological examination, the congestion in portal veins and sinusoids, mononuclear cell inflitration and hidropic degeneration in hepatocytes in the liver of rats in both alcohol and propolis groups were observed. It was reported that propolis (at dose of 200 mg/kg body weight/day) caused protective effect in liver damage and lipid accumulation, which was demonstrated by AST enzyme level and the lipid profile in serum (10), in the present study although histopathological lesions were observed in the liver. Merino et al. (12) found a significant reduction of ballooned cells in the liver of rats treated with propolis at doses 25, 50 and 100 mg/kg body weight compared with $CCl_4$-treated group. Ramirez et al. (8) reported also hepatoprotective effects of Cuban propolis on acetaminophen-administered liver injury in mice. The congestion and tubular damage were also observed in the kidney of rats in both alcohol and propolis groups. There was no histopathological change in the spleen, adrenal gland and testis of treated rats.

As a conclusion, these changes observed in propolis group may be attributed to the alcohol that was found in the propolis extract, as same changes were determined in both alcohol and propolis groups. The findings are probably the toxicological effects of alcohol. We suggest that propolis did not cause significant changes in male rats.

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# FLORA OF ANKARA CITY

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**Abstract**

This study is concerned with the native flora of the city of Ankara. Research conducted over a period of three years determined that there are 1142 taxa (including 995 species, 147 subspecies and varietas) belonging to 385 genera and 76 families. The number of endemic species in the area is 146, which corresponds to 14.6 % of the total number of species. Of the 995 species of flora 276 (27.7 %) are Irano-Turanian, 76 (7.6 %) are Mediterranean, and 62 (6.2 %) are Euro - Siberian elements. The remaining 581 species (58.3 %) are multiregional.

**Key Words:** Flora, Flora of City, Ankara

## Introduction

In the past few years there has been an increase in the number of floristic studies in the natural areas surrounding Ankara (1,2,3). The first book presenting data on Ankara plants is called " Ankara'nın Floru" by Krause (4) enables a comparison between the current data and data in the past. The other research performed in the city was carried out by J. Hantz (5). This study is based on 53 plant species from different areas in Ankara; there are no other studies considering Ankara city flora.

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**General Properties of the Study Area**

Ankara, in the north of central Anatolia, lies in the line between 38°-43` and 40°-41` north latitude and 30°-51` and 34°-05` east longitude. Ankara Plateau, is a transitional area between north Anatolia, rather hilly, mountainous and forested, and Konya Plain which is rather flat and dry. The province is surrounded by Kızılırmak in the east and the Engürü plain stretching in the direction of East-West in the West. Ankara province lies in the eastern part of this plain (6). In the north of the study area lies Bağlum, in the south Gölbaşı, in the east Elmadağ, in the West Sincan and Etimesgut towns. The study area includes towns such as Altındağ in the centre, Keçiören in the north, Çankaya in the south, Mamak in the east and Yenimahalle in the West.

The study area is in the squares A4 and B4 (7). While Aktepe, Hacıkadın Deresi, Kuşçağız, Sanatoryum, Yükseltepe and Esentepe areas under the authority of Keçiören Municipality extending along the north intersection of Çubuk Dam road are in A4, the places in the south of these areas are in square B4.

This study mainly aims to identify the natural floristic structure of an urban area, Ankara. The other reasons for the selection of Ankara as the area of study are as follows: to identify the effects of rapid urbanisation on the natural flora of the city, to identify the extent to which some plants collected in Ankara in 1834, recorded in Ankara flora, are threatened with extinction, to form a data base for similar studies in the future.

**Materials and Methods**

3600 plant samples were collected from 1993-1995 during 180 excursions. The identification was done with reference to the Flora of Turkey (7,8) ; Flora of Iraq (9), Flora Europaea (10). The identified plants were checked in the herbaria in Hacettepe, Ankara and Gazi Universities. Experts were consulted for the identification of species : Prof. Dr. Musa Doğan for *Poaceae*, Prof. Dr. Şinasi Yıldırımlı for *Brassicaceae*, Prof. Dr. Mehmet Koyuncu for *Allium*, Prof. Dr. Mecit Vural for *Verbascum*, and Prof. Dr. Ekrem Sezik for *Orchidaceae*.

Amongst the collected specimens during the study, only the new ones for HUB were kept in this Herbarium. All the other specimens were kept in the reference Herbarium in Faculty of Science Education. The findings were presented with reference to the Flora of Turkey (7), and all the taxa were classified with reference to the evolutionary order. While presenting localities, samples corresponding to different squares in the study area were

**RESULTS** (Floristic list)

The list of the vascular plant species, found in Ankara City. The sequence of families, genera and species in the following list follows the system adopted in the Flora of Turkey (7).

## PTERIDOPHYTA

### EQUISETACEAE

***Equisetum ramosissimum*** Desf.

B4 Dikmen, Keklik pınarı, 1100 m, 6/8/1995, *Akaydın* 4489.

***E. arvense*** L.

A4 Keçiören,Hacıkadın Stream, 940m, 2/5/1995, *Akaydın* 3405.

## SPERMATOPHYTA

## GYMNOSPERMAE

### CUPRESSACEAE

***Juniperus oxycedrus*** L. subsp. ***oxycedrus***

A4 Keçiören, Hacıkadın, 980 m, 3/5/1995, *Akaydın* 3895.

***J. excelsa*** M.Bieb

B4 Dikmen, Keklik Pınarı, rocky slopes, 1200 m, 5/4/1995, *Akaydın* 3177.

### EPHEDRACEAE

***Ephedra major*** Host

A4 Hasköy, Dam District, rocky slopes, 950 m, 3/8/1993, *Akaydın* 2295.

## ANGIOSPERMAE

## DICOTYLEDONAE

### RANUNCULACEAE

***Nigella latisecta*** P.H.Davis

B4 Mamak, Tuzluçayır, 970 m, 29/7/1995, *Akaydın* 4399. **Ir.-Tur.**

***N. segetalis*** M.Bieb

B4 Bahçelievler, TEK surroundings, 850 m, 30/5/1993, *Akaydın* 1727.

***N. arvensis*** L. subsp. ***brevifolia*** Strid var. ***glauca*** Boiss.

B4 Çankaya, Botanical Garden, 1000 m, 10/7/1993, *Akaydın* 1938.

***N. nigellastrum*** (L.) Willk.

B4 Balgat, Çiğdem District, environs of Buildings, 1000 m, 26/6/1995, *Akaydın* 4172.

***Delphinium venulosum*** Boiss.

A4 Hasköy, Dam District, 950 m, 3/8/1993, *Akaydın* 2303. **End. Ir.-Tur.**

***Consolida thirkeana*** (Boiss.) Schröd.

B4 Dikmen, Keklik Pınarı,1100 m., 3/7/1993, *Akaydın* 1814. **End.**

***C. orientalis*** (Gay) Schröd.

A4 Keçiören, Kuşcağız District, 1070 m, 27/6/1993, *Akaydın* 1580.

***C. regalis*** Gray subsp. ***paniculata*** (Host) Soo' var. ***paniculata***

B4 Yenimahalle, A.K.M. surroundings, 830 m, 13/7/1993, *Akaydın* 2032.

***C. raveyi*** (Boiss.) Schröd.

B4 Çankaya, rocky slopes, 1000 m, 5/7/1993, *Akaydın* 1845. **End. Ir.-Tur.**

***C. hellespontica*** (Boiss.) Chater

B4 Balgat, Karakusunlar village, open places, 1000 m, 13/6/1995, *Akaydın* 4028.

***Adonis aestivalis*** L. subsp. ***aestivalis***

B4 Gazi District, 880 m, 6/5/1993, *Akaydın* 1084.

***A. flammea*** Jacq.

A4 Keçiören, environs of Bağlum road, 1000 m, 17/4/1994, *Akaydın* 2585.

***Ranunculus sericeus*** Banks et Sol.

B4 Dikmen, stream banks, 1000 m, 6/6/1995, *Akaydın* 3009. **Ir.-Tur.**

***R. neapolitanus*** Ten.

B4 Mamak dump, 1100 m, 8/5/1994, *Akaydın* 2750.

***R. repens*** L.

A4 Keçiören, Hacıkadın Stream, 950 m, 30/5/1995, *Akaydın* 3816.

***R. constantinopolitanus*** (D'Cruz) d'Urv.

B4 Yenimahalle, Akköprü, surroundings of A.K.M., 830 m, 1/5/1995, *Akaydın* 3342.

***R. damascenus*** Boiss. et Gaill.

B4 Sokullu, open places, 1100 m, 30/4/1995, *Akaydın* 3336., **Ir.-Tur.**

***R. oxyspermus*** Willd.

B4 Anıttepe, 850 m, 22/5/1993, *Akaydın* 1227.

***R. argyreus*** Boiss.

B4 Hasköy, Solfasol, open places, 900 m, 17/5/1993, *Akaydın* 1191.

***R. cuneatus*** Boiss.

A4 Keçiören, Aktepe, afforestation area, 1000 m, 25/5/1995, *Akaydın* 3255.

***R. reut.ianus*** Boiss.

B4 Bahçelievler, environs of TEK, 860 m, 24/4/1994, *Akaydın* 2623. **End.**

***R. illyricus*** L. subsp. ***illyricus***

B4 Mamak, edges of dump road, 1100 m, 8/5/1994, *Akaydın* 2740.

***R. isthmicus*** Boiss. subsp. ***stepporum*** P.H.Davis

B4 Balgat, Çiğdem District, 1000 m, 4/6/1995, *Akaydın* 3932.

***R. marginatus*** d' Urv. var. ***trachycarpus*** ( Fisch.et Mey.) Azn.

B4 A.O.Ç., afforestation area, 900 m, 15/5/1994, *Akaydın* 2778.

***R. arvensis*** L.

B4 Dikmen, Öveçler, 1100 m, 10/6/1995, *Akaydın* 3989.

***R. sceleratus*** L.

A4 Keçiören, Aktepe, afforestation area, 970 m, 25/5/1995, *Akaydın* 3616.

***R. trichophyllus*** Chaix

B4 Çankaya, İmrahor Stream, 1000 m, 3/4/1994, *Akaydın* 2542.

***Ceratocephalus falcatus*** (L.) Pers.

A4 Keçiören, Kuşcağız District,1070 m, 26/3/1995, *Akaydın* 3160. B4 Cebeci, Topraklık, 960 m, 28/4/1995, *Akaydın* 3311.

**BERBERIDACEAE**

***Berberis crataegina*** D'Cruz

A4 Keçiören, Hacıkadın Stream, step, 980 m, 30/5/1995, *Akaydın* 3805.

**PAPAVERACEAE**

***Glaucium corniculatum*** (L.) Rud. subsp. ***corniculatum***

B4 Gazi District, A.O.Ç., State Cemetery, 870 m, 24/5/1994, *Akaydın* 2843.

subsp. ***refractum***. (Na'be'lek.)Cullen

B4 Çankaya, Botanical Garden,1000 m, 5/7/1993, *Akaydın* 1180. **Ir.-Tur.**

***G. grandiflorum*** Boiss. et A.L.P.Huet. var. ***grandiflorum***

B4 Beştepe, afforestation area, 880 m, 6/5/1993, *Akaydın* 1092.

***G. leiocarpum*** Boiss.

B4 Çankaya, Portakal Çiçeği valley, 1000 m, 25/6/1993, *Akaydın* 1524.

***Roemeria hybrida*** (L.) D'Cruz. subsp. ***hybrida***

B4 Balgat, Cevizlidere valley, 930 m, 24/4/1994, *Akaydın* 2640.

***Papaver rhoeas*** L.

A4 Keçiören, Hacıkadın Stream, step, 980 m, 19/6/1993, *Akaydın* 1400.

***P. lacerum*** Popov

B4 Keçiören, Gazino surroundings, 950 m, 12/7/1993, *Akaydın* 1991.

***P. commutatum*** Fisch. et Mey.

B4 Cebeci, 880 m, 8/5/1993, *Akaydın* 1121.

***P. dubium*** L.

B4 Beştepe, Atatürk High School surroundings, 850 m, 15/5/1994, *Akaydın* 2771.

***P. minus*** (Boivin) Meikle

B4 Keçiören, Kuyubaşı District, 950 m, 25/5/1995, *Akaydın* 1234. **E.Medit.**

***Hypecoum procumbens*** L.

B4 Gazi District, State Cemetery, 900 m, 18/3/1995, *Akaydın* 3124. **Medit.**

***H. imberbe*** Sibthorp et Sm.

B4 Cebeci, Environs of Hacettepe Hospital, 880 m, 29/4/1995, *Akaydın* 3299.

***H. pendulum*** L.

B4 Beştepe, 880 m, 23/4/1995, *Akaydın* 3244.

***Fumaria officinalis*** L.

B4 Yenimahalle, AKM surroundings, 830 m,16/4/1994, *Akaydın* 2576.

***F. cilicica*** Hausskn.

A4 Keçiören,Hacıkadın Stream,950 m,29/5/1994,*Akaydın* 2925.

***F. vaillatii*** R.J.Loisel

B4 Çankaya, Portakal Çiçeği valley, 970 m, 25/6/1993, *Akaydın* 1529.

***F. parviflora*** Lam.

B4 Cebeci, , 880 m, 8/5/1993, *Akaydın* 1107.

***F. asepala*** Boiss.

B4 Mamak, dump surroundings, 1100 m, 8/5/1994, *Akaydın* 2735. **Ir.-Tur.**

**CRUCIFERAE (BRASSICACEAE)**

***Brassica elongata*** Ehrh.

A4 Keçiören, Hacıkadın Stream, 950 m, 19/6/1993, *Akaydın* 1380.

***Sinapis arvensis*** L.

B4 Dikmen, Keklik Pınarı, stream banks, 1100 m, 10/6/1995, *Akaydın* 3985.

***Hirschfeldia incana*** (L.) Lag.-Foss.

B4 Keçiören, Kalaba, 860 m, 2/6/1995, *Akaydın* 3839.

***Diplotaxis tenuifolia*** (L.) D'Cruz

B4 Çankaya, Portakal Çiçeği valley, 950 m, 25/6/1993, *Akaydın* 1526.

***Raphanus raphanistrum*** L.

B4 Çankaya, Portakal Çiçeği valley, 950 m, 25/6/1993, *Akaydın* 1523.

***Crambe tataria*** Sebeo'k var. ***tataria***

A4 Keçiören, Bağlum road, 14.km, 1000 m, 17/4/1994, *Akaydın* 2597.

***C. orientalis*** L. var. ***orientalis***

B4 Keçiören, Kuyubaşı, 950 m, 28/5/1993, *Akaydın* 1255. **Ir.-Tur.**

***Rapistrum rugosum*** (L.) All.

B4 Yenimahalle, Demetevler, Karşıyaka Cemetery, 950 m, 9/4/1995, *Akaydın* 3193.

***Conringia orientalis*** (L.) Andrz.

B4 Çankaya, Oran, open places, 1000 m, 5/5/1994, *Akaydın* 2721.

***C. planisiliqua*** Fisch. et Mey.

B4 Dikmen, Keklik Pınarı, 1000 m, 28/4/1994, *Akaydın* 2642. **Ir.-Tur.**

***C. perfoliata*** (C.A.Mey.) Busch

B4 Dikmen Atatürk Sitesi surroundings,1130 m, 28/4/1995, *Akaydın* 3280.

***Lepidium perfoliatum*** L.

B4 Cebeci, 50. Yıl Park, 960 m, 9/5/1993, *Akaydın* 1128.

***L. latifolium*** L.

A4 Keçiören, Kuşcağız District,1070 m, 27/6/1993, *Akaydın* 1606.

***Cardaria draba*** (L.) Desv. subsp. ***draba***

B4 Bahçelievler, TEK surroundings, 860 m, 5/6/1993, *Akaydın* 1269.

subsp. ***chalepensis*** (L.) Schulz

A4 Keçiören, Aktepe, 1000 m, 25/4/1995, *Akaydın* 3266.

***Isatis glauca*** Aucher ex Boiss. subsp. ***glauca***

B4 Anıttepe, 900 m, 29/6/1993, *Akaydın* 1691. **Ir.-Tur.**

***Aethionema arabicum*** (L.) Andrz. ex D'Cruz

A4 Keçiören, Hacıkadın Stream, 970 m, 27/3/1994, *Akaydın* 2505.

***Ae. armenum*** Boiss.

B4 Dikmen, Cevizlidere valley, 900 m, 6/6/1994, *Akaydın* 2984. **Ir.-Tur.**

***Thlaspi perfoliatum*** L.

B4 Cebeci, Mutlu District, İncesu Stream, 960 m, 16/4/1995, *Akaydın* 3211.

***T. oxyceras*** (Boiss.) S.N.Hedge

B4 Balgat, 1000 m, 22/3/1995, *Akaydın* 3132.

***Capsella bursa-pastoris*** (L.) Medik.

B4 Cebeci, 50. Yıl Parkı, 960 m, 9/5/1993, *Akaydın* 1127.

***Boreava orientalis*** Jaub..et Spach

B4 Dikmen, Akpınar District,1100 m, 6/6/1994, *Akaydın* 3003.

***Euclidium syriacum*** (L.) R.Br.

B4 Yenimah. Akköprü, AKM surroundings, 830 m, 1/5/1995, *Akaydın* 3341.

***Neslia apiculata*** Fisch.

B4 Dikmen, 1200 m, 15/5/1995, *Akaydın* 3535.

***Fibigia clypeata*** (L.) Medik.

B4 Dikmen, Keklik Pınarı, 1200 m, 15/5/1995, *Akaydın* 3542.

***Alyssum linifolium*** Stephan ex. Willd. var. ***linifolium***

B4 Beştepe, Yumurtatepe 870 m, 12/5/1993, *Akaydın* 1155.

var. ***teheranicum*** Bornm.

B4 Balgat, Çiğdem District, open places, 1050 m, 22/3/1995, *Akaydın* 3131.

***A. blepharocarpum*** Dudley et Hub.-Mor.

B4 Beştepe, 900 m, 24/5/1994, *Akaydın* 2848. **End. Ir.-Tur.**

***A. dasycarpum*** Stephan ex Willd.

B4 Beştepe, 880 m, 24/4/1993, *Akaydın* 1033.

***A. desertorum*** Stapf var. ***desertorum***

B4 Mamak, Çiğiltepe, 900 m, 23/4/1994, *Akaydın* 2618.

var. ***prostratum*** Dudley

B4 Dikmen, Sokullu, rocky slopes, 1100 m, 5/4/1995, *Akaydın* 3170.

***A. minutum*** Schltr. ex D'Cruz

B4 Keçiören, Kalaba, rocky slopes, 860 m, 26/3/1995, *Akaydın* 3152.

***A. strictum*** Willd.

B4 Dikmen, Keklik Pınarı, 1130 m, 6/6/1994, *Akaydın* 3016. **Ir.-Tur.**

***A. szowitsianum*** Fisch. et Mey.

A4 Keçiören, Hacıkadın Stream, 970 m, 1/5/1994, *Akaydın* 2661.

***A. minus*** (L.) Rothm. var. ***micranthum*** (Meyer) Dudley

B4 Cebeci, Aktepe, 50.Yıl Park, 960 m, 9/5/1993, *Akaydın* 1133.

***A. strigosum*** Banks et Sol. subsp. ***Strigosum***

B4 Beştepe, 920 m, 23/4/1995, *Akaydın* 3234.

***A. hirsutum*** M.Bieb

B4 Dikmen, Sokullu, open places, 1100 m, 30/4/1995, *Akaydın* 3330.

***A. corningii*** Dudley

B4 Balgat, Çiğdem District, 1100 m,27/5/1995, *Akaydın* 3671. **End. Ir.-Tur.**

***A. pateri*** Nya'r. subsp. ***Pateri***

B4 Keçiören, 950 m, 25/7/1993, *Akaydın* 2190. **End. Ir.-Tur.**

***A. sibiricum*** Willd.

B4 Balgat, 1000 m, 13/6/1995, *Akaydın* 4024.

***A. condensatum*** Boiss.et Hausskn. subsp.***flexibile*** (Nya'r) Dudley

B4 Yenimahalle, A.O.Ç., State Cemetery, 880 m, 15/5/1994, *Akaydın* 2776.

***A. filiforme*** Nya'r.

B4 Balgat, Çiğdem District, 1050 m, 4/6/1995, *Akaydın* 3929. **End. Ir.-Tur.**

***A. murale*** Waldstein et Kit. subsp. ***murale*** var. ***murale***

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1865.

***Clypeola jonthlaspi*** L.

B4 Çankaya, İmrahor Stream, 1050 m, 16/5/1995, *Akaydın* 3551.

***Erophila verna*** (L.) Chevall. subsp. ***Verna***

B4 Söğütözü, Çukurambar, open places, 900 m, 2/4/1994, *Akaydın* 2518.

subsp. ***spathulata*** (Lang) Walters

B4 Gazi District, tren roadsides, 820 m, 8/3/1995, *Akaydın* 3115.

***Arabis nova*** Vill.

A4 Keçiören,Bağlum Yolu, 1000 m, 17/4/1994, *Akaydın* 2595.

***Nasturtium officinale*** R.Br.

B4 Dikmen, Keklik Pınarı, 1100 m,10/6/1995, *Akaydın* 3982.

***Barbarea plantaginea*** D'Cruz

B4 Mamak, stream banks, 1000 m, 8/5/1994, *Akaydın* 2760.

***Cardamine hirsuta*** L.

A4 Keçiören,Hacıkadın Stream, 960 m, 22/4/1995, *Akaydın* 3225.

***Matthiola longipetala*** (Vent.) D'Cruz subsp. ***longipetala***

B4 Dikmen, Keklikpınarı, 1100 m, 24/7/1995, *Akaydın* 4361.

subsp. ***bicornis*** (Sibthorp et Smith) P.W.Ball

B4 Demetevler, Lalegül, 850 m, 13/6/1993, *Akaydın* 1309.

***Chorispora tenella*** (Pall.) D'cruz

B4 Yenimahalle, Akköprü, A.K.M. surroundings, 830 m, 1/5/1995, *Akaydın* 3346.

***Hesperis pendula*** D'Cruz

B4 Çankaya, Botanical Garden, rocky slopes, 1000 m, 01/5/1994, *Akaydın* 2679.

***Malcolmia africana*** (L.) R.Br.

B4 Beştepe, State Cemetery, 900 m, 15/5/1994, *Akaydın* 2786.

***M. crenulata*** (D'Cruz) Boiss.

B4 Çankaya, İmrahor Stream, 1200 m, 3/4/1994, *Akaydın* 2532. Det. S.Erik. **Ir.-Tur.**

***Erysimum diffusum*** Ehrh.

B4 Cebeci, Aktepe, 50.Yıl Park, 960 m, 23/6/1993, *Akaydın* 1492. **Euro.- Sib.**

***E. crassipes*** Fisch. et Mey.

A4 Keçiören, Aktepe, open places, 950 m, 21/7/1995, *Akaydın* 4322.

***E. repandum*** L.

B4 Bahçelievler, TEK surroundings, 850 m, 24/4/1994, *Akaydın* 2632.

***Alliaria petiolata*** (M.Bieb.) Cavara et Grande

B4 Yenimahalle, Akköprü, 830 m, 1/5/1995, *Akaydın* 3345.

***Sisymbrium altissimum*** L.

B4 Bahçelievler, TEK surroundings, 850 m, 24/4/1994, *Akaydın* 2631.

***S. loeselii*** L.

B4 G.O.P. Çiçekdağı, open places, 950 m, 27/7/1993, *Akaydın* 2223.

***Descurainia sophia*** (L.) Webb ex Prantl

A4 Keçiören, Hacıkadın Stream, 950 m, 19/6/1993, *Akaydın* 1430.

***Torularia torulosa*** (Desf.) Schulz

B4 Cebeci, Topraklık, 50. Yıl Parkı, 960 m, 29/4/1995, *Akaydın* 3326.

***Camelina laxa*** C.A.Mey.

B4 Mamak, Gülveren, afforestation area, 950 m, 23/4/1994, *Akaydın* 2619.

***C. rumelica*** Vell.

B4 Dikmen, Keklikpınarı, 1100 m, 28/5/1995, *Akaydın* 3710.

***C. microcarpa*** Andrz.

A4 Keçiören, Bağlum road, 14. km, 950 m, 17/4/1994, *Akaydın* 2596.

***C. hispida*** Boiss. var. ***grandiflora*** (Boiss.) Hedge

B4 Gazi District, 880 m, 6/5/1993, *Akaydın* 1070. **End.**

**CAPPARACEAE**

***Capparis ovata*** Desf. var. ***canescens*** (Coss.) Heywood

B4 G.O.P. Kırkkonaklar, valley slopes, 950 m, 28/7/1993, *Akaydın* 2234.

**RESEDACEAE**

***Reseda lutea*** L. var. ***lutea***

B4 Gazi District, Gazi Univ. 850 m, 11/6/1993, *Akaydın* 1289.

***R. luteola*** L.

B4 Çankaya, İmrahor Stream, 1000 m, 8/8/1993, *Akaydın* 2356.

**CISTACEAE**

***Helianthemum nummularium*** (L.) Miller subps. ***lycaonicum*** Coode et Cullen

B4 Balgat, Çiğdem District, 1050 m, 27/5/1995, *Akaydın* 3635. **End.**

***H. canum*** (L.) Baumg.

B4 Dikmen, Sokullu, 1100 m, 15/5/1995, *Akaydın* 3514.

***H. ledifolium*** (L.) Miller var. ***ledifolium***

A4 Keçiören, Hacıkadın Stream, 970 m, 25/5/1995, *Akaydın* 3625.

***H. salicifolium*** (L.) Miller

B4 Beştepe, 880 m, 23/4/1995, *Akaydın* 3248.

***Fumana procumbens*** (Dun) Gren. et Godr.

B4 Mamak, 970 m, 29/7/1995, *Akaydın* 4416.

***F. paphlagonica*** Bornm. et Janch.

B4 Dikmen, Sokullu, 1100 m, 6/6/1995, *Akaydın* 3942. **End ? Ir.-Tur.**

***F. aciphylla*** Boiss.

B4 100.Yıl, Karakusunlar, 950 m, 18/6/1995, *Akaydın* 4118.

**VIOLACEAE**

***Viola odorata*** L.

B4 Balgat, 880 m, 2/4/1994, *Akaydın* 2531.

***V. occulta*** Lehm.

B4 Gazi District, 830 m, 18/3/1995, *Akaydın* 3114.

***V. parvula*** Tineo

B4 Keçiören, Kalaba, rocky slopes, 860 m, 26/3/1995, *Akaydın* 3144.

***V. kitaibeliana*** Roem. et Schult.

B4 Tepebaşı, 970 m, 9/4/1995, Akaydın 3182.

**POLYGALACEAE**

***Polygala supina*** Schreb.

B4 Mamak, dump, open places, 1200 m, 8/4/1994, *Akaydın* 2726.

***P. pruinosa*** Boiss. subsp. ***pruinosa***

B4 Kayaş, Üreğil, 1000 m, 19/7/1993, *Akaydın* 2079.

***P. anatolica*** Boiss. et Heldr.

B4 Çankaya, Oran, 980 m, 7/7/1993, *Akaydın* 1903.

***P. papilionaceae*** Boiss.

B4 Dikmen, Atatürk Sitesi, 1000 m, 6/6/1994, *Akaydın* 3012.

**CARYOPHYLLACEAE**

***Arenaria serpyllifolia*** L.

B4 Cebeci, Topraklık, 50.Yıl Park, 960 m, 29/4/1995, *Akaydın* 3315. B4 Balgat, Karakusunlar Cemetery, 1000 m, 13/6/1995, *Akaydın* 4000.

***A. ledebouriana*** Fenzl var. ***ledebouriana***

A4 Keçiören, Bağlum roadsides, open places, 980 m, 24/7/1993, *Akaydın* 2143. **End.**

***Minuartia juniperina*** (L.) Maire et Petitm.

B4 Çankaya, TRT Buildings, surroundings, 1050 m, 26/4/1994, *Akaydın* 2605.

***M. hamata*** (Hausskn.) Mattf.

B4 Cebeci, Topraklık, 960 m, 29/4/1995, *Akaydın* 3316.

***M. anatolica*** (Boiss.) Woronow var. ***arachnoidea*** Mc Neill

B4 Dikmen, Sokullu, 1100 m, 2/7/1993, *Akaydın* 1789b. **End. Ir.-Tur.**

***Cerastium perfoliatum*** L.

B4 Dikmen, Sokullu, rocky slopes, 1100 m, 30/4/1995, *Akaydın* 3333.

***C. dichotomum*** L. subsp. ***dichotomum***.

A4 Keçiören, Hacıkadın Stream, 960 m,13/5/1995, *Akaydın* 3488.

***C. gracile*** Dufr.

B4 Gazi District, 830 m, 18/3/1995, *Akaydın* 3119.

***Holosteum umbellatum*** L. var. ***umbellatum***.

A4 Keçiören, Kuşcağız Park, 1070 m, 26/3/1995, *Akaydın* 3164.

var. ***glutinosum*** (M.Bieb) Gay

B4 Beştepe, State Cemetery,880 m, 10/4/1994, *Akaydın* 2546.

***Moenchia mantica*** (L.) Bartl. subsp. ***mantica***

B4 Keçiören, Kalaba, rocky slopes, 870 m, 22/5/1994, *Akaydın* 2835.

***Bufonia tenuifolia*** L.

B4 Dikmen, Keklik Pınarı, 1100 m, 6/8/1995, *Akaydın* 4495.

***Telephium imperati*** L. subsp. ***orientale*** (Boiss.) Nyman

B4 Balgat, 1000 m, 13/6/1995,*Akaydın* 4036

***Dianthus anatolicus*** Boiss.

A4. Hasköy, Dam District, 970 m, 3/8/1993, *Akaydın* 2296. **End.**

***D. micranthus*** Boiss. et Heldr.

B4 Dikmen, Keklik Pınarı, rocky slopes, 1100 m, 3/7/1993, *Akaydın* 1803.

***D. ancyrensis*** Hausskn. et Bornm.

B4 Dikmen,Turtaş, roky slopes, 1150 m, 24/7/1995, *Akaydın* 4349. **End. Ir.- Tur.**

***D. crinitus*** Sm. var. ***crinitus***

B4 Cebeci, 960 m, 15/6/1994, *Akaydın* 3026.

***D. zonatus*** Fenzl var. ***aristatus*** (Boiss.) Reeve

B4 Mamak, Tuzluçayır, 980 m, 6/8/1993, *Akaydın* 2338.

***D. calocephalus*** Boiss.

B4 Mamak, Hüseyin Gazi, 1200 m, 3/7/1995, *Akaydın* 4466.

***Petrorhagia cretica*** (L.) Ball et Heywood

B4 100. Yıl, open places, 950 m, 18/6/1995, *Akaydın* 4116.

***Velezia rigida*** L.

A4 Keçiören, Hacıkadın Stream, 970 m, 19/6/1993, *Akaydın* 1364.

***Saponaria officinalis*** L.

B4 Balgat, 1050 m, 4/6/1995, *Akaydın*, 3908.

***S. viscosa*** C.A.Meyer

A4 Keçiören,Hacıkadın Stream,rocky slopes, 980 m,17/5/1995, *Akaydın* 3567.

B4 Dikmen,Sokullu, open places, 1100 m, 15/5/1995, *Akaydın* 3517. **Ir.-Tur.**

***S. prostrata*** Willd. subsp. ***prostrata***.

A4 Keçiören, Hacıkadın Stream, 970 m, 11/7/1993, *Akaydın* 1978.**End. Ir.-Tur.**

***Gypsophila viscosa*** Murray

B4 Dikmen, Öveçler, rocky slopes,1100 m, 10/6/1995, *Akaydın* 3979. **Ir.- Tur.**

***G. pilosa*** J.Huds.

B4 Beştepe, 870 m, 20/6/1993, *Akaydın* 1440. **Ir.-Tur.**

***G. venusta*** Fenzl

B4 Çankaya, Oran, 960 m, 7/7/1993, *Akaydın* 1900. **Ir.-Tur.**

***Vaccaria pyramidata*** Medik. var. ***grandiflora*** (Fisch. ex D'Cruz) Cullen

B4 Dikmen,Keklikpınarı, 1100 m, 10/6/1995,*Akaydın* 3978.

***Silene chlorifolia*** Sm.

B4 Keçiören, Subayevleri, rocky slopes, 860 m, 2/6/1995, *Akaydın* 3826. **Ir.-Tur.**

***S. otites*** (L.) Wibel

A4 Keçiören, Hacıkadın Stream, 980 m, 4/8/1993, *Akaydın* 2326.

***S. cappadocica*** Boiss. et Heldr.

B4 Keçiören, Kalaba, rocky slopes, 870 m, 3/6/1995, *Akaydın* 3856. **Ir.-Tur.**

***S. spergulifolia*** (Desf.) M.Bieb

A4 Keçiören, Hacıkadın Stream, 980 m, 17/6/1995, *Akaydın* 4101. **Ir.-Tur.**

***S. supina*** M.Bieb subsp. ***pruinosa*** (Boiss.) Chowdh.

B4 Dikmen, Öveçler, 1100 m, 24/6/1995, *Akaydın* 4137.

***S. vulgaris*** (Moench) Garcke var. ***vulgaris***

B4 Cebeci, Cemetery, 22/7/1993, *Akaydın* 2125.

***S. alba*** (Miller) K. Krause subsp. ***eriocalycina*** (Boiss.) Walters

A4 Keçiören, Hacıkadın Stream, 19/6/1993, *Akaydın* 1367.

***S. noctiflora*** L.

A4 Keçiören, Hacıkadın Stream, 17/6/1995, *Akaydın* 4064.

***S. dichotoma*** Ehrh. subsp. ***dichotoma***

B4 Dikmen, Keklik Pınarı, 1100 m, 31/7/1993, *Akaydın* 2268.

***S. conica*** L.

B4 Etlik, Karşıyaka Cemetery, 950 m, 1/6/1994, *Akaydın* 2936.

***S. subconica*** Friv.

B4 Beştepe, 870 m, 15/5/1994, *Akaydın* 2762.

***S. conoidea*** L.

B4 Keçiören, Meteoroloji surroundings, 860 m, 19/5/1995, *Akaydın* 3583.

***Agrostemma githago*** L.

B4 Mamak, dump, 1150 m, 28/6/1993, *Akaydın* 1641.

**ILLECEBRACEAE**

***Herniaria incana*** Lam.

B4 Mamak, Hüseyin Gazi, 1200 m, 3/8/1995, *Akaydın* 4482.

***Paronychia kurdica*** Boiss. subsp. ***kurdica*** var. ***kurdica***

B4 Keçiören, Hacıkadın Stream, 950 m, 2/5/1995, *Akaydın* 3372.

***P. angorensis*** Chaudhri

A4 Keçiören, Hacıkadın Stream, 980 m, 19/6/1993, *Akaydın* 1355. **End. Ir.-Tur.**

**POLYGONACEAE**

***Atraphaxis billardieri*** Jaub.. et Spach var. ***billardieri***

B4 Kayaş, 1000 m, 4/6/1994, *Akaydın* 2956.

***Polygonum lapathifolium*** L.

B4 Bahçelievler, TEK. surroundings, 860 m, 20/9/1993, *Akaydın* 2440.

***P. cognatum*** Meisn.

B4 Keçiören, Çubuk Stream,20/7/1995, *Akaydın* 4290.

***P. arenastrum*** Bor.

B4 Balgat, Karakusunlar, 1000 m, 10/7/1995, *Akaydın* 4233.

***P. bellardii*** All.

B4 Balgat, 100. Yıl Buildings, 950 m, 13/6/1995, *Akaydın* 4030.

***P. convolvulus*** L.

A4 Keçiören, Aktepe, 960 m, 21/7/1995, *Akaydın* 4309.

***Rumex acetsella*** L..

B4 Mamak, open places, 1000 m, 8/5/1994, *Akaydın* 2783.

***R. scutatus*** L.

B4 Balgat, Konya high way, 950 m, 10/6/1995, *Akaydın* 3971.

***R. crispus*** L.

A4 Keçiören, Hacıkadın Stream, 950 m, 3/6/1995, *Akaydın*, 3868.

***R. conglomeratus*** Murray

A4 Keçiören, Hacıkadın Stream, 950 m, 17/6/1995, *Akaydın*, 4090.

***R. pulcher*** L.

B4 Dikmen, 1100 m, 10/6/1995, *Akaydın* 3968.

***R. dentatus*** L. subsp. ***halacsyi*** (Rech. pat.) Rech.

B4 Dikmen, Sokullu, meadow, 1100 m, 6/6/1995, *Akaydın* 3944.

**CHENOPODIACEAE**

***Beta lomatogona*** Fisch. et Mey.

B4 Dikmen, Atatürk Sitesi surroundings, 1130 m, 6/6/1994, *Akaydın* 3007.

***Chenopodium botrys*** L.

A4 Keçiören, Hacıkadın Stream, 940 m, 21/7/1995, *Akaydın* 4318.

***C. foliosum*** (Moench) Asch.

B4 Söğütözü, 880 m, 17/8/1995, *Akaydın* 4528.

***C. murale*** L.

B4 Gazi District, 850 m, 10/8/1993, *Akaydın* 2390.

***C. album*** L. subsp. ***album*** var. ***album***

B4 Cebeci, Kurtuluş, 880 m, 17/9/1993, *Akaydın* 2439.

***Atriplex hortensis*** L.

B4 Bahçelievler, TEK surroundings, 850 m, 20/9/1993, *Akaydın* 2441.

***A. nitens*** Schkuhr

B4 Söğütözü, 870 m,10/10/1993, *Akaydın* 2462.

***A. laevis*** C.A. Mey.

B4 Söğütözü, on rubbles, 870 m, 10/10/1993, *Akaydın* 2477.

***A. lasiantha*** Boiss.

B4 Beştepe, 880 m, 23/8/1995, *Akaydın* 4599.

***A. tatarica*** L. var. ***tatarica***

B4 Söğütözü, 870 m, 10/10/1993, *Akaydın* 2474.

***Salsola ruthenica*** Iljin

A4 Keçiören, Hacıkadın Stream, 950 m, 21/7/1995, *Akaydın* 4304.

***Noaea mucronata*** (Forssk.) Asch. et Schweinf. subsp. ***mucronata***

B4 İvedik, Karşıyaka Cemetery, 980 m, 25/7/1993, *Akaydın* 2203.

**AMARANTHACEAE**

***Amaranthus retroflexus*** L.

B4 Ulus, 870 m, 17/7/1993, *Akaydın* 2045.

***A. chlorostachys*** Willd.

B4 Keçiören, Kalaba, 860 m, 19/7/1995. *Akaydın* 4539.

***A. blitoides*** S.Watson

B4 Beştepe, 880 m, 23/8/1995, *Akaydın* 4601.

***A. albus*** L.

B4 Keçiören, Kalaba, 850 m, 19/8/1995, Akaydın 4542.

**TAMARICACEAE**

***Tamarix smyrnensis*** Bunge

B4 GOP, Kırkkonaklar District, 28/7/1993, *Akaydın* 2239.

**GUTTIFERAE (HYPERICACEAE)**

***Hypericum lydium*** Boiss.

A4 Keçiören, Hacıkadın Stream,960 m, 29/5/1994, *Akaydın* 2914.,

***H. pseudolaeve*** Robson

A4 Keçiören, Hacıkadın Stream, 29/5/1994, *Akaydın* 2912. **End. Ir.-Tur.**

***H. scabrum*** L.

B4 Dikmen, Sokullu, 1100 m, 2/7/1993, *Akaydın* 1764. **Ir.-Tur.**

***H. orientale*** L.

B4 Balgat, Karakusunlar, 980 m, 10/6/1995, *Akaydın* 4221.

***H. origanifolium*** Willd.

B4 Balgat, 1050 m, 27/5/1995, *Akaydın* 3646.

***H. avicullariifolium*** Jaub.. et Spach

B4 Mamak, Kayaş, 1000 m, 4/6/1994, *Akaydın* 2940. **End. Ir.-Tur.**

***H. perforatum*** L.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1848.

**MALVACEAE**

***Malva sylvestris*** L.

B4 Ulus, Kore Garden, 850 m, 15/7/1993, *Akaydın* 2039.

***M. neglecta*** Wallr.

B4 Çankaya, GOP, open places, 950 m, 27/7/1993, *Akaydın* 2211.

***Malvella sherardiana*** (L.) Jaub. et Spach

B4 Bahçelievler, TEK surroundings, 850 m, 30/6/1993, *Akaydın* 1703.

***Alcea apterocarpa*** (Fenzl) Boiss.

B4 Balgat, Çiğdem District, 1050 m, 14/8/1995, *Akaydın* 4519. **Endemic.**

***A. pallida*** Waldstein et Kit.

B4 Oran - Dikmen village 1000 m, 8/7/1993, *Akaydın*, 1923.

***Althaea cannabina*** L.

B4 Cebeci, 900 m, 22/7/1993, *Akaydın* 2136

***A. officinalis*** L.

B4 Çankaya, İmrahor Stream, 1000 m, 8/8/1993, *Akaydın* 2357.

**LINACEAE**

***Linum cariense*** Boiss.

B4 Dikmen, Keklik Pınarı, 1100 m, 28/5/1995, *Akaydın* 3721. **End. Ir.-Tur.**

***L. mucronatum*** Bertol. subsp. ***armenum*** (Bordz.) P.H.Davis

B4 100.Yıl, Karakusunlar, Cemetery, 1000 m, 13/6/1995, *Akaydın* 4012. **Ir.-Tur.**

***L. flavum*** L. subsp. ***scarinerve*** (P.H.Davis) P.H.Davis

B4 Çankaya, Oran, 950 m, 7/7/1993, *Akaydın* 1914. **End. Ir.-Tur.**

***L. nodiflorum*** L.

B4 Beştepe, State Cemetery, afforestation area 900 m, 24/5/1994, *Akaydın* 2844. **Medit.**

***L. hirsutum*** L. subsp. ***anatolicum*** (Boiss.) Hayek var. ***anatolicum***

B4 Çankaya, 900 m, 5/7/1993, *Akaydın* 1876. **End. Ir.-Tur.**

subsp. ***pseudoanatolicum*** P.H.Davis

B4 Dikmen, afforestation area, 1000 m, 6/6/1994, *Akaydın* 3005. **End. Ir.-Tur.**

***L. tenuifolium*** L.

B4 Çankaya surroundings, 1000 m, 14/5/1995 *Akaydın* 3502.

**GERANIACEAE**

***Geranium lucidum*** L.

B4 Altınpark surroundings, 960 m, 5/5/1995, *Akaydın* 3457.

***G. rotundifolium*** L.

B4 Keçiören, Subayevleri, 860 m, 2/5/1995, *Akaydın* 3356.

***G. tuberosum*** L. subsp. ***tuberosum***

A4 Hasköy, Dam District, 950 m, 25/4/1993, *Akaydın* 1060.

***G. macrostylum*** Boiss.

B4 Mamak, 1100 m, 8/5/1994, *Akaydın* 2739. **E. Medit.**

***G. asphodeloides*** Burm. subsp. ***asphodeloides***

A4 Keçiören, Hacıkadın Stream, 940 m, 29/5/1994, *Akaydın* 2897. **Euro- Sib.**

***G. pyrenaicum*** Burm.

B4 Cebeci, Cemetery, waste places, 900 m, 28/4/1995, *Akaydın* 3272.

***Erodium ciconium*** (L.) L' He'rit.

A4 Hasköy, Dam District, 950 m, 25/4/1993, *Akaydın* 1049.

***E. cicutarium*** (L.) L' He'rit. subsp.***cicutarium***

B4 Çankaya, Portakal Çiçeği valley, 970 m, 25/6/1993, *Akaydın* 2524. **Medit.**

***E. acaule*** (L.) Bech. et Thell.

B4 100. Yıl Buildings, 900 m, 2/4/1994, *Akaydın* 2524. **Medit.**

**ZYGOPHYLLACEAE**

***Zygophyllum fabago*** L.

B4 Gazi District, 840 m, 11/6/1993, *Akaydın* 1286. **Ir.-Tur.**

***Tribulus terrestris*** L.

B4 Anıttepe, afforestation area, 870 m, 29/6/1993, *Akaydın* 1666.

***Peganum harmala*** L.

B4 Lalegül, Hürriyet Park, 870 m, 15/6/1993, Akaydın 1310.

**RUTACEAE**

***Haplophyllum thesioides*** (Fisch. ex D'Cruz.) Don

B4 Beştepe, 860 m, 21/6/1993, *Akaydın* 1455.

***H. buxbaumii*** (Poir.) Don subsp. ***buxbaumii***

B4 Bahçelievler, TEK surroundings, 860 m, 5/6/1993, *Akaydın* 1274.

**RHAMNACEAE**

***Paliurus spina-christi*** Miller

B4 G.O.P. Kırkkonaklar, 970 m, 28/7/1993, *Akaydın* 2249.

***Rhamnus petiolaris*** Boiss.

B4 Dikmen, Keklik Pınarı, rocky slopes, 1100 m, 6/8/1995, *Akaydın* 4493. **End.**

***R. rhodopeus*** Velenovsky.

B4 Mamak, Hüseyin Gazi, rocky slopes, 1200 m, 3/8/1995, *Akaydın* 4461.

***R. oleoides*** L. subsp. ***graecus*** (Boiss. et Reut.) Holmboe

B4 Keçiören, Kalaba,870 m, 2/6/1995, *Akaydın* 3837. **Medit.**

***R. hirtellus*** Boiss.

B4 Dikmen, Keklikpınarı, 1100 m, 28/5/1995, *Akaydın* 3767. **End. Ir.-Tur.**

**ANACARDIACEAE**

***Rhus coriaria*** L.

B4 GOP, Kırkkonaklar, 970 m, 28/7/1993, *Akaydın* 2232.

***Pistacia atlantica*** Desf.

A4 Keçiören, Hacıkadın Stream, 950 m, 19/6/1993, *Akaydın* 1414.

**LEGUMINOSAE (FABACEAE)**

***Genista aucheri*** Boiss.

B4 AOÇ., Lalegül, 870 m, 13/6/1993, *Akaydın* 1306. **End. Ir.-Tur.**

***G. sessilifolia*** D'Cruz.

B4 Beştepe, afforestation area, 880 m, 24/5/1994, *Akaydın* 2870. **Ir.-Tur.**

***Galega officinalis*** L.

B4 Çankaya, GOP., open places, 970 m, 26/7/1994, *Akaydın* 3074. **Euro.-Sib.**

***Colutea cilicica*** Boiss. et Bal.

A4 Keçiören, Sanatoryum Street, 970 m, 26/6/1993, *Akaydın* 1549.

***Astragalus sesameus*** L.

B4 Beştepe, Öğretmen Evi around, 880 m, 23/8/1995, *Akaydın* 4603. **Medit.**

***A. hamosus*** L.

B4 Dikmen, Öveçler, open areas, 1100 m, 10/6/1995, *Akaydın* 3996.

***A eriopphyllus*** Boiss.

B4 Dikmen, Keklik Pınarı, 1100 m, 28/5/1995, *Akaydın* 3735. **End.**

***A. melanophrurius*** Boiss.

B4 Beştepe, afforestation area, 900 m, 24/5/1994, *Akaydın* 2853. **End. Ir.-Tur.**

***A. gilvus*** Boiss.

A4 Keçiören, Hacıkadın Stream, empty places, 970 m, 19/6/1993, *Akaydın* 1328. **End.**

***A. microcephalus*** Willd.

B4 Yahyalar, Karşıyaka Cemetery, 950 m, 28/7/1994, *Akaydın* 3077. **Ir.-Tur.**

***A. plumosus*** Willd. var. ***plumosus***

B4 Balgat, Çiğdem District, 1050 m, 27/5/1995, *Akaydın* 3676.

***A. strictifolius*** Boiss. var. ***kutepovii*** S'irj.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1889. **Ir.-Tur.**

***A. micropterus*** Fischer

B4 Yahyalar, Karşıyaka Cemetery, 950 m, 28/7/1994, *Akaydın* 3078. **End. Ir.-Tur.**

***A. acicularis*** Bunge

B4 Kayaş, 1000 m, 4/6/1994, *Akaydın* 2976. **End. Ir.-Tur.**

***A. brachypterus*** Fischer

B4 Beştepe, State Cemetery,900 m, 24/5/1994, *Akaydın* 2871. **End. Ir.-Tur.**

***A. macrocephalus*** Willd. subsp. ***macrocephalus***

A4 Keçiören, Hacıkadın Stream, 970 m, 11/7/1993, *Akaydın* 1979. **End. Ir.-Tur.**

***A. ornithopodioides*** Lam.

B4 Balgat, 880 m, 3/5/1994, *Akaydın* 2696. **End.**

***A. lydius*** Boiss.

B4 100. Yıl, open places, 980 m, 13/6/1995, *Akaydın* 4011. **End. Ir.-Tur.**

***A. karamasicus*** Boiss. et Bal.

B4 Beştepe, 870 m, 11/5/1993, *Akaydın* 1145. **End. Ir.-Tur.**

***A. lycius*** Boiss.

B4 Hasköy, Solfasol, open places, 900 m, 19/5/1993, *Akaydın* 1186. **End.**

***A. xylobasis*** Freyn et Bornm. var.***angustus*** (Freyn et Sint.) Freyn et Bornm.

A4 Keçiören, Hacıkadın, 16/6/1993, *Akaydın* 1332. **End. Ir.-Tur.**

***A. elongatus*** Willd. subsp. ***elongatus***

A4 Keçiören, Hacıkadın Stream, 980 m, 1/5/1995, *Akaydın* 3529.

***A. campylosema*** Boiss. subsp. ***campylosema***

B4 Hasköy, Solfasol, open places, 900 m, 17/5/1993, *Akaydın* 1172. **End. Ir.-Tur.**

***A. nitens*** Boiss. et Heldr.

B4 Beştepe, afforestation area, 880 m, 22/6/1993, *Akaydın* 1474. **End. Ir.-Tur.**

***A. angustifolius*** Lam. subsp. ***pungens*** (Willd.) Hayek

B4 Keçiören, Şose, valley slopes, 970 m, 21/5/1993, *Akaydın* 1199.

***A. vulnerariae*** D'Cruz.

B4 Cebeci, Topraklık, 960 m, 23/6/1993, *Akaydın* 1500. **End.**

***Glycyrrhiza glabra*** L. var. ***glandulifera*** (Waldstein et Kit.) Boiss.

B4 Yenimahalle, AKM. around, 830 m, 13/7/1993, *Akaydın* 2031.

***Cicer anatolicum*** Alef.

B4 Dikmen, Konya highway, 1100 m, 28/5/1995, *Akaydın* 3760. **Ir.-Tur.**

***Vicia cracca*** L. subsp. ***stenophylla*** Vell.

A4 Keçiören, Hacıkadın Stream, 960 m, 29/5/1994, *Akaydın* 2907.

***V. villosa*** Roth subsp. ***eriocarpa*** (Hausskn.) P.W. Ball

B4 Dikmen, Akpınar District,1100 m, 6/6/1994, *Akaydın* 2996.

***V. ervillia*** (L.) Willd.

B4 Dikmen, 1100 m, 15/5/1995, *Akaydın* 3519.

***V.nonea*** Reut. ex Boiss. var. ***nonea***

B4 100. Yıl, 980 m, 13/6/1995, *Akaydın* 4006. **Ir.-Tur.**

***V. peregrina*** L.

B4 Beştepe, State Cemetery, afforestation area, 900 m, 15/5/1994, *Akaydın* 2790.

***V. narbonensis*** L. var. ***narbonensis***.

B4 Beştepe, State Cemetery, 900 m,15/5/1994, *Akadın* 2780.

***Lens nigricans*** (M.Bieb) Godr.

B4 Dikmen, Keklik pınarı, 1100 m, 28/5/1995, *Akaydın* 3733. **Medit.**

***L. orientalis*** (Boiss.) Hand.-Mazz.

B4 Dikmen, Keklik pınarı, 1100 m, 28/5/1995, *Akaydın* 3731.

***Lathyrus cicera*** L.

A4 Keçiören, Aktepe, 970 m, 13/5/1995, *Akaydın* 3487.

***L. sativus*** L.

B4 Keçiören, Kalaba, Subayevleri, 860 m, 19/5/1995, *Akaydın* 3584.

***L. nissolia*** L.

B4 Çankaya, Oran , 1100 m, 5/5/1994, *Akaydın* 2702.

***L. aphaca*** L. var. ***biflorus*** Post

B4 Balgat, Konya highway, 980 m, 23/4/1993, *Akaydın* 1030.

***Pisum sativum*** L. subsp. ***elatius*** (M.Bieb) Asch. et Graebn.

var. ***brevipedunculatum*** P.H.Davis et Meikle

B4 Çankaya, Botanical Garden, 1000 m, 2/5/1994, *Akaydın* 2680.

var. ***pumilio*** Meikle

B4 Mamak, dump area, 1150 m, 8/5/1994, *Akaydın* 2728.

***Ononis spinosa*** L. subsp. ***leiosperma*** (Boiss.) S'irJ.

B4 Çankaya, 1000 m, 9/7/1993, *Akaydın* 1934.

***Trifolium repens*** L. var. ***repens***

A4 Keçiören, Hacıkadın Stream, 950 m, 22/4/1995, *Akaydın* 3221.

var. ***macrorrhizum*** (Boiss.) Boiss.

B4 Cebeci, Kurtuluş Park, 870 m, 8/5/1993, *Akaydın* 1122.

***T. nigrescens*** Viv. subsp. ***petrisavii*** (Clem.) Holmboe

A4 Keçiören, Hacıkadın Stream, 950 m, 19/6/1993, *Akaydın* 1329.

***T. retusum*** L.

B4 Çankaya, İmrahor Stream, 1000 m, 8/8/1993, *Akaydın* 2360.

***T. speciosum*** Willd.

A4 Keçiören, Hacıkadın Stream, 900 m, 19/6/1993, *Akaydın* 1353.

***T. campestre*** Schreb.

B4 Balgat, Çiğdem District, stream banks, 1000 m, 26/6/1995, *Akaydın* 4145.

***T. pratense*** L.

B4 Maltepe, open areas, 870 m, 23/5/1993, *Akaydın* 1233.

***T. scabrum*** L.

B4 Dikmen, Turtaş, 1100 m, 14/71995, *Akaydın* 4243.

***T. hirtum*** All.

B4 Dikmen, Keklik pınarı, 1100 m, 14/71995, *Akaydın* 4242. **Medit.**

***T. arvense*** L. var. ***arvense***

B4 Mamak, Hüseyin Gazi District, 1200 m, 3/8/1995, *Akaydın* 4475.

***T. purpureum*** R.J.Loisel var. ***purpureum***

B4 Dikmen, Sokullu, 1100 m, 15/5/1995, *Akaydın* 3507.

***Melilotus officinalis*** (L.) Desr.

B4 Çankaya, around Köşk, 1000 m, 4/7/1993, *Akaydın* 1836.

***M. alba*** Desr.

B4 Mamak, roadsides of dump, 1000 m, 28/6/1993, *Akaydın* 1645.

***M. taurica*** (M.Bieb) Ser.

B4 Beştepe, afforestation area, 870 m, 17/7/1994, *Akaydın* 3058.

***M. bicolor*** Boiss. et Bal.

B4 Mamak, Hüseyin Gazi District, 1200 m, 3/8/1995, *Akaydın* 4470. **End. Ir.-Tur.**

***Trigonella brachycarpa*** (Fisch.) Moris

B4 Karakusunlar Cemetery, 1000 m, 13/6/1995, *Akaydın* 4010. **Ir.-Tur.**

***T. lunata*** Boiss.

B4 Dikmen, Sokullu, 1100 m, 15/5/1995, *Akaydın* 3520. **Ir.-Tur.**

***T. spruneriana*** Boiss. var. ***spruneriana***

B4 Mamak, Hüseyin Gazi District, 1200 m, 3/8/1995, *Akaydın* 4472. **Ir.-Tur.**

***T. filipes*** Boiss.

B4 Balgat surroundings, 1050 m, 27/5/1995, *Akaydın* 3640. **Ir.-Tur.**

***T. velutina*** Boiss.

B4 Çankaya, İmrahor Stream, 1050 m, 16/5/1995, *Akaydın* 3543. **Ir.-Tur.**

***T. aurantiaca*** Boiss.

A4 Keçiören, Kuyubaşı District, 970 m, 28/5/1994, *Akaydın*, 1257. **Ir.-Tur.**

***T. fischeriana*** Ser.

B4 Cebeci, Hacettepe Hospital surroundings, 880 m, 8/5/1993, *Akaydın* 1119. **Ir.-Tur.**

***T. tenuis*** Fisch.

B4 Çankaya, Portakal Çiçeği valley, 970 m, 25/6/1993, *Akaydın* 1532. **Ir.-Tur.**

***T. crassipes*** Boiss.

B4 Dikmen, Sokullu, 1100 m, 15/5/1995, *Akaydın* 3522. **Ir.-Tur.**

***T. monantha*** C.A. Meyer subsp. ***monantha***

A4 Keçiören, Hacıkadın Stream, 980 m, 3/6/1995, *Akaydın* 3872. **Ir.-Tur.**

***T. monspeliaca*** L.

B4 Mamak, dump area, 1100 m, 8/5/1994, *Akaydın* 2731. **Medit.**

***Medicago radiata*** L.

B4 Balgat, Çiğdem District, open areas, 1000 m, 27/5/1995, *Akaydın* 3639. **Ir.-Tur.**

***M. lupulina*** L.

A4 Keçiören, Hacıkadın Stream, 980 m, 21/7/1995, *Akaydın* 4313.

***M. sativa*** L. subsp. ***sativa***

B4 Çankaya, Portakal Çiçeği valley, 970 m, 25/6/1993, *Akaydın* 1533.

***M. x varia*** Martyn

B4 Cebeci, 50. Yıl Park, 960 m, 23/6/1993, *Akaydın* 1498.

***M. falcata*** L.

B4 Mamak, Hüseyin Gazi District, 1200 m, 3/8/1995, *Akaydın* 4469.

***M. nonea*** Boiss.

B4 Balgat, Karakusunlar Cemetery, 1000 m, 13/6/1995, *Akaydın* 4020. **Ir.-Tur.**

***M. minima*** (L.) Bart. var. ***minima***

A4 Keçiören, Hacıkadın Stream, 980 m, 1/5/1994, *Akaydın* 2674.

***M. rigidula*** (L.) All. var. ***rigidula***

B4 Keçiören, Köşk District, 1000 m, 29/5/1994, *Akaydın* 2887.

var. ***cinerascens*** (Jord.) Rouy

B4 Dikmen, Sokullu, open areas, 1100 m, 15/5/1995, *Akaydın* 3508.

***Dorycnium hirsutum*** (L.) Ser.

B4 Balgat, Çiğdem District, open areas, 1050 m, 4/6/1995, *Akaydın* 3928. **Medit.**

***D. pentaphyllum*** Scop. subsp. ***anatolicum*** (Boiss.) Gams

B4 Mamak, dump areas, 1100 m, 28/6/1993, *Akaydın* 1654.

***Lotus corniculatus*** L. var. ***corniculatus***

B4 Ulus, around railway station, 850 m, 17/7/1993, *Akaydın* 2044.

var. ***tenuifolius*** L.

B4 Çankaya, 1000 m, 9/7/1993, *Akaydın* 1932.

***L. aegaeus*** (Gris.) Boiss.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1869. **Ir.-Tur.**

***Coronilla scorpioides*** (L.) Koch

B4 Balgat, Çiğdem District, stream banks, 980 m, 26/6/1995, *Akaydın* 4152.

***C. varia*** L. subsp. ***varia***

A4 Keçiören, Hacıkadın Stream, 980 m, 19/6/1993, *Akaydın* 1377.

***Hedysarum varium*** Willd.

B4 Lalegül, hills, 870 m, 13/6/1993, *Akaydın* 1305. **Ir.-Tur.**

***Onobrychis armena*** Boiss.et A.L.P.Huet

B4 Çankaya, Portakal Çiçeği valley, 970 m, 25/6/1993, *Akaydın* 1505. **End.**

***O. viciifolia*** Scop.

B4 Mamak, roadsides of dump, 1000 m, 28/6/1993, *Akaydın* 1639.

***O. oxyodonta*** Boiss.

B4 Anıttepe, Around Atatürk's mausoleum, 870 m, 29/6/1993, *Akaydın* 1692.

***O. ornata*** (Willd.) Desv.

B4 Balgat, 1050 m, 16/7/1995, *Akaydın* 4261. **End. Ir.-Tur.**

***O. hypargyrea*** Boiss.

B4 Dikmen, Keklik Pınarı, 1100 m, 24/6/1995, *Akaydın* 4140.

***O. tournefortii*** (Willd.) Desv.

B4 Mamak, Hüseyin Gazi, 1200 m, 3/8/1995, *Akaydın* 4487. **End.**

***Alhagi pseudalhagi*** (M.Bieb) Desv.

B4 Balgat, 950 m, 30/7/1993, *Akaydın* 2257. **Ir.-Tur.**

**ROSACEAE**

***Prunus spinosa*** L. subsp. ***dasyphylla*** (Schur) Domin

B4 Balgat, Çiğdem District, 1050 m, 15/4/1995, *Akaydın* 3200. **Euro.-Sib.**

***P. divaricata*** Ledeb. subsp. ***divaricata***

B4 Dikmen, Konya highway, rocky slopes, 1250 m, 10/8/1995, *Akaydın* 4502.

***Amygdalus orientalis*** Miller

B4 Cebeci, Topraklık, rocky slopes, 960 m, 29/4/1995, *Akaydın* 3320. **Ir.-Tur.**

***A. x balansae*** Boiss.

B4 Keçiören, Kalaba, rocky slopes, 880 m, 2/5/1995, *Akaydın* 3388. **End.**

***Rubus caesius*** L.

A4 Keçiören, Hacıkadın Stream, 800 m, 17/6/1995, *Akaydın* 4073.

***R. sanctus*** Schreber

B4 Kayaş, Samsun highway, 1000 m, 19/7/1993, *Akaydın* 2062.

***Potantilla astracanica*** Jacq.

B4 Balgat, 1000 m, 27/5/1995, *Akaydın* 3643. **Euro.-Sib.**

***P. recta*** L.

B4 Beştepe, Başkent Öğretmen Evi surroundings, 880 m, 18/6/1994, *Akaydın* 3039.

***P. supina*** L.

B4 Balgat, Çiğdem District, on pavements, 1000 m, 27/5/1995, *Akaydın* 3654.

***P. reptans*** L.

B4 Dikmen, Atatürk Buildings, stream banks, 1000 m, 1/8/1993, *Akaydın* 2284.

***Geum urbanum*** L.

A4 Keçiören, Hacıkadın Stream, 950 m, 29/5/1994, *Akaydın* 2896. **Euro.-Sib.**

***Agrimonia eupatoria*** L.

A4 Keçiören, Hacıkadın, 950 m, 21/7/1995, *Akaydın* 4295.

***A. repens*** L.

B4 Balgat, Çiğdem District, stream banks, 1000 m, 19/6/1995, *Akaydın* 4123.

***Sanguisorba minor*** Scop. subsp. ***muricata*** (Spach) Briq.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1873.

***Rosa gallica*** L.

B4 Dikmen, KeklikPınarı,1100m,10/6/1995,*Akaydın* 3951.

***R. canina*** L.

B4 Balgat around, 1050 m, 27/5/1995, *Akaydın* 3674.

***Cotoneaster integerrimus*** Medik.

B4 Dikmen, rocky slopes, 1130 m, 24/7/1995, *Akaydın* 4347.

***Crataegus tanecetifolia*** (Lam.) Pers.

B4 Balgat, Çiğdem District, 1050 m, 27/5/1995, *Akaydın* 3700. **End.**

***C. orientalis*** J.Pall. ex M.Bieb var. ***orientalis***

B4 Kayaş, Samsun highway, rocky slopes, 1000 m, 19/7/1993, *Akaydın* 2109.

***C. szovitsii*** Pojark.

B4 Dikmen, Keklik Pınarı, 1100 m, 10/6/1995, *Akaydın* 3972. **Ir.-Tur.**

***C. curvisepala*** Lindm.

A4 Keçiören, Hacıkadın Stream, 980 m, 3/6/1995, *Akaydın* 3867.

***C. monogyna*** Jacq. subsp. ***monogyna***

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1888.

subsp. ***azarella*** (Gris.) Franco

B4 Dikmen, Turtaş, 1130 m, 24/8/1995, *Akaydın* 4356.

***C. microphylla*** C.Koch

B4 Çankaya, İmrahor Stream, 1050 m, 16/5/1995, *Akaydın* 3549. **Hyrcano.-Euxin.**

***Sorbus domestica*** L.

B4 Dikmen, rocky slopes, 1250 m, 10/8/1995, *Akaydın* 4503. **Euro.-Sib.**

***Pyrus elaeagnifolia*** J.Pall. subsp. ***elaeagnifolia***

B4 Çankaya, 1050 m, 8/8/1993, *Akaydın* 2379.

**LYTHRACEAE**

***Lythrum salicaria*** L.

B4 Beştepe, State Cemetery, stream banks, 880 m 4/8/1993, *Akaydın* 2308. **Euro.-Sib.**

**ONAGRACEAE**

***Epilobium hirsutum*** L.

B4 Çankaya, 1000 m, 5/7/1993, *Akaydın* 1847.

***E. montanum*** L.

A4 Keçiören, Hacıkadın Stream, 950 m, 1/8/1995, *Akaydın* 4446. **Euro.-Sib.**

***E. minutiflorum*** Hausskn.

B4 Dikmen, Turtaş, 1130 m, 23/7/1995, *Akaydın* 4339. **Ir.-Tur.**

**CUCURBITACEAE**

***Ecbalium elaterium*** (L.) A.G.Richt..

A4 Keçiören, Kuşcağız District, 1070 m, 27/6/1993, *Akaydın* 1596. **Medit.**

**CRASSULACEAE**

***Sedum acre*** L.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1867.

***S. sartorianum*** Boiss. subsp. ***sartorianum***

B4 Keçiören, Kalaba, rocky slopes, 870 m, 2/6/1995, *Akaydın* 3828.

***S. album*** L.

B4 Cebeci, Cemetery, 870 m, 22/7/1993, *Akaydın* 2123.

***S. confertiflorum*** Boiss.

B4 Dikmen, Keklik Pınarı, rocky slopes, 1100 m, 28/5/1995, *Akaydın* 3725. **E. Medit.**

***S. hispanicum*** L. var. ***hispanicum***

B4 Keçiören, Kuyubaşı, rocky slopes, 970 m, 28/5/1993, *Akaydın* 1246.

**SAXIFRAGACEAE**

***Saxifraga tridactylites*** L.

B4 Keçiören, Kalaba, rocky slopes, 870 m, 2/5/1995, *Akaydın* 3365.

**UMBELLIFERAE (APIACEAE)**

***Eryngium bithynicum*** Boiss.

B4 Çankaya, open areas, 1000 m, 9/7/1993, *Akaydın* 1935. **End. Ir.-Tur.**

***E. campestre*** L. var. ***virens*** Link

B4 Keçiören, Kalaba, 870 m, 16/6/1995, *Akaydın* 4057.

***Echinophora tournefortii*** Jaub.. et Spach

B4 GOP, Kırkkonaklar, open areas, 970 m, 28/7/1993, *Akaydın* 2248. **Ir.-Tur.**

***E. tenuifolia*** L. subsp. ***sibthorpiana*** (Guss.) Tutin

B4 Balgat, around Balgat highschool, 870 m, 20/9/1993, *Akaydın* 2446. **Ir.-Tur.**

***Scandix stellata*** Banks et Sol.

B4 Dikmen, Keklik Pınarı, 1100 m, 28/5/1995, *Akaydın* 3742.

***S. iberica*** M.Bieb

B4 Lalegül, Hürriyet Park, 870 m, 13/6/1993, *Akaydın* 1303.

***S. pecten-veneris*** L.

B4 Beştepe, surroundings, 860 m, 3/5/1993, *Akaydın* 1082.

***S. australis*** L. subsp. ***grandiflora*** (L.) Thell.

B4 Mamak, 1100 m, 8/5/1994, *Akaydın* 2746.

***Coriandrum tordylium*** (Fenzl) Bornm.

A4 Keçiören, Hacıkadın Stream, 950 m, 17/6/1995, *Akaydın* 4079. **Ir.-Tur.**

***Bifora radians*** M.Bieb

B4 Çankaya, Portakal Çiçeği Valley, 980 m, 25/6/1993, *Akaydın* 1519.

***Seseli tortuosum*** L.

B4 Balgat, Cevizlidere, 950 m, 23/9/1993, *Akaydın* 2450.

***Oenanthe pimpinelloides*** L.

A4 Keçiören, 960m, 29/5/1994, *Akaydın* 2931.

***Conium maculatum*** L.

B4 Gazi District, 840 m, 11/6/1993, *Akaydın* 1294.

***Bupleurum rotundifolium*** L.

B4 Dikmen, 1100 m, 31/7/1993, *Akaydın* 2226.

***B. croceum*** Fenzl

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1875. **Ir.-Tur.**

***B. heldreichii*** Boiss. et Bal.

B4 Dikmen, Öveçler, open areas, 1100 m, 10/6/1995, Akaydın 3998. **End. Ir.-Tur.**

***B. flavum*** Forssk.

B4 Kayaş, Samsun highway, 1000 m, 4/6/1994, *Akaydın* 2957. **E. Medit.**

***B. sulphureum*** Boiss. et Bal.

B4 Mamak, Hüseyingazi District, 1200 m, 3/8/1995, *Akaydın* 4478. **End. Ir.-Tur.**

***Apium nodiflorum*** (L.) Lag.

B4 Dikmen, Atatürk Buildings, meadows, 1100 m, 1/8/1993, *Akaydın* 2287.

***Falcaria vulgaris*** Bernh.

B4 Beştepe, Başkent Öğretmen Evi surroundings, 850 m, 10/7/1993, *Akaydın* 1941.

***Johrania tortuosa*** (Fisch. et Mey.) Chamberlain

B4 Keçiören, Kalaba, 860 m, 20/7/1995, *Akaydın* 4273.

***J. polyscias*** Bornm.

B4 Cebeci, Cemetary, 940 m, 22/7/1993, *Akaydın* 2128. **End.**

***Ferulago pauciradiata*** Boiss. et Heldr.

A4 Keçiören, Hacıkadın Stream, 970 m, 28/7/1994, *Akaydın* 3079. **End. Ir.-Tur.**

***Opopanax hispidus*** (Friv.) Gris.

A4 Keçiören, Kuşcağız District, 1070 m, 27/6/1993, *Akaydın* 1561.

***Peucedanum palimbioides*** Boiss.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1879. **End. Ir.-Tur.**

***Pastinaca sativa*** L. subsp. ***urens*** (Req. ex Godron) Celak

B4 Gazi District, railways, stream banks, 830 m, 19/7/1994, *Akaydın* 3065.

***Malabaila secacul*** Banks et Sol.

B4 Balgat, Cevizlidere, 900 m, 6/6/1994, *Akaydın* 2985.

***Zosima absinthifolia*** (Vent.) Link

A4 Keçiören, Hacıkadın Stream, 960 m, 19/6/1993, *Akaydın* 1344.

***Torilis arvensis*** (Huds.) Link subsp. ***arvensis***

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1878.

***T. ucranica*** Sprengel

B4 Mamak, Hüseyingazi District,1200 m, 3/8/1995, *Akaydın* 4467.

***T. leptophylla*** (L.) Reichb.

B4 Keçiören, Meteorology District, 1090 m, 27/6/1993, *Akaydın* 1570.

***Astrodaucus orientalis*** (L.) Drude

B4 Dikmen, Sokullu, open areas, 1100 m, 2/7/1993, *Akaydın* 1766. **Ir.-Tur.**

***Caucalis platycarpos*** L.

B4 Beştepe, afforestation area, 900 m, 24/5/1994, *Akaydın* 2869.

***Turgenia latifolia*** (L.) Hoffm.

B4 Bahçelievler, 850 m, 5/6/1993, *Akaydın* 1273.

***Lisaea papyracea*** Boiss.

B4 Çankaya, Oran, 970 m, 7/7/1993, *Akaydın* 1910. **Ir.-Tur.**

***Orlaya daucoides*** (L.) G. Reut.

B4 Keçiören, 1000 m, 29/5/1994, *Akaydın* 2886. **Medit.**

***Daucus carota*** L.

B4 Anıttepe, Around Atatürk's mausoleum, 870 m, 29/6/1993, *Akaydın* 1690.

***D. guttatus*** Sm.

B4 Bahçelievler, 850 m, 30/6/1993, *Akaydın* 1729.

***Artedia squamata*** L.

B4 Beştepe, Atatürk Anadolu Highschool surroundings, 870 m, 20/6/1993, *Akaydın* 1447.

**CORNACEAE**

***Cornus mas*** L.

A4 Keçiören, Hacıkadın Stream, 950 m, 17/5/1995, *Akaydın* 3577. **Euro.-Sib.**

**CAPRIFOLIACEAE**

***Sambucus ebulus*** L.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1866. **Euro.-Sib.**

***S. nigra*** L.

A4 Keçiören, Hacıkadın Stream, 950 m, 19/6/1993, *Akaydın* 1389. **Euro.-Sib.**

***Viburnum opulus*** L.

A4 Keçiören, Hacıkadın , 950 m, 17/5/1995, *Akaydın* 3576. **Euro.-Sib.**

***Lonicera etrusca*** Santi var. ***etrusca***

A4 Keçiören, Hacıkadın Stream, 950 m, 19/6/1993, *Akaydın* 1413. **Medit.**

***L. caprifolium*** L.

B4 Dikmen, rocky slopes, 1100 m, 31/7/1993, *Akaydın* 2272.

**RUBIACEAE**

***Crucianella bithynica*** Boiss.

A4 Keçiören, Hacıkadın Stream, 970 m, 19/6/1993, *Akaydın* 1351. **E. Medit.**

***C. disticha*** Boiss.

B4 Balgat, Çiğdem District, 1050 m, 27/5/1995, *Akaydın* 3682. **End. Ir.-Tur.**

***Asperula lilaciflora*** Boiss. subsp. ***phrygia*** (Bornm.) Schönb.-Tem.

B4 Şentepe, Karşıyaka Cemetery, 980 m, 25/7/1993, *Akaydın* 2191. **End.**

***A. bornmuelleri*** Velen.

B4 Mamak, 900 m, 6/8/1993, *Akaydın* 2340. **End.**

***A. arvensis*** L.

A4 Keçiören, Hacıkadın Stream, 950 m, 17/5/1995, *Akaydın* 3569.

***Galium verum*** L. subsp. ***verum***

B4 Mamak, 1100 m, 28/6/1993, *Akaydın* 1631. **Euro.-Sib.**

subsp. ***glabrescens*** Ehrend.

B4 Oran, afforestation area, 970 m, 7/7/1993, *Akaydın* 1907. **Ir.-Tur.**

***G. subuliferum*** Sommier et Lev.

B4 Çankaya, Portakal Çiçeği Valley, 980 m, 25/6/1993, *Akaydın* 1518. **Ir.-Tur.**

***G. radulifolium*** Ehrend. et Schönb.-Tem.

A4 Keçiören, Aktepe, slopes, 970 m, 19/6/1933, Akaydın 1390., **End.**

***G. incanum*** Sm. subsp. ***elatius*** (Boiss.) Ehrend.

B4 Keçiören, Meteorology, 1050 m, 27/6/1993, *Akaydın* 1574. **Ir.-Tur.**

***G. spurium*** L. supsp. ***spurium***

B4 Keçiören, Subayevleri, rocky slopes, 870 m, 2/5/1995, *Akaydın* 3362.

***G. tricornutum*** Dandy

B4 Anıttepe, Around Atatürk's mausolcum, 860 m, 29/6/1993, *Akaydın* 1678. **Medit.**

***G. floribundum*** Sm. subsp. ***floribundum***

B4 Balgat, Çiğdem District, stream banks, 1000 m, 26/6/1995, *Akaydın* 4162. **Ir.-Tur.**

***Callipeltis cucullaria*** (L.) Steven

B4 Cebeci, Topraklık, rocky slopes, 960 m, 29/4/1995, *Akaydın* 3325. **Ir.-Tur.**

***Cruciata taurica*** (J.Pall. ex Willd.) Ehrend.

B4 Beştepe, afforestation area, 890 m, 15/5/1994, *Akaydın* 2777. **Ir.-Tur.**

***Rubia tinctorum*** L.

B4 G.O.P., Çiçekdağı street, open areas, 980, 27/7/1993, *Akaydın* 2222. **Ir.-Tur.**

VALERIANACEAE

***Valeriana tuberosa*** L.

A4 Keçiören, Hacıkadın, steppes, 970 m, 1/5/1994, *Akaydın*, 2671.

***Centranthus longiflorus*** J.B.Stev. subsp. ***longiflorus***

B4 Oran, 980 m, 8/7/1993, *Akaydın* 1930. **Ir.-Tur.**

***Valerianella costata*** (J.B.Stev.) Betcke

A4 Keçiören, Hacıkadın Stream, 970 m, 17/5/1995, *Akaydın* 3566. **Medit.**

***V. carinata*** R.J.Loisel

B4 Çankaya, İmrahor, 1100 m, 3/4/1994, *Akaydın* 2533.

***V. pumila*** (L.) D'Cruz

B4 Cebeci, Topraklık, 960 m, 29/4/1995, *Akaydın* 3306.

***V. coronata*** (L.) D'Cruz

B4 Cebeci, 50. Yıl Park, 960 m, 9/5/1993, *Akaydın* 1141.

***V. vesicaria*** (L.) Moench

B4 Beştepe, surroundings, 870 m, 15/5/1994, *Akaydın* 2764.

**MORINACEAE**

***Morina persica*** L.

B4 Kayaş, 1000 m, 4/6/1994, *Akaydın* 2977. **Ir.-Tur.**

**DIPSACACEAE**

***Dipsacus laciniatus*** L.

B4 Dikmen, Atatürk Buildings, meadow, 1100 m, 1/8/1993, *Akaydın* 2292.

***Cephalaria syriaca*** (L.) C.Schröd.

B4 Dikmen, Öveçler, 1100 m, 10/6/1995, *Akaydın* 3990.

***Scabiosa argentea*** L.

B4 Çankaya, President's Pavillion, 1000 m, 4/7/1993, *Akaydın* 1838.

***S. hispidula*** Boiss.

B4 Keçiören, Kalaba, rocky slopes, 870 m, 2/6/1995, *Akaydın* 3820.

***S. rotata*** M.Bieb

B4 Çankaya, President's Pavillion, 1000 m, 4/7/1993, *Akaydın* 1834. **Ir.-Tur.**

***Pterocephalus plumosus*** (L.) J.M.Coult.

B4 Balgat, Çiğdem District, 1050 m, 14/8/1995, *Akaydın* 4524.

**COMPOSITAE (ASTERACEAE)**

***Bidens tripartita*** L.

A4 Keçiören, Hacıkadın Stream, 950 m, 21/8/1995, *Akaydın* 4574.

***Xanthium spinosum*** L.

B4 Söğütözü, Oto Koç surroundings, 870 m, 10/10/1993, *Akaydın* 2475.

***X. strumarium*** L. subsp. ***cavanillesii*** (Schouw) D. Löve et P. Dansereau

B4 Çankaya, G.O.P., 1000 m, 27/7/1993, *Akaydın* 2219.

***Inula oculus-christi*** L.

B4 Balgat, Çiğdem District, 1000 m,19/6/1995, *Akaydın* 4129. **Euro.-Sib.**

***I. montbretiana*** D'Cruz.

B4 Dikmen, Sokullu, 1100 m, 2/7/1993, *Akaydın* 1770. **Ir.-Tur.**

***I.germ.anica*** L.

B4 Dikmen, Keklik Pınarı, stream banks, 1100 m, 23/7/1995, *Akaydın* 4388. **Euro.-Sib.**

***Pulicaria dysenterica*** (L.) Bernh.

B4 G.O.P., Kırkkonaklar District, stream banks, 1000 m, 28/7/1993, *Akaydın* 2242.

***Helichrysum arenarium*** (L.) Moench subsp. ***aucheri*** (Boiss.) P.H. Davis et Kupicha

B4 Balgat, Çiğdem District, 1000 m, 19/6/1995, *Akaydın* 4120. **End? Ir.-Tur.**

***Logfia arvensis*** (L.) Holub

B4 Mamak, Hüseyin Gazi District, 1200 m, 3/8/1995, *Akaydın* 4480.

***Conyza canadensis*** (L.) Cronquist

B4 Balgat, Karakusunlar village, stream banks, 1000 m, 10/7/1995, *Akaydın* 4219.

***Bellis perennis*** L.

A4 Keçiören, Hacıkadın Stream, 950 m, 19/6/1993, *Akaydın* 1330.

***Senecio vernalis*** Waldstein et Kit.

B4 Çankaya,Portakal Çiçeği valley, 980 m, 25/6/1993, *Akaydın* 1530.

***S. viscosus*** L.

A4 Keçiören, Köşk District, 950 m ,29/5/1994, *Akaydın* 2888.

***Tussilago farfara*** L.

A4 Keçiören, Hacıkadın Stream, 950 m, 30/5/1995, *Akaydın* 3812. **Euro.-Sib.**

***Anthemis cretica*** L. subsp. ***tenuiloba*** (D'Cruz.) Grierson

B4 Dikmen, 1150 m, 15/5/1995, *Akaydın* 3532.

subsp. ***umbilicata*** (Boiss. et A.L.P.Huet) Grierson

B4 Dikmen, Keklik Pınarı, 1100 m, 10/6/1995, *Akaydın* 3970.

***A. fumariifolia*** Boiss.

B4 Dikmen, Keklik Pınarı, 1100 m, 28/5/1995, *Akaydın* 3737. **End. Ir.-Tur.**

***A. cotula*** L.

B4 Cebeci, Hacettepe surroundings, 870 m, 8/5/1993, *Akaydın* 1097.

***A. tinctoria*** L. var. ***tinctoria***

A4 Keçiören, Hacıkadın Stream, 970 m, 16/6/1993, *Akaydın* 1421.

var. ***pallida*** D'Cruz

B4 Dikmen, Turtaş, 1100 m, 23/9/1993, *Akaydın* 2455.

***A. triumfettii*** (L.) All.

B4 Dikmen, Sokullu, open areas, 1100 m, 6/6/1995, *Akaydın* 3950.

***A.austriaca*** Jacq.

A4 Keçiören, Sanatoryum street, valley slopes, 1000 m, 26/6/1993, *Akaydın* 1553.

***A.wiedemanniana*** Fisch. et Mey.

A4 Keçiören, Hacıkadın Stream, 970 m, 19/6/1993, *Akaydın* 1417. **End.**

***Achillea wilhelmsii*** C. Koch

B4 Bahçelievler, TEK, 860 m, 5/6/1993, *Akaydın* 1272. **Ir.-Tur.**

***A. phrygia*** Boiss. et Bal.

B4 Mamak, Çiğiltepe, 950 m, 23/4/1994, *Akaydın* 2613. **End. Ir.-Tur.**

***A. aleppica*** D'Cruz

B4 Keçiören, Meteorology Station, 1070 m, 27/6/1993, *Akaydın* 1579. **End. Ir.-Tur.**

***A. teretifolia*** Willd.

A4 Keçiören, Hacıkadın Stream, 970m, 30/5/1995, *Akaydın* 3814. **End. Ir.-Tur.**

***A. millefolium*** L. subsp. ***millefolium***

B4 Mamak, roadsides of dump, 1050 m, 28/6/1993, *Akaydın* 1626. **Euro.-Sib.**

***A. setacea*** Waldstein et Kit.

B4 Cebeci, Cemetery, 880 m, 22/7/1993, *Akaydın* 2127. **Euro.-Sib.**

***A. nobilis*** L. subsp. ***neilreichii*** (A.Kern.) Forma'nek

B4 Keçiören, Kalaba, rocky slopes, 860 m, 20/7/1995, *Akaydın* 4284. **Euro.-Sib.**

***A. biebersteinii*** Afan.

B4 Beştepe, 870 m, 20/6/1993, *Akaydın* 1443. **Ir.-Tur.**

***A. cappadocica*** Hausskn. et Bornm.

B4 Cebeci, Topraklık, 960 m, 9/5/1993, *Akaydın* 1134. **End. Ir.-Tur.**

***Tripleurospermum callosum*** (Boiss. et Heldr.) E. Hostsain

B4 Beştepe, State Cemetery, 860 m, 23/8/1995, *Akaydın* 4615. **End.**

***T. decipiens*** (Fisch. et Mey.) Bornm.

B4 Dikmen, Keklikpınarı, 1150 m, 13/7/1995, *Akaydın* 4337.

***Artemisia austriaca*** Jacq.

B4 G.O.P., Kırkkonaklar , 980 m, 28/7/1993, *Akaydın* 2233.

***A. absinthium*** L.

A4 Keçiören, Ufuktepe, 970 m, 24/7/1993, *Akaydın* 2184.

***A. santonicum*** L.

A4 Keçiören, Hacıkadın Stream, 1000 m, 21/8/1995, *Akaydın* 4558. **Euro.-Sib.**

***Cousina stapfiana*** Freyn et Sint.

B4 Beştepe, 880 m, 23/8/1995,*Akaydın* 4597. **End. Ir.-Tur.**

***Onopordum turcicum*** Danin

A4 Keçiören, Bağlum, 980 m, 24/7/1993, *Akaydın* 2174. **Ir.-Tur.**

***O. anatolicum*** (Boiss.) Eig

B4 Yenimahalle, Demetevler , 860 m, 12/7/1993, *Akaydın* 2012. **End. Ir.-Tur.**

***O. acanthium*** L.

B4 Cebeci, Topraklık, afforestation area, 960 m, 6/5/1995, *Akaydın* 3468.

***Cirsium canum*** (L.) All.

A4 Keçiören, Hacıkadın Stream, 950 m, 1/8/1995, *Akaydın* 4436. **Euro.-Sib.**

***C. alatum*** (Gmelin) Bobrov subsp. ***pseudocreticum*** P.H. Davis et Parris

B4 Sıhhıye, railways, 850 m, 17/7/1993, *Akaydın* 2047. **End. Ir.-Tur.**

***C. arvense*** (L.) Scop. subsp. ***vestitum*** (E.Wimm. et Grab.) Petr.

B4 Çankaya, Portakal Çiçeği Valley, 980 m, 25/6/1993, *Akaydın*1525.

***Picnomon acarna*** (L.) Cass.

A4 Keçiören, roadsides of Bağlum, 970 m, 24/7/1993, *Akaydın* 2172. **Medit.**

***Carduus nutans*** L. subsp. ***nutans***

A4 Keçiören, Kuşcağız, 1070 m, 27/6/1993, *Akaydın* 1613.

***C. pycnocephalus*** L. subsp. ***albidus*** (M.Bieb) Kazmi

B4 Balgat, around high school, open areas, 870 m, 3/5/1994, *Akaydın* 2694.

***Jurinea consanguinea*** D'Cruz

A4 Keçiören, Hacıkadın Stream, 980 m, 17/6/1995, *Akaydın* 4099.

***J. pontica*** Hausskn. et Freyn ex Hausskn.

B4 Oran, afforestation area, 970 m, 7/7/1993, *Akaydın* 1905. **End. Ir.-Tur.**

***Acroptilon repens*** (L.) D'Cruz.

B4 Yenimahalle, A.K.M. surroundings, 830 m, 3/7/1993, *Akaydın* 2022. **Ir.-Tur.**

***Centaurea coronopifolia*** Lam.

B4 Beştepe, State Cemetery, 870 m, 18/7/1993, *Akaydın* 2054. **Ir.-Tur.**

***C. virgata*** Lam.

B4 A.O.Ç., 860 m, 12/8/1993, *Akaydın* 2394. **Ir.-Tur.**

***C. drabifolia*** Sm. subsp. ***detonsa*** (Bornm.) Wagenitz

B4 Şentepe, Karşıyaka Cemetery, 980 m, 25/7/1993, *Akaydın* 2205.

***C. kotschy*** (Boiss. et Heldr.) Hayek var. ***persica*** (Boiss.) Wagenitz

B4 Balgat, Çiğdem District, 1050 m, 26/6/1995, *Akaydın* 4169.

***C. solstitialis*** L. subsp. ***solstitialis***

B4 Çankaya, Ayrancı, open areas, 950 m, 25/6/1993, *Akaydın* 1512.

***C. iberica*** Trevis. ex Sprengel

B4 Ulus, Gençlik Parkı, 850 m, 15/7/1993, *Akaydın* 2040.

***C. urvillei*** D'Cruz. subsp. ***stepposa*** Wagenitz

B4 Çankaya, Portakal Çiçeği valley, 970 m, 25/6/1993, *Akaydın* 1539. **Ir.-Tur.**

***C. carduiformis*** D'Cruz. subsp. ***carduiformis*** var. ***carduiformis***

B4 100. Yıl Buildings, empty places, 950 m, 18/6/1995, *Akaydın* 4110.

***C. pichleri*** Boiss. subsp. ***pichleri***

B4 A.O.Ç., Lalegül, Hürriyet Park, 870 m, 13/6/1993, *Akaydın* 1299.

***C. triumfettii*** All.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1882.

***C. depressa*** M.Bieb

B4 Anıttepe, Around Atatürk's mausoleum, 860 m, 29/6/1993, *Akaydın* 1698.

***Crupina vulgaris*** Cass.

B4 Dikmen, Keklik Pınarı, 1100 m, 3/7/1993, *Akaydın* 1810.

***C. crupinastrum*** (Moris) Vis.

B4 Beştepe, afforestation areas, 880 m, 22/6/1993, *Akaydın* 1475.

***Cnicus benedictus*** L. var. ***kotschy*** Boiss.

B4 Dikmen, Keklik Pınarı, 1100 m, 28/5/1995, *Akaydın* 3720.

***Carthamus persicus*** Willd.

B4 Beştepe, hills, 870 m, 10/7/1993, *Akaydın* 1960. **Ir.-Tur.**

***C. lanatus*** L.

A4 Keçiören, Ufuktepe, open areas, 970 m, 24/7/1993, *Akaydın* 2175.

***C. dentatus*** Vahl

A4 Hasköy, Dam District, rocky slopes, 950 m, 3/8/1993, *Akaydın* 2304.

***C. glaucus*** M.Bieb

A4 Keçiören, Aktepe,1000 m,21/8/1995,Akaydın 4559.

***Carlina corymbosa*** L.

B4 Mamak, Hüseyingazi District, 1200 m, 3/8/1995, *Akaydın* 4486. **Medit.**

***C. oligocephala*** Boiss. et Kotschy subsp. ***oligocephala***

B4 Keçiören, Şentepe, Karşıyaka Cemetery, 980 m, 28/7/1994, *Akaydın* 3075.

***Xeranthemum annuum*** L.

B4 Çankaya, G.O.P., Çiçekdağı street, 970 m, 27/7/1993, *Akaydın* 2216.

***X. inapertum*** (L.) Miller

B4 Çankaya, Oran,TRT Buildings, 1000 m, 8/7/1993, *Akaydın* 1925.

***X. longipapposum*** Fisch. et Mey.

B4 Sıhhıye, railways, 850 m, 17/7/1993, *Akaydın* 2048. **Ir.-Tur.**

***Chardinia orientalis*** (L.) Kuntze

B4 Balgat, Karakusunlar Cemetery, 1000 m, 13/6/1995, *Akaydın* 4014. **Ir.-Tur.**

***Echinops ritro*** L.

B4 Şentepe, Karşıyaka Cemetery, 980 m, 25/7/1993, *Akaydın* 2206.

***E. sphaerocephalus*** L. subsp. ***sphaerocephalus***

A4 Keçiören, Hacıkadın Stream, 980 m, 22/10/1995, *Akaydın* 4647.

***E. pungens*** Trautv. var. ***pungens***

B4 Cebeci, Cemetery, 880 m, 22/7/1993, *Akaydın* 2139. **Ir.-Tur.**

***E. orientalis*** Trautv.

B4 Beştepe surroundings, 870 m, 10/7/1993, *Akaydın* 1945. **Ir.-Tur.**

***Scolymus hispanicus*** L.

B4 Yenimahalle-Demetevler, open areas, 860 m, 12/7/1993,*Akaydın* 2013. **Medit.**

***Cichorium intybus*** L.

B4 Çankaya, Seğmenler Park, 980 m, 4/7/1993, *Akaydın* 1822.

***Scorzonera laciniata*** L. subsp. ***laciniata***

B4 Dikmen, Keklik Pınarı, 1100 m, 28/5/1995, *Akaydın* 3704.

***S. cana*** (C.A.Meyer) Hoffm. var. ***jacquiniana*** (W.Koch) Chamberlain

B4 Mamak, dump area surroundings, open areas, 1100 m, 8/5/1994, *Akaydın* 2751.

***S. suberosa*** C. Koch subsp. ***suberosa***

A4 Keçiören, Aktepe, afforestation area, 1000 m, 25/4/1995, *Akaydın* 3257. **Ir.-Tur.**

***S. eriophora*** D'Cruz.

B4 Çankaya, İmrahor Stream, 1050 m, 16/5/1995, *Akaydın* 3548. **End.**

***S. pseudolanata*** Grossh.

B4 Çankaya, İmrahor Stream, 1050 m, 3/4/1994., *Akaydın* 2543. **Ir.-Tur.**

***Tragopogon porrifolius*** L.

B4 Keçiören, Kalaba, rocky slopes, 870 m, 22/5/1994, *Akaydın* 2838. **Medit.**

***T. longirostris*** Bisch. ex Schultz var. ***longirostris***

A4 Keçiören, Hacıkadın, 960 m, 1/5/1994, *Akaydın* 2657.

***T. coloratus*** C.A. Meyer

B4 Keçiören, Kalaba, rocky slopes, 860 m, 2/5/1995, *Akaydın* 3391. **Ir.-Tur.**

***T. dubius*** Scop.

B4 Anıttepe, Around Atatürk's mausoleum, 860 m, 29/7/1993, *Akaydın* 1682.

***T. pratensis*** L.

B4 Keçiören, Kalaba, rocky slopes, 870 m, 22/5/1994, *Akaydın* 2839. **Euro.-Sib.**

***T. latifolius*** Boiss. var. ***angustifolius*** Boiss.

B4 Çiğdem District, open areas, 1050 m, 27/5/1995, *Akaydın* 3663. **Ir.-Tur.**

***T. buphthalmoides*** (D'Cruz.) Boiss. var. ***latifolius*** Boiss.

B4 Şentepe, Karşıyaka Cemetery, 970 m, 1/6/1994, *Akaydın* 2934. **Ir.-Tur.**

***T. aureus*** Boiss.

B4 Balgat, Çiğdem District, empty places, 4/6/1995, *Akaydın* 3936. **End.**

***Leontodon asperrimus*** (Willd.) Ball

B4 Beştepe, afforestation area, 870 m, 8/6/1993, *Akaydın* 1279. **Ir.-Tur.**

***L. crispus*** Vill. subsp. ***asper*** (Waldstein et Kit.) Rohl.

var. ***setulosus*** (Hal.) Kupicha

B4 Balgat, Çiğdem District, open areas, 1050 m, 27/5/1995, *Akaydın* 3699.

***Picris strigosa*** M.Bieb

B4 Balgat, Çiğdem District, empty places, 1050 m, 14/5/1995, *Akaydın* 4521. **Ir.-Tur.**

***P. pauciflora*** Willd.

B4 Balgat, Karakusunlar,1000 m, 4/6/1995, *Akaydın* 3938. **Medit.**

***Rhagadiolus angulosus*** (Jaub.. et Spach) Kupicha

B4 Çankaya, Oran, TRT Buildings, 1050 m, 20/4/1994, *Akaydın* 2600. **Ir.-Tur.**

***Sonchus asper*** (L.) Hill subsp. ***glaucescens*** (Jord.) Ball

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1850.

***Reichardia glauca*** Matthews

B4 Keçiören, Kalaba, Çubuk, rocky slopes, 870 m, 20/7/1995, *Akaydın* 4271. **Ir.-Tur.**

***Hieracium pannosum*** Boiss.

B4 Dikmen, Keklik Pınarı, rocky slopes, 1100 m, 6/8/1995, *Akaydın* 4499. **E. Medit.**

***H. paphlagonicum*** Freyn et Sint.

B4 Mamak, Hüseyingazi District, rocky slopes, 1200 m, 3/8/1995, *Akaydın* 4449. **End.**

***Pilosella piloselloides*** (Vill.) Sojak subsp. ***megalomastix*** (NP.) P.D.Sell et L.West

B4 Balgat, Çiğdem District, stream banks, 1000 m, 19/6/1995, *Akaydın* 4125.

***P. echioides*** (Lumn..) C.H. et F.W.Schultz subsp. ***procera*** (Fries) P.D.Sell et L.West

B4 Mamak Hüseyingazi District, rocky slopes, 1200 m, 3/8/1995, *Akaydın* 4450.

***P. x macrotricha*** (Boiss.) C.H. et F.W.Schultz

B4 Balgat, Karakusunlar, stream banks, 1000 m, 10/7/1995, *Akaydın* 4220.

***Steptorhamphus tuberosus*** (Jacq.) Grossh.

A4 Keçiören, 960 m, 19/6/1993, *Akaydın* 1358.

***Lactuca serriola*** L.

B4 Balgat, Cevizlidere, empty places, 950 m, 30/7/1993, *Akaydın* 2250. **Euro.-Sib.**

***L. aculeata*** Boiss. et Kotschy ex Boiss.

B4 A.O.Ç. State Cemetery, 900 m, 23/8/1995, *Akaydın* 4619. **Ir.-Tur.**

***Scariola viminea*** (L.) F.W.Schmidt

A4 Hasköy, Dam District, rocky slopes, 950 m, 3/8/1993, *Akaydın* 2302.

***S. orientalis*** (Boiss.) Soja'k

B4 Balgat, Çiğdem District, 1050 m, 26/7/1995, *Akaydın* 4391. **Ir.-Tur.**

***Taraxacum serotinum*** (Waldstein et Kit.) Poir.

B4 Dikmen, Öveçler, empty places, 980 m, 23/9/1993, *Akaydın* 2452.

***T. oliganthum*** Schott et Kotschy ex Hand.-Mazz.

B4 Çankaya, G.O.P., Çiçekdağı street, roadsides, 1000 m, 27/7/1993, *Akaydın* 2227.

***T. scaturiginosum*** G.E.Haglung

B4 Çankaya, Seğmenler Park, 980 m, 4/7/1993, *Akaydın* 1821.

***T. buttleri*** van Soest

B4 Anıttepe, around swimming pool, 860 m, 22/5/1993, *Akaydın* 1222.

***Chondrilla juncea*** L. var. ***juncea***

B4 Demetevler, Hürriyet Park, 870 m, 12/8/1993, *Akaydın* 2396.

var. ***acantholepis*** (Boiss.) Boiss.

B4 Sıhhıye, railways, 860 m, 17/7/1993, *Akaydın* 2049.

***Crepis macropus*** Boiss. et Heldr.

B4 Beştepe afforestation area, 870 m, 18/7/1993, *Akaydın* 2055. **End. Ir.-Tur.**

***C. alpina*** L.

B4 Balgat, Çiğdem District, 1000 m, 19/6/1995, *Akaydın* 4127.

***C. foetida*** L. subsp. ***rhoeadifolia*** (M.Bieb) Celak.

B4 Çankaya, Portakal Çiçeği Valley, 980 m, 25/6/1993, *Akaydın* 1537.

subsp. ***commutata*** (Spreng.) Babc.

B4 Bahçelievler, TEK around, 850 m, 30/6/1993, *Akaydın* 1711.

***C. sancta*** (L.) Babc.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1872.

**CAMPANULACEAE**

***Campanula lyrata*** Lam. subsp. ***lyrata***

A4 Keçiören, Hacıkadın Stream, 970 m, 19/6/1993, *Akaydın* 1331. **End.**

***C. glomerata*** L. subsp. ***hispida*** (Witasek) Hayek

B4 Keçiören, Kalaba, rocky slopes, 870 m, 16/6/1995, *Akaydın* 4056. **Euro.-Sib.**

***C. argaea*** Boiss. et Bal.

B4 Mamak, Hüseyingazi District, rocky slopes, 1200 m, 3/8/1995, *Akaydın* 4455. **End. Ir.-Tur.**

***Asyneuma limonifolium*** (L.) Janch. subsp. ***pestalozzae*** (Boiss.) Dumbolt

A4 Keçiören, slopes, 980 m, 3/6/1995, *Akaydın* 3862. **End.**

***A. lobelioides*** (Willd.) Hand.-Mazz.

B4 Balgat, 100. Yıl, empty places, 950 m, 18/6/1995, *Akaydın* 4108. **Ir.-Tur.**

***A. virgatum*** (Labill.) Bornm.

B4 Çankaya, 1000 m, 5/7/1993, *Akaydın* 1854.

***Legousia speculum-veneris*** (L.) Chaix

B4 Keçiören, Kalaba, Çubukçayı, 850 m, 22/5/1994, *Akaydın* 2837. **Medit.**

**PRIMULACEAE**

***Androsace maxima*** L.

B4 Yahyalar District, Karşıyaka Cemetery, 960 m, 9/4/1995, *Akaydın* 3190.

***Lysimachia vulgaris*** L.

A4 Keçiören, Hacıkadın, 950 m, 8/7/1995, *Akaydın* 4204.

***Anagallis arvensis*** L. var. ***coerulea*** (L.) Gouan

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1846.

***A. foemina*** Miller

B4 Çankaya, Portakal Çiçeği Valley, 970 m, 25/6/1993, *Akaydın* 1510. **Medit.**

**OLEACEAE**

***Jasminum fruticans*** L.

B4 Keçiören, Kalaba, rocky slopes, 860 m, 2/5/1995, *Akaydın* 3381. **Medit.**

**APOCYNACEAE**

***Vinca herbaceae*** Waldstein et Kit.

B4 Balgat, Konya highway, 980 m, 23/4/1993, *Akaydın* 1019.

**ASCLEPIADACEAE**

***Cynanchum acutum*** L. subsp. ***acutum***

A4 Hasköy, Dam District, empty places, 950 m, 3/8/1993, *Akaydın* 2306.

***Vincetoxicum fuscatum*** (Hornem.) Reichb. subsp. ***fuscatum***

B4 Balgat, Fen High school surroundings, 1050 m, 27/5/1995, *Akaydın* 3673.

**GENTIANACEAE**

***Centaurium pulchellum*** (Swartz) Druce

B4 Beştepe, roadsides, stream banks, 870 m, 18/7/1993, *Akaydın* 2060.

**CONVOLVULACEAE**

***Convolvulus cantabrica*** L.

A4 Keçiören, 970 m, 19/6/1993, *Akaydın* 1397.

***C. lineatus*** L.

B4 Cebeci Cemetery, 900 m, 27/4/1995, *Akaydın* 3271.

***C. holosericeus*** M.Bieb subsp. ***holosericeus***

B4 100. Yıl, Karakusunlar, 1000 m, 13/6/1995, *Akaydın* 4015.

***C. arvensis*** L.

B4 Bahçelievler, TEK surroundings, 860 m, 5/6/1993, *Akaydın* 1270.

***C. galaticus*** Rostan ex Choisy

B4 Çankaya, Portakal Çiçeği valley, 970 m, 25/6/1993, *Akaydın* 1504. **End. Ir.-Tur.**

**CUSCUTACEAE**

***Cuscuta campestris*** Yunck.

B4 Yenimahalle, Akköprü, A.K.M. surroundings, 830 m, 13/7/1993, *Akaydın* 2014.

***C. palaestina*** Boiss. subsp. ***balansae*** (Yunck.) Plitmannann

B4 100. Yıl, Karakusunlar Cemetery, 1000m, 13/6/1995, *Akaydın* 4032.

***C. approximata*** Bab. var. ***approximata***

B4 Çankaya, Oran, afforestation area, 970 m, 7/7/1993, *Akaydın* 1892.

**BORAGINACEAE**

***Heliotropium europaeum*** L.

B4 Cebeci, Cemetery, 900 m, 22/7/1993, *Akaydın* 2140. **Medit.**?

***H. dolosum*** De Not.

B4 Çankaya, Portakal Çiçeği Valley, 970 m, 25/6/1993, *Akaydın* 1522.

***H. ellipticum*** Ledeb.

B4 Demetevler, Bağdat Street, 870 m, 12/7/1993, *Akaydın* 2002. **Ir.-Tur.**

***H. lasiocarpum*** Fisch. et Mey.

A4 Keçiören, Hacıkadın Stream, 980 m, 21/8/1995, *Akaydın* 4568. **Ir.-Tur.**

***H. suaveolens*** M.Bieb

B4 Bahçelievler, TEK. surroundings, 860 m, 30/6/1993, *Akaydın* 1737. **E. Medit.**?

***Lappula barbata*** (M.Bieb) Gürke

A4 Hasköy, Solfasol, 900 m, 17/5/1993, *Akaydın* 1182. **Ir.-Tur.**

***L. squarrosa*** (Retz.) Dumort.

B4 Beştepe, around Atatürk Anadolu High school, 870 m, 20/6/1993, *Akaydın* 1446.

***Rochelia disperma*** (L.fil.) C.Koch var. ***disperma***

B4 Cebeci, Topraklık, 50. Yıl Park, 960 m, 28/4/1995, *Akaydın* 3310.

***Asperugo procumbens*** L.

B4 Beştepe, afforestation area, 900 m, 24/5/1994, *Akaydın* 2867. **Euro.- Sib.**

***Myosotis stricta*** Link ex Roemer et Schultes

B4 Keçiören, Kalaba, Çubuk stream banks, 860 m, 2/5/1995, *Akaydın* 3357. **Euro.- Sib.**

***M. refracta*** Boiss. subsp. ***refracta***

B4 Akköprü, A.K.M., 830 m, 16/4/1994, *Akaydın* 2573. **Medit.**

***M. lithospermifolia*** (Willd.) Hornem.

B4 İncesu Stream, Mutlu District, open areas, 960 m,16/7/1995,*Akaydın* 3215.

***Paracaryum incanum*** (Ledeb.) Boiss.

B4 Dikmen, Öveçler, 1100 m, 10/6/1995, *Akaydın* 3955. **Ir.-Tur.**

***P. calycinum*** Boiss. et Bal.

B4 İvedik, Şentepe, 960 m,1/6/1994, *Akaydın* 2935. **End. Ir.-Tur.**

***P. ancyritanum*** Boiss.

B4 Balgat, Cevizlidere Valley, 930 m, 6/6/1994, *Akaydın* 2982. **End. Ir.-Tur.**

***Cynoglossum creticum*** Miller

B4 Yenimahalle, Akköprü, A.K.M. surroundings, 830 m, 16/4/1994, *Akaydın* 2558.

***C. montanum*** L.

B4 Dikmen, Öveçler, 1100 m, 1/7/1993, *Akaydın* 1752. **Euro.- Sib.**

***Buglossoides arvensis*** (L.) Johnst.

B4 İncesu Stream, Mutlu District, 960 m, 16/4/1995, *Akaydın* 3216.

***B. incrassata*** (Guss.) Johnst.

B4 Gazi District, State Cemetery, 900 m, 10/6/1994, *Akaydın* 2545. **Medit.**

***Neatostema apulum*** (L.) Johnst.

B4 Çankaya Botanical Garden, 1000 m, 2/5/1994, *Akaydın* 2691. **Medit.**

***Echium italicum*** L.

B4 Bahçelievler, TEK surroundings, 860 m, 30/6/1993, *Akaydın* 1722. **Medit.**

***Moltkia coerulea*** (Willd.) Lehm.

B4 Cebeci, Cemetery, 900 m, 28/4/1995, *Akaydın* 3273. **Ir.-Tur.**

***M. aurea*** Boiss.

B4 Keçiören, Kalaba, rocky slopes, 870 m, 19/5/1995, *Akaydın* 3589. **End. Ir.-Tur.**

***Onosma cappadocicum*** Siehe ex H. Riedl

B4 Dikmen, Keklik Pınarı, 1200 m, 15/5/1995, *Akaydın* 3540. **End. E. Medit.**

***O. isauricum*** Boiss. et Heldr.

A4 Keçiören, Hacıkadın, 970 m, 19/6/1993, *Akaydın* 1387. **End. Ir.-Tur.**

***O. briquettii*** Czech

A4 Keçiören, Hacıkadın, 970 m, 19/6/1993, *Akaydın* 1395. **End. Ir.-Tur.**

***O. sieheanum*** Hayek

B4 Dikmen, Keklik Pınarı, 1100 m, 10/6/1995, *Akaydın* 3958. **End. Ir.-Tur.**

***O. tauricum*** J.Pall. ex Willd. var. ***tauricum***

A4 Hasköy, Dam District, rocky slopes, 950 m, 3/8/1993, *Akaydın* 2300.

***O. aucheranum*** D'Cruz

B4 Demetevler, Lalegül, empty places, 880 m, 13/6/1993, *Akaydın* 1298. **E. Medit.**

***O. armenum*** D'Cruz

B4 Cebeci, Aktepe, empty places, 960 m, 9/5/1993, *Akaydın* 1135. **End.**

***O. hebebulbum*** D'Cruz

B4 Dikmen, Keklik Pınarı, 1100 m, 28/5/1995, *Akaydın* 3746. **Ir.-Tur.**

***Cerinthe minor*** L. subsp. ***auriculata*** (Ten.) Domac

B4 Dikmen, Keklik Pınarı, 1100 m, 3/7/1993, *Akaydın* 1799.

***Anchusa leptophylla*** Roemer et Schultes subsp. ***leptophylla***.

B4 Çankaya, Portakal Çiçeği Valley, 970 m, 25/6/1993, *Akaydın* 1511.

subsp. ***incana*** (Ledeb.) Chamb.

B4 Beştepe, 870 m, 21/6/1993, *Akaydın* 1451. **End. Ir.-Tur.**

***A. undulata*** L. subsp. ***hybrida*** (Ten.) Cout.

B4 İncesu Stream, Mutlu District, 960 m, 16/5/1995, *Akaydın* 3214. **Medit.**

***A. azurea*** Miller var. ***azurea***

B4 Bahçelievler, TEK surroundings, 860 m, 30/6/1993, *Akaydın* 1723.

***A. pusilla*** Guşul.

B4 Gazi District, Faculty of Pharmacy surroundings, 840 m, 11/6/1993, *Akaydın* 1291.

***A. barrelieri*** (All.) Vitman

B4 Cebeci, Numune Hospitalsi surroundings, 850 m, 29/4/1995, *Akaydın* 3296. **End.**

***Nonea caspica*** (Willd.) Don

B4 Gazi District, 840 m, 11/6/1993, *Akaydın* 1292. **Ir.-Tur.**

***N. macrosperma*** Boiss. et Heldr.

B4 A.O.Ç. State Cemetery, 900 m, 10/4/1994, *Akaydın* 2556. **End. Ir.-Tur.**

***N. ventricosa*** (Sm.) Griseb.

B4 Kurtuluş, edges of railways, 880 m, 8/5/1993, *Akaydın* 1106. **Medit.**

***Alkanna orientalis*** (L.) Boiss. var. ***orientalis***

B4 Keçiören, Subayevleri, rocky slopes, 870 m, 26/3/1995, *Akaydın* 3147. **Ir.-Tur.**

**SOLANACEAE**

***Solanum nigrum*** L. subsp. ***schultesii*** (Opiz) Wessely

A4 Keçiören, Hacıkadın Stream, 950 m, 21/7/1995, *Akaydın* 4292.

***S. alatum*** Moench

B4 Söğütözü surroundings, 850 m, 17/8/1995, *Akaydın* 4529.

***S. dulcamara*** L.

B4 Çankaya, GOP, 950 m, 28/7/1993, *Akaydın* 2240. **Euro.-Sib.**

***Lycium depressum*** Stocks

B4 Balgat, Karakusunlar, 1000 m, 10/7/1995, *Akaydın* 4225. **Ir.-Tur.**

***L. anatolicum*** A.Baytop et R.B.Mill.

B4 Yenimahalle, 830 m, 18/8/1993, *Akaydın* 2416. **End. Ir.-Tur.**

***Datura stramonium*** L.

B4 Söğütözü, 860 m, 17/8/1995, *Akaydın* 4530.

***Hyoscyamus pusillus*** L.

B4 Cebeci, Kurtuluş, 840 m, 29/4/1995, *Akaydın* 3292. **Ir.-Tur.**

***H. niger*** L.

B4 Balgat, 870 m, 3/5/1994, *Akaydın* 2699.

***H. reticulatus*** L.

B4 Çankaya, Portakal Çiçeği Valley, 970 m, 25/6/1993, *Akaydın* 1513. **Ir.-Tur.**

**SCROPHULARIACEAE**

***Verbascum caudatum*** Freyn et Bornm.

B4 Keçiören, Kuyubaşı, 970 m, 25/5/1993, *Akaydın* 1239. **End. Ir.-Tur.**

***V. stachydifolium*** Boiss. et Heldr. var. ***adspersum*** (Freyn et Sint.) Murb.

B4 Balgat, around Bilim College, 1000 m, 25/5/1994, *Akaydın* 2878. **End. Ir.-Tur.**

***V. lasianthum*** Boiss. ex Benth.

B4 Dikmen, Keklik Pınarı, 1100 m, 31/7/1993, *Akaydın* 2275.

***V. ancyritanum*** Bornm.

B4 Demetevler, Lalegül, 900 m, 15/6/1993, *Akaydın* 1316. **End. Ir.-Tur.**

***V. cherianthifolium*** Boiss. var. ***asperulum*** (Boiss.) Murb.

A4 Keçiören, Hacıkadın Stream, 970 m, 19/6/1993, *Akaydın* 1345. **End.**

***Scrophularia scopolii*** Hoppe ex Pers. var. ***scopolii.***

A4 Keçiören, Hacıkadın Stream, 950 m, 30/5/1995, *Akaydın* 3815.

***S. lucida*** L.

B4 Dikmen, Keklikpınarı, 1150 m, 28/5/1995, *Akaydın* 3708. **Medit.**

***S. xanthoglossa*** Boiss. var. ***decipiens*** (Boiss. et Kotschy) Boiss.

B4 Balgat, Cevizlidere, empty places, 900 m, 6/6/1994, *Akaydın* 2986. **Ir.-Tur.**

***Chaenorhinum minus*** (L.) Lange subsp. ***anatolicum*** P.H. Davis

B4 Balgat, Çiğdem District, stream banks, 1000 m, 26/6/1995, *Akaydın* 4163. **End.**

***Linaria genistifolia*** (L.) Miller subsp. ***confertiflora*** (Boiss.) P.H.Davis

B4 Dikmen, Akpınar, 1100 m, 6/6/1994, *Akaydın* 2995. **End? Ir.-Tur.**

***L. grandiflora*** Desf.

B4 Söğütözü surroundings, 850 m, 17/8/1995, *Akaydın* 4529.

***S. dulcamara*** L.

B4 Çankaya, GOP, 950 m, 28/7/1993, *Akaydın* 2240. **Euro.-Sib.**

***Lycium depressum*** Stocks

B4 Balgat, Karakusunlar, 1000 m, 10/7/1995, *Akaydın* 4225. **Ir.-Tur.**

***L. anatolicum*** A.Baytop et R.B.Mill.

B4 Yenimahalle, 830 m, 18/8/1993, *Akaydın* 2416. **End. Ir.-Tur.**

***Datura stramonium*** L.

B4 Söğütözü, 860 m, 17/8/1995, *Akaydın* 4530.

***Hyoscyamus pusillus*** L.

B4 Cebeci, Kurtuluş, 840 m, 29/4/1995, *Akaydın* 3292. **Ir.-Tur.**

***H. niger*** L.

B4 Balgat, 870 m, 3/5/1994, *Akaydın* 2699.

***H. reticulatus*** L.

B4 Çankaya, Portakal Çiçeği Valley, 970 m, 25/6/1993, *Akaydın* 1513. **Ir.-Tur.**

**SCROPHULARIACEAE**

***Verbascum caudatum*** Freyn et Bornm.

B4 Keçiören, Kuyubaşı, 970 m, 25/5/1993, *Akaydın* 1239. **End. Ir.-Tur.**

***V. stachydifolium*** Boiss. et Heldr. var. ***adspersum*** (Freyn et Sint.) Murb.

B4 Balgat, around Bilim College, 1000 m, 25/5/1994, *Akaydın* 2878. **End. Ir.-Tur.**

***V. lasianthum*** Boiss. ex Benth.

B4 Dikmen, Keklik Pınarı, 1100 m, 31/7/1993, *Akaydın* 2275.

***V. ancyritanum*** Bornm.

B4 Demetevler, Lalegül, 900 m, 15/6/1993, *Akaydın* 1316. **End. Ir.-Tur.**

***V. cherianthifolium*** Boiss. var. ***asperulum*** (Boiss.) Murb.

A4 Keçiören, Hacıkadın Stream, 970 m, 19/6/1993, *Akaydın* 1345. **End.**

***Scrophularia scopolii*** Hoppe ex Pers. var. ***scopolii***.

A4 Keçiören, Hacıkadın Stream, 950 m, 30/5/1995, *Akaydın* 3815.

***S. lucida*** L.

B4 Dikmen, Keklikpınarı, 1150 m, 28/5/1995, *Akaydın* 3708. **Medit.**

***S. xanthoglossa*** Boiss. var. ***decipiens*** (Boiss. et Kotschy) Boiss.

B4 Balgat, Cevizlidere, empty places, 900 m, 6/6/1994, *Akaydın* 2986. **Ir.-Tur.**

***Chaenorhinum minus*** (L.) Lange subsp. ***anatolicum*** P.H. Davis

B4 Balgat, Çiğdem District, stream banks, 1000 m, 26/6/1995, *Akaydın* 4163. **End.**

***Linaria genistifolia*** (L.) Miller subsp. ***confertiflora*** (Boiss.) P.H.Davis

B4 Dikmen, Akpınar, 1100 m, 6/6/1994, *Akaydın* 2995. **End? Ir.-Tur.**

***L. grandiflora*** Desf.

B4 Balgat , 1050 m, 27/5/1995, *Akaydın* 3691. **Ir.-Tur.**

***L. corifolia*** Desf.

B4 Çankaya, Oran, afforestation area, 980 m, 7/7/1993, *Akaydın* 1909. **End. Ir.-Tur.**

***L. iconia*** Boiss. et Heldr.

B4 Cebeci, Aktepe, 960 m, 23/6/1993, *Akaydın*1484b. **End. Ir.-Tur.**

***L. kurdica*** Boiss.et Hohen. subsp. ***kurdica***

B4 Dikmen, 1050 m, 1/8/1993, *Akaydın* 2281, **Ir.-Tur.**

subsp. ***aucheri*** (Boiss.) P.H.Davis.

B4 Çankaya, GOP, 970 m, 26/7/1994, *Akaydın* 3073. **Ir.-Tur.**

***L. simplex*** (Willd.) D'Cruz

B4 Dikmen, Sokullu, 1100 m, 30/4/1995, *Akaydın* 3337. **Medit?**

***Kickxia spuria*** (L.) Dumort. subsp. ***integrifolia*** (Brot.) R. Fernandes

B4 Keçiören, Kalaba, 860 m, 19/7/1995, *Akaydın* 4550.

***Digitalis lamarckii*** Ivan.

B4 Mamak, Hüseyingazi District, 1200 m, 3/8/1995, *Akaydın* 4465. **End.**

***Veronica grisebachii*** Walters

B4 Keçiören, Subayevleri, rocky slopes, 860 m, 2/5/1995, *Akaydın* 3393. **E. Medit.**

***V. tryphyllos*** L.

B4 Söğütözü, Çukurambar, empty places, 900 m, 2/4/1994, *Akaydın* 2517.

***V. campylopoda*** Boiss.

A4 Keçiören, Hacıkadın Stream, 980 m, 21/7/1995, *Akaydın* 4328. **Ir.-Tur.**

***V. polita*** Fries

B4 Anıttepe, 860 m, 23/5/1993, *Akaydın* 1230.

***V. persica*** Poir.

B4 Kurtuluş, near Hacettepe Hospital, 880 m, 8/5/1993, *Akaydın* 1111.

***V. triloba*** (Opiz) A.Kern.

B4 Demetevler, Karşıyaka Cemetery, 970 m, 20/3/1994, *Akaydın* 2490.

***V. hederifolia*** L.

B4 Cebeci, Aktepe, 950 m, 9/5/1993, *Akaydın* 1132.

***V. angallis-aquatica*** L.

B4 Balgat, Karakusunlar, stream banks, 1000 m, 10/7/1995, *Akaydın* 4217.

***V. oxycarpa*** Boiss.

A4 Keçiören, Sanatoryum, 970 m, 26/6/1993, *Akaydın* 1550. **Ir.- Tur.**

***V. anagalloides*** Gauss.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1849.

***V. jacquinii*** Baumg.

B4 Balgat, 1000 m, 19/6/1995, *Akaydın* 4131.

***V. multifida*** L.

B4 Keçiören, Şose, 970 m, 21/5/1993, *Akaydın*, 1203. **End. Ir.-Tur.**

***Odontites aucheri*** Boiss.

B4 100. Yıl Buildings, empty places, 950 m, 18/6/1995, *Akaydın* 4117. **Ir.-Tur.**

***Pedicularis comosa*** L. var. ***acmodonta*** (Boiss.) Boiss.

B4 Dikmen, Atatürk Sitesi, stream banks, 1050 m, 6/6/1994, *Akaydın* 3008.

***Bungea trifida*** (Vahl) C.A.Meyer

B4 Ankara, Solfasol, 900 m, 19/5/1993, *Akaydın* 1192. **Ir.-Tur.**

**OROBANCHACEAE**

***Orobanche ramosa*** L.

B4 Dikmen, Konya highway, 1100 m, 28/5/1995, *Akaydın* 3739.

***O. nana*** Noe' ex Beck

B4 Balgat surroundings, 1000 m, 4/6/1995, *Akaydın* 3933.

***O. mutelii*** F. Schultz

A4 Keçiören, Hacıkadın Stream, 1000 m, 11/7/1993, *Akaydın* 1966.

***O. cernua*** Loefl.

B4 Mamak, Hüseyin Gazi, 1200 m, 3/8/1995, *Akaydın* 4459.

***O. alba*** Stephan

B4 Balgat, 1050 m, 27/5/1995, *Akaydın* 3647.

***O. hadroantha*** Beck

B4 Bahçelievler, TEK surroundings, 860 m, 30/6/1993, *Akaydın* 1704. **End.**

***O. minor*** Sm.

B4 Dikmen, Sokullu, empty places, 1100 m, 6/6/1995, *Akaydın* 3940.

***O. anatolica*** Boiss. et Reut.

B4 Çankaya, Oran, 980 m, 7/7/1993, *Akaydın* 1911.

**ACANTHACEAE**

***Acanthus hirsutus*** Boiss.

B4 Balgat, empty places, 1000 m, 25/5/1994, *Akaydın* 2872. **End. Ir.-Tur.**

**GLOBULARIACEAE**

***Globularia orientalis*** L.

B4 Keçiören, Yayla District, 980 m, 25/7/1993, *Akaydın* 2202. **Ir.-Tur.**

***G. trichostantha*** Fisch. et Mey.

B4 Dikmen, Sokullu, empty places, 1100 m, 15/5/1995, *Akaydın* 3528.

**VERBENACEAE**

***Verbena officinalis*** L.

B4 Çankaya, GOP Kırkkonaklar valley, 970 m, 28/7/1993, *Akaydın* 2235.

**LABIATAE (LAMIACEAE)**

***Ajuga salicifolia*** (L.)Schreber

A4 Keçiören, Hacıkadın Stream, 970 m, 25/5/1995, *Akaydın* 3628. **Ir.-Tur.**

***A. chamaepitys*** (L.) Schreber subsp. ***chia*** (Schreber) Arcang. var. *chia*.

B4 Yenimahalle, Akköprü, A.K.M. surroundings, 830 m, 16/4/1994, *Akaydın* 2562.

***Teucrium orientale*** L. var. ***orientale***

B4 Mamak, Hüseyin Gazi, 1200 m, 3/8/1995, *Akaydın* 4462. **Ir.-Tur.**

***T. pruinosum*** Boiss.

B4 Balgat, Çiğdem District, 1050 m, 1/7/1995, *Akaydın* 4187. **Ir.-Tur.**

***T. parviflorum*** Schreber

A4 Keçiören, Hacıkadın, 970 m, 11/7/1993, *Akaydın* 1973.

***T. scordium*** L. subsp. ***scordioides*** (Schreber) Maire et Petitmengin

B4 Keçiören, Metcorology Station, 1070 m, 27/6/1993, *Akaydın* 1578. **Euro.-Sib.**

***T. chamaedrys*** L. subsp. ***chamaedrys***

B4 Çankaya, Oran, TRT surroundings, 980 m, 8/7/1993, *Akaydın* 1921 **Euro.-Sib.**

***T. polium*** L.

B4 G.O.P. Kırkkonaklar District, among the houses, 980 m, 28/7/1993, *Akaydın* 2245.

***Scutellaria orientalis*** L. subsp. ***macrostegia*** (Hausskn. ex Bornm.) J.R.Edm.

A4 Keçiören, Hacıkadın Stream, 970 m, 19/6/1993, *Akaydın* 1347. **Ir.-Tur.**

subsp. ***pinnatifida*** J.R.Edm.

B4 Demetevler, Lalegül, 860 m, 13/6/1993, *Akaydın* 1302.

***Phlomis pungens*** Willd. var. ***pungens***

B4 100.Yıl, Karakusunlar Cemetery, 1000 m, 13/6/1995, *Akaydın* 4005.

var. ***hirta*** Velen.

B4 Şentepe, 980 m, 25/7/1993, *Akaydın* 2199.

***P. armeniaca*** Willd.

B4 Keçiören, Köşk, empty places, 980 m, 29/5/1994, *Akaydın* 2891. **End. Ir.-Tur.**

***Lamium amplexicaule*** L.

B4 AOÇ., afforestation area, 890 m, 18/3/1995, *Akaydın* 3122 **Euro.-Sib.**

***L. purpureum*** L. var. ***purpureum***

B4 İncesu, Mutlu District, 860 m, 16/4/1995, *Akaydın* 3217. **Euro.-Sib.**

***Wiedemannia orientalis*** Fisch. et Mey.

B4 Cebeci, Cemetery, open areas, 900 m, 27/4/1995, *Akaydın* 3268. **End. Ir.-Tur.**

***Marrubium vulgare*** L.

A4 Keçiören, Sanatoryum, 960 m, 26/6/1993, *Akaydın* 1554.

***M. parviflorum*** Fisch. et Mey. subsp. ***oligodon*** (Boiss.) Seybold.

B4 Bahçelievler, TEK surroundings, 860 m, 5/6/1993, *Akaydın* 1263. **End.**

***M. trachyticum*** Boiss.

B4 Beştepe, roadsides, 890 m, 11/5/1993, *Akaydın* 1146. **End. Ir.-Tur.**

***Sideritis lanata*** L.

B4 Cebeci, Kurtuluş, 870 m, 29/4/1995, *Akaydın* 3301. **E. Medit.**

***S. montana*** L. subsp. ***montana***

B4 Çankaya, 1000 m, 5/7/1993, *Akaydın* 1877. **Medit.**

subsp. ***remota*** (d'Urv) P.W.Ball ex Heywood.

B4 Dikmen. Öveçler, 1100 m, 1/7/1993, *Akaydın* 1741. **E.Medit.**

***S. galatica*** Bornm.

B4 Dikmen Keklik Pınarı, rocky slopes, 1100 m, 31/7/1993, *Akaydın* 2270. **End.**

***Stachys cretica*** L. subsp. ***anatolica*** Rech.

B4 Beştepe, A.O.Ç. road junction, 860 m, 20/6/1993, *Akaydın* 1437. **End. Ir.-Tur.**

***S. byzantina*** C. Koch

B4 Çankaya, 980 m, 25/6/1993, *Akaydın* 1538. **Euro.-Sib.**

***S. iberica*** M.Bieb subsp. ***stenostachya*** (Boiss.) Rech.

B4 Çankaya, 980 m, 4/7/1993, *Akaydın* 1828. **Ir.-Tur.**

***S. annua*** (L.) L. subsp. ***annua*** var. ***lycaonica*** R.Bhattacharjee

A4 Keçiören, Hacıkadın Stream, 950 m, 17/6/1995, *Akaydın* 4067. **Ir.-Tur.**

var. ***annua***

B4 Dikmen, Keklik Pınarı, 1100 m, 28/5/1995, *Akaydın* 3705.

***Melissa officinalis*** L. subsp. ***officinalis***

A4 Keçiören, Hacıkadın, stream banks, 950 m, 21/7/1995, *Akaydın* 4297.

***Nepeta italica*** L.

A4 Keçiören, 960 m, 19/6/1993, *Akaydın* 1342.

***N. cataria*** L.

B4 Kalaba, rocky slopes, 870 m, 16/6/1993, *Akaydın* 4042. **Euro.-Sib.**

***N. nuda*** L. subsp. ***albiflora*** (Boiss.) Gams

B4 Mamak, around dump area, 1200 m, 28/6/1993, *Akaydın* 1652.

***N. racemosa*** Lam.

B4 Cebeci, Kurtuluş, 870 m, 8/5/1993, *Akaydın* 1105. **Ir.-Tur.**

***Lallemantia iberica*** (M.Bieb) Fisch. et Mey.

B4 A.O.Ç. afforestation area, 900 m, 24/5/1994, *Akaydın* 2846. **Ir.-Tur.**

***Prunella vulgaris*** L.

B4 Kayaş, 950 m, 19/7/1993, *Akaydın* 2078. **Euro.-Sib.**

***Clinopodium vulgare*** L. subsp. ***vulgare***

A4 Keçiören, Hacıkadın, meadows, 950 m, 17/6/1995, *Akaydın* 4081.

***Acinos rotundifolius*** Pers.

B4 Cebeci, Topraklık, 960 m, 29/4/1995, *Akaydın* 3308.

***Thymus sipyleus*** Boiss. subsp. ***rosulans*** (Borba's) Jalas

A4 Keçiören, Hacıkadın, 970 m, 19/6/1993, *Akaydın* 1357.

***T. longicaulis*** Pers. subsp. ***longicaulis*** var. *subisophyllus* (Borbas) Jalas

B4 Demetevler, Lalegül, edges of İstanbul highway, 870 m, 13/6/1993, *Akaydın* 1301.

***Mentha longifolia*** (L.) J.Huds. subsp. ***typhoides*** (Briq.) Harley var. ***typhoides***

B4 A.O.Ç., State Cemetery, stream banks, 860 m, 17/7/1994, *Akaydın* 3060.

***M. spicata*** L. subsp. ***spicata***

B4 Çankaya, GOP.,Kırkkonaklar, 960 m, 28/7/1993, *Akaydın* 2244.

***Lycopus europaeus*** L.

B4 Çankaya, 1000 m, 8/8/1993, *Akaydın* 2361. **Euro.-Sib.**

***Ziziphora capitata*** L.

B4 Anıttepe, Around Atatürk's mausoleum, 870 m, 29/6/1993, *Akaydın* 1671. **Ir.-Tur.**

***Z. persica*** Bunge

B4 Balgat, Cevizlidere, empty places, 900 m, 6/6/1994, *Akaydın* 2989. **Ir.-Tur.**

***Z. tenuior*** L.

B4 Dikmen, Sokullu, rocky slopes, 1100 m, 15/5/1995, *Akaydın* 3512. **Ir.-Tur.**

***Salvia recognita*** Fisch. et Mey.

B4 Keçiören, Kalaba, rocky slopes, 870 m, 19/7/1995, *Akaydın* 4540. **End. Ir.-Tur.**

***S. bracteata*** Banks et Sol.

B4 Balgat, Çiğdem District, 1050 m, 4/5/1995, *Akaydın* 3919. **Ir.-Tur.**

***S. tchihatcheffii*** (Fisch. et Mey.) Boiss.

B4 Balgat, around Balgat High school, 1050 m, 27/5/1995, *Akaydın* 3693. **End. Ir.-Tur.**

***S. suffruticosa*** Montbret et Aucher ex Benth.

B4 Balgat, Çiğdem District, empty places, 1050 m, 4/5/1995, *Akaydın* 3921. **Ir.-Tur.**

***S. cadmica*** Boiss.

A4 Keçiören, Hacıkadın Stream, valley slopes, 960 m, 3/6/1995, *Akaydın* 3899. **End.**

***S. cryptantha*** Montbret et Aucher ex Benth.

B4 Demetevler, Lalegül, roadsides, 870 m, 13/6/1993, *Akaydın* 1308. **End. Ir.-Tur.**

***S. syriaca*** L.

A4 Keçiören, Hacıkadın Stream, valley slopes, 960 m, 14/8/1993, *Akaydın* 2400.**Ir.-Tur.**

***S. viridis*** L.

B4 Çankaya, İmrohor, around the houses, 1000 m, 16/5/1995, *Akaydın* 3544. **Medit.**

***S. hypargeia*** Fisch. et Mey.

B4 Balgat, Çiğdem District, 1050 m, 27/5/1995, *Akaydın* 3688.**End. Ir.-Tur.**

***S. sclarea*** L.

B4 Çankaya, Portakal Çiçeği valley, 980 m, 25/6/1993, *Akaydın* 1516.

***S. aethiopis*** L.

B4 Bahçelievler, TEK surroundings, 860 m, 30/6/1993, *Akaydın* 1721.

***S. ceratophylla*** L.

B4 Balgat, Cevizlidere, empty places, 950 m, 6/6/1994, *Akaydın* 2991. **Ir.-Tur.**

*S. candidissima* Vahl subsp. ***occidentalis*** S.N.S.N.Hedge

B4 Çankaya, Botanical Garden, 1000 m, 5/7//1993, *Akaydın* 1852. **Ir.-Tur.**

***S. cyanescens*** Boiss. et Bal.

B4 Çankaya, 970 m, 25/6/1993, *Akaydın* 1515. **End. Ir.-Tur.**

***S. virgata*** Jacq.

B4 Çankaya, GOP, 980 m, 27/7/1993, *Akaydın* 2225. **Ir.-Tur.**

***S. verticillata*** L. subsp. ***amasiaca*** (Freyn et Bornm.) Bornm.

B4 Keçiören, 860 m, 20/7/1995, *Akaydın* 4288. **Ir.-Tur.**

***S. russellii*** Benth.

B4 A.O.Ç. State Cemetery, 900 m, 22/6/1993, *Akaydın* 1479. **Ir.-Tur.**

**PLUMBAGINACEAE**

***Plumbago europaea*** L.

B4 Demetevler, Lalegül, 860 m, 12/8/1993, *Akaydın* 2391. **Euro.-Sib.**

***Limonium gmelinii*** (Willd.) Kuntze

B4 Gazi District, edges of railways, 850 m, 10/8/1993, *Akaydın* 2382. **Euro.-Sib.**

***Acantholimon acerosum*** (Willd.) Boiss. var. ***acerosum***

B4 Demetevler, Lalegül, 870 m, 11/6/1993, *Akaydın* 2392. **Ir.-Tur.**

**PLANTAGINACEAE**

***Plantago major*** L. subsp. ***major***

B4 Çankaya, GOP, Kırkkonaklar, 970 m, 28/7/1993, *Akaydın* 2231.

***P. maritima*** L.

A4 Keçiören, Bağlum roadsides, 24/7/1993, *Akaydın* 2168.

***P. holosteum*** Scop.

B4 Mamak, Hüseyin Gazi, around houses, 1200 m, 3/8/1995, *Akaydın* 4458. **Medit.**

***P. lanceolata*** L.

B4 Çankaya, Seğmenler, 980 m, 4/7/1993, *Akaydın* 1839.

**THYMELAEACEAE**

***Thymelaea passerina*** (L.) Cosson et Germ..

B4 Beştepe, environs of Başkent Öğretmenevi, 880 m, 23/8/1995, *Akaydın* 4593.

**ELAEAGNACEAE**

***Elaeagnus angustifolia*** L.

B4 Keçiören, Kalaba, 860 m, 2/6/1995, *Akaydın* 3822.

**SANTALACEAE**

***Thesium arvense*** Horv.

B4 Dikmen, Öveçler, 1100 m, 10/6/1995, *Akaydın* 3987. **Euro.-Sib.**

***T. procumbens*** C.A.Meyer

B4 Keçiören, Kalaba, Çubuk stream surroundings, 860 m, 20/7/1995, *Akaydın* 4279.

**LORANTHACEAE**

***Viscum album*** L. subsp. ***album***

B4 Dikmen, Sokullu, 1100 m, 2/7/1993, *Akaydın* 1777.

subsp. ***austriacum*** (Wiesb.) Vollman

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1868.

**ARISTOLOCHIACEAE**

***Aristolochia maurorum*** L.

B4 Çankaya, Oran afforestation area, 980 m, 7/7/1993, *Akaydın* 1893. **Ir.-Tur.**

**EUPHORBIACEAE**

***Andrachne telephioides*** L.

B4 Cebeci, Kurtuluş, around railways, 870 m, 17/9/1993, *Akaydın* 2438.

***Chrozophora tinctoria*** (L.) Raf.

B4 Beştepe, Öğretmenevi surroundings, 880 m, 23/8/1995, *Akaydın* 4605.

***Mercurialis annua*** L.

A4 Hacıkadın Stream, 950 m, 16/6/1995, *Akaydın* 4063.

***Euphoria cardiophylla*** Boiss. et Heldr.

B4 Altındağ, Kayaş, 1000 m, 4/6/1994, *Akaydın* 2972. **End.**

***E. stricta*** L.

B4 Çankaya, İmrahor, 1000 m, 8/8/1993, *Akaydın* 2366. **Euro.-Sib.**

***E. eriophora*** Boiss.

B4 Balgat, Around Konya highway, 1200 m, 10/8/1995 *Akaydın* 4506. **Ir.-Tur.**

***E. coniosperma*** Boiss. et Buhse

A4 Keçiören, Bağlum roadsides, 1000 m, 17/4/1994, *Akaydın* 2586. **Ir.-Tur.**

***E. rhabdotosperma*** A.Radcliffe-Smith

B4 A.O.Ç., State Cemetery, 890 m, 18/3/1995, *Akaydın* 3125. **Ir.-Tur.**

***E. helioscopia*** L.

B4 Cebeci, around Hacettepe Hospital, 870 m, 8/5/1993, *Akaydın* 1118.

***E.aleppica*** L.

B4 İvedik, Şentepe, 970 m, 25/7/1993, *Akaydın* 2188.

***E. ledebourii*** Boiss.

B4 Cebeci, Topraklık, 960 m, 28/4/1995, *Akaydın* 3324.

***E. falcata*** L. subsp. ***falcata*** var. ***falcata***

B4 A.O.Ç., State Cemetery, 900 m, 24/5/1994, *Akaydın* 2847.

***E. anacampseros*** Boiss. var. ***anacampseros***

B4 Dikmen, Cevizlidere, 900 m, 6/6/1994, *Akaydın* 2987. **End.**

***E. myrsinites*** L.

B4 Balgat, Konya highway, afforestation area, 930 m, 23/4/1993, *Akaydın* 1022.

***E. macroclada*** Boiss.

B4 Bahçelievler, TEK. 860 m, 30/6/1993, *Akaydın* 1716. **Ir.-Tur.**

**URTICACEAE**

***Urtica dioica*** L.

A4 Keçiören, Hacıkadın Stream, 950 m, 19/6/1993, *Akaydın* 1433. **Euro.-Sib.**

***Parietaria judaica*** L.

A4 Keçiören, Aktepe, 970 m, 3/6/1995, *Akaydın* 3851.

**ULMACEAE**

***Ulmus glabra*** J.Huds.

B4 Keçiören, Subayevleri, rocky slopes, 870 m, 2/5/1995, *Akaydın* 3366. **Euro.-Sib.**

***U. minor*** Miller subsp. ***minor***

B4 Dikmen, Konya highway, 1200 m, 10/8/1995, *Akaydın* 4501.

**FAGACEAE**

***Quercus robur*** L. subsp. ***robur***

A4 Hasköy, Dam District, 950 m, 3/8/1993, *Akaydın* 2294. **Euro.-Sib.**

***Q. ithaburensis*** Decne. subsp. ***macrolepis*** (Kotschy) Hedge et Yalt.

A4 Keçiören, Hacıkadın Stream, 980 m, 19/6/1993, *Akaydın* 1406. **E. Medit.**

**CORYLACEAE**

***Corylus avellana*** L. var. ***avellana***

A4 Keçiören, Hacıkadın Stream, 950 m, 17/6/1995, *Akaydın* 4087. **Euro.-Sib.**

## MONOCOTYLEDONAE

**LILIACEAE**

***Allium paniculatum*** L. subsp. ***paniculatum*** subsp. ***paniculatum***

B4 Çankaya, 1000 m, 5/7/1993. *Akaydın* 1885. Det: M. Koyuncu. **Medit.**

***A. pseudoflavum*** Vved.

B4 Altındağ, Kayaş, among the houses, 1000 m,19/7/1993, *Akaydın* 2092. **Ir.-Tur.**

***A. huber-morathii*** Kollmann, N. Özhatay et M.Koyuncu

B4 Cebeci, Aktepe, 960 m, 23/6/1993, *Akaydın* 1496. Det: M. Koyuncu. **End. Ir.-Tur.**

***A. ampeloprasum*** L.

B4 Yenimahalle, A.K.M. surroundings, 830 m, 13/7/1993, *Akaydın* 2017. **Medit.**

***A. atroviolaceum*** Boiss.

B4 Anıttepe, around Atatürk's mausoleum, 880 m, 29/6/1993, *Akaydın* 1675.

***A. scorodoprasum*** L. subsp. ***rotundum*** (L.) Stearn

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1884. **Medit.**

***A. stylosum*** O. Schwarz

B4 Dikmen, Sokullu, 1000 m, 1/7/1993, *Akaydın* 1742. Det: M.Koyuncu. **End. Ir.-Tur.**

***A. vineale*** L.

B4 Dikmen, meadows, 1100 m, 24/7/1995, *Akaydın* 4358.

***Ornithogalum pyrenaicum*** L.

B4 Keçiören, Meteorology Station, 1070 m, 27/6/1993, *Akaydın* 1566.

***O. sphaerocarpum*** A.Kern.

B4 Mamak, around dump area, 1150 m, 28/6/1993, Akaydın 1632.

***O. narbonense*** L.

B4 Çankaya, Oran, afforestation area, 970 m, 7/7/1993, *Akaydın* 1899. **Medit.**

***O. ulophyllum*** Hand.-Mazz.

A4 Hasköy, Dam District, 950 m, 25/4/1993, *Akaydın* 1047.

***O. comosum*** L.

B4 Keçiören, Kalaba, 860 m, 2/5/1995, *Akaydın* 3355.

***O. umbellatum*** L.

B4 Beştepe, Öğretmenevi surroundings, 860 m, 6/5/1993, *Akaydın* 1091.

***O. orthophyllum*** Ten.

B4 Keçiören, Meteorology Station, 860 m, 26/3/1995, *Akaydın* 3149.

***Muscari tenuiflorum*** Tausch

B4 A.O.Ç., State Cemetery, wet places, 870 m, 23/4/1995, *Akaydın* 3238.

***M. longipes*** Boiss.

B4 Söğütözü, MTA surroundings, 850 m, 4/5/1995, *Akaydın* 3435. **Ir.-Tur.**

***M. neglectum*** Guss.

B4 Cebeci, Topraklık, 960 m, 9/5/1993, *Akaydın* 1136.

***Fritillaria fleischeriana*** Steud. et Hochst.. ex Schultes et Schultes

A4 Keçiören, Aktepe, 980 m, 25/4/1995, *Akaydın* 3256.**End. Ir.-Tur.**

***F. pinardii*** Boiss.

A4 Keçiören, Hacıkadın Stream, 970 m, 1/5/1994, *Akaydın* 2658. **Ir.-Tur.**

***Gagea bohemica*** (Zauschn.) Schultes et Schultes

B4 Demetevler, Karşıyaka Cemetery surroundings, 970 m, 20/3/1994, *Akaydın* 2489.

***G. peduncularis*** (J. et C. Presl) Pascher

A4 Keçiören, Kuşcağız, 1000 m, 20/3/1994, *Akaydın* 2496. **Medit.**

***G. villosa*** (M.Bieb) Duby var. ***villosa***

A4 Keçiören, Hacıkadın Stream, 970 m, 27/3/1994, *Akaydın* 2512. **Medit.**

***Colchicum triphyllum*** Kunze

B4 Balgat, 100. Yıl, empty places, 900 m, 2/4/1994, *Akaydın* 2521. **Medit.**

***Merendera sobolifera*** C.A.Meyer

B4 Dikmen, Atatürk Buildings, meadows, 1100 m, 26/3/1994, *Akaydın* 2502. **Ir.-Tur.**

***M. attica*** (Spruner) Boiss. et Spruner

B4 Balgat, Çiğdem District, empty places, 1050 m, 18/2/1995, *Akaydın* 3101. **E. Medit.**

**IRIDACEAE**

***Crocus ancyrensis*** (Herb.) Maw

B4 Dikmen, around Turtaş Buildings, 1100 m, 26/5/1994, *Akaydın* 2500. **End. Ir.-Tur.**

***C. danfordiae*** Maw

B4 Çankaya, Oran, around TRT Buildings, 980 m, 18/3/1994, *Akaydın* 1002. **End.**

***C. olivieri*** Gay subsp. ***olivieri***

B4 Dikmen, around Turtaş Buildings, 1100 m, 26/5/1994, *Akaydın* 2499.

***Gladiolus atroviolaceus*** Boiss.

B4 Cebeci, Topraklık, 960 m, 6/5/1995, *Akaydın* 3470. **Ir.-Tur.**

**ORCHIDACEAE**

***Epipactis condensata*** Boiss. ex D.P.

A4 Keçiören, Hacıkadın Stream, 950 m, 17/6/1995, *Akaydın* 4065. **E. Medit.**

***Orchis coriophora*** L.

A4 Keçiören, Hacıkadın Stream, valley slopes, 960 m, 3/6/1995, *Akaydın* 3855.

***O. palustris*** Jacq.

B4 Çankaya, Oran, 970 m, 7/7/1993, *Akaydın* 1902.

***O. laxiflora*** Lam.

B4 Dikmen, 1000 m, 6/6/1994, *Akaydın* 3010. Det: E.Sezik. **Medit.**

**TYPHACEAE**

***Typha angustifolia*** L.

B4 Beştepe, roadsides, edges of ponds, 880 m, 4/8/1994, *Akaydın* 2310.

***T. domingensis*** Pers.

B4 Çankaya, İmrahor, edges of water channels, 1000 m, 8/8/1992, *Akaydın* 2354.

**JUNCACEAE**

***Juncus gerardi*** Loisel. subsp. ***gerardi***

B4 Beştepe, roadsides, 880 m, 5/9/1993, *Akaydın* 2422.

subsp. ***libanoticus*** (Thiéb.) B.Snogerup

B4 Çankaya, G.O.P., Kırkkonaklar, 960m, 28/7/1993, *Akaydın* 2241. **Ir.-Tur.**

***J. sphaerocarpus*** Ness

B4 Balgat, Çiğdem District, stream sides, 1000 m, 1/7/1995, *Akaydın* 4195.

***J. bufonius*** L.

B4 Dikmen,Keklik Pınarı, 1100 m, 14/7/1995, *Akaydın* 4244.

***J. articulatus*** L.

B4 Dikmen, Turtaş, stream sides, 1100 m, 31/7/1993, *Akaydın* 2261. **Euro.-Sib.**

**CYPERACEAE**

***Schoenoplectus lacustris*** (L.) Palla subsp. ***tabernaemontani*** (C.C.Gmel.) A.et D.Löve

B4 Balgat, stream sides, 1000 m, 19/6/1995, *Akaydın* 4128.

***Scirpoides holoschoenus*** (L.) Sojak

B4 Mamak, Kayaş, stream sides, 1000 m, 19/7/1993, *Akaydın*2069.

***Carex divulsa*** Stokes subsp. ***leersii*** (Kneuck.) W. Koch

A4 Keçiören, Hacıkadın Stream, 950 m, 21/7/1995, *Akaydın* 4294. **Euro.-Sib.**

***C. riparia*** Curtis

B4 Mamak, 970 m, 29/8/1995, *Akaydın* 4433. **Euro.-Sib.**

***C. distans*** L.

B4 Balgat, Çiğdem District, stream sides, 1000 m, 1/7/1995, *Akaydın* 4196. **Euro.-Sib.**

**GRAMINEAE (POACEAE)**

***Trachynia distachya*** (L.) Link

A4 Keçiören, 970 m, 30/5/1995, *Akaydın* 3773. Det: M. Doğan. **Medit.**

***Agropyron cristatum*** (L.) Gartner subsp. ***pectinatum*** (M.Bieb) Tzvelev. var. ***pectinatum***

B4 Beştepe, roadsides, 860 m, 14/7/1994, *Akaydın* 3055. Det: M. Doğan.

***Elymus repens*** (L.) Gould

B4 Yenimahalle, A.K.M. surroundings, 830 m, 18/8/1993, *Akaydın* 2417. **Ir.-Tur.**

***E. hispidus*** (Opiz) Melderis subsp. ***barbulatus*** (Schur) Melderis

B4 Gazi District, railways, 840 m, 10/8/1993, *Akaydın* 2386.

***Eremopyrum triticeum*** (Gaertn.) Nevski

B4 Dikmen, Keklik Pınarı, among the houses, 1100 m, 10/6/1995, *Akaydın* 3965.

***Aegilops speltoides*** Tausch var. ***ligustica*** (Savign.) Bornm.

B4 Beştepe, Başkent Öğretmenevi surroundings, 850 m, 18/6/1994, *Akaydın* 3037.

***Ae. cylindrica*** Hostt

B4 Dikmen, Akpınar District, 1100 m, 6/6/1994, *Akaydın* 2997. **Ir.-Tur.**

***Ae. umbellulata*** Zhukovsky subsp. ***umbellulata***

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1841. **Ir.-Tur.**

***Ae. triuncialis*** L. subsp. ***triuncialis***

B4 Gazi District, 840 m, 11/6/1993, *Akaydın* 1290.

***Ae. columnaris*** Zhukovsky

B4 Çankaya, 970 m, 25/6/1993, *Akaydın* 1514. **Ir.-Tur.**

***Triticum baeoticum*** Boiss. subsp. ***thaoudar*** (Reut. ex Hausskn.) Schiem.

B4 Balgat, 1000 m, 10/7/1995, *Akaydın* 4230.

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

B4 Çankaya, Oran, afforestation area, 970 m, 7/7/1993, *Akaydın* 1904.

***Hordeum marinum*** J.Huds. var. ***marinum***

B4 Bahçelievler, TEK surroundings, 850 m, 24/4/1994, *Akaydın* 2635.

***H. murinum*** L. subsp. ***glaucum*** (Steud.) Tzvelev

B4 Çankaya, Portakal Çiçeği valley, 970 m, 25/6/1993, *Akaydın* 1520.

subsp. ***leporinum*** (Link) Arc. var. ***leporinum***

B4 Gazi Üniv., Buildings, around Pharmacy Faculty, 840 m, 11/6/1993, *Akaydın* 1295.

***H. bulbosum*** L.

B4 Beştepe, 860 m, 21/6/1993, *Akaydın* 1453.

***Taeniatherum caput-medusae*** (L.) Nevski subsp. ***asper*** (Simonk.) Melderis

B4 Beştepe, 870 m, 14/7/1994, *Akaydın* 3056.

subsp. ***crinitum*** (Schreber) Melderis

B4 Balgat, Çiğdem District, empty places, 1050 m, 26/7/1995, *Akaydın* 4386. **Ir.-Tur.**

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

B4 Beştepe, around Atatürk Anadolu High school, 850 m, 20/6/1993, *Akaydın* 1449.

***B. scoparius*** L.

A4 Keçiören, Köşk District, on hills, 1000 m, 29/5/1994, *Akaydın* 2881. Det: M. Doğan. ***B. tectorum*** L.

B4 Bahçelievler, TEK surroundings, 850 m, 24/4/1994, *Akaydın* 2633.

***B. sterilis*** L.

B4 Çankaya, 970 m, 25/6/1993, *Akaydın* 1521. Det: M.Doğan.

***B. rigidus*** Roth

B4 Cebeci, 840 m, 29/4/1995, *Akaydın* 3293. Det: M.Doğan.

***B. cappadocicus*** Boiss. et Bal. subsp. ***cappadocicus***

B4 Çankaya, Oran, İmrahor valley, 16/5/1995, *Akaydın* 3550.

***B. tomentellus*** Boiss.

B4 Dikmen, Keklik Pınarı, 1100 m, 28/5/1995, *Akaydın* 3754. **Ir.-Tur.**

***Arrhenatherum elatius*** (L.) P. Beauv. ex J. et C. Presl

B4 Dikmen, Keklik Pınarı, 1100 m, 28/5/1995, *Akaydın* 3709. Det:M. Doğan. **Euro.Sib.**

***A. palaestinum*** Boiss.

A4 Keçiören, Hacıkadın 960 m, 29/5/1994, *Akaydın* 2922. Det: M. Doğan. **E. Medit.**

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

B4 Cebeci, Aktepe slopes, 960 m, 23/6/1993, *Akaydın* 1499.

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

A4 Keçiören, Bağlum roadsides, 970 m, 24/7/1993, *Akaydın* 2153. . **Euro.-Sib.**

***A. intermedia*** Hackel

A4 Keçiören, Bağlum roadsides, 970 m, 24/7/1993, *Akaydın* 2167. **Ir.-Tur.**

***Agrostis stolonifera*** L.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1843. . **Euro.-Sib.**

***Polypogon viridis*** (Gouan) Breistr.

B4 Dikmen, Keklik Pınarı, 1100 m, 31/7/1993, *Akaydın* 2263. Det:M. Doğan. **Euro.Sib.**

***P. monspeliensis*** (L.) Desf.

B4 Çankaya, İmrahor Stream,1000 m, 8/8/1993, *Akaydın* 2359. Det: M. Doğan.

***Alopecurus arundinaceus*** Poir.

B4 Yenimahalle, A.K.M. surroundings, 840 m, 16/4/1994, *Akaydın* 2566. **Euro.-Sib.**

***A. myosuroides*** J.Huds. var. ***myosuroides***

B4 Yenimahalle, A.K.M. surroundings, 840 m, 16/4/1994, *Akaydın* 2560. . **Euro.-Sib.**

***Phleum bertolonii*** D'Cruz

A4 Keçiören, Bağlum roadsides, 970 m, 24/7/1993, *Akaydın* 2170. Det: M. Doğan.

***P. exaratum*** Hochst.. ex Griseb. subsp. ***exaratum***

B4 Balgat, Çiğdem District, empty places, 1050 m, 14/8/1995, *Akaydın* 4525.

***Festuca arundinacea*** Schreber subsp. ***arundinacea***

B4 Balgat, Çiğdem District, 1000 m, 26/6/1995, *Akaydın* 4167.

***F. heterophylla*** Lam.

A4 Keçiören, Köşk District, 1000 m, 29/5/1994, *Akaydın* 2885. . **Euro.-Sib.**

***F. logipanicula*** Markgr. -Dann.

B4 Beştepe, roadsides, stream sides, 850 m, 24/5/1994, *Akaydın* 2841. **End. Ir.-Tur.**

***Lolium perenne*** L.

B4 Anıttepe, Around Atatürk's mausolcum, 870 m, 29/6/1993, *Akaydın* 1685. . **Euro.-Sib.**

***Vulpia persica*** (Boiss. et Buhse) V. Krecz. et Bobrov

A4 Keçiören, Hacıkadın Stream, 950 m, 17/5/1995, *Akaydın* 3574. **Ir.-Tur.**

***V. unilateralis*** (L.) Stace

B4 Dikmen, Keklik Pınarı, 1200 m, 15/5/1995, *Akaydın* 3531. Det: M. Doğan.

***Micropyrum tenellum*** (L.) Link

B4 Dikmen, Keklik Pınarı, 1100 m, 28/5/1995, *Akaydın* 3723. Det: M.Doğan. **Medit.**

***Poa trivialis*** L.

A4 Keçiören, Hacıkadın Stream, *D.* 18843., 950 m, 19/6/1993, *Akaydın* 1322.

***P. pratensis*** L.

B4 Yenimahalle, 830 m, 16/4/1994, *Akaydın* 2564. Det: M.Doğan.

***P.nemoralis*** L.

B4 Keçiören, Kalaba, Çubuk stream surroundings, 860 m, 2/5/1995, *Akaydın* 3383.

***P. alpina*** L. subsp. ***fallax*** F. Hermann

B4 Beştepe, Atatürk Anadolu High school surroundings, 860 m, 6/5/1993, *Akaydın* 1090.

***P. timoleontis*** Heldr. ex Boiss.

B4 Mamak, 1000 m, 8/5/1994, *Akaydın* 2747. **E. Medit.**

***P. bulbosa*** L.

B4 Cebeci, Aktepe, 960 m, 29/4/1995, *Akaydın* 3319.

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

B4 Beştepe, A.O.Ç., watersides, 870 m, 15/9/1993, *Akaydın* 2421.

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

B4 Yenimahalle, 830 m, 16/4/1994, *Akaydın* 2563. Det: M.Doğan. **Eıro.-Sib.**

***Dactylis glomerata*** L. subsp. ***hispanica*** (Roth) Nyman

B4 Beştepe, State Cemetery, 880 m, 24/5/1994, *Akaydın* 2840.

***Briza humilis*** M.Bieb

A4 Keçiören, Hacıkadın Stream, 980 m, 29/5/1994, *Akaydın* 2904.

***Echinaria capitata*** (L.) Desf.

B4 Beştepe, around Atatürk Anadolu High school, 870 m, 3/5/1993, *Akaydın* 1079.

***Melica penicillaris*** Boiss. et Bal.

B4 Çankaya, Botanical Garden, 1000 m, 5/7/1993, *Akaydın* 1840. Det: M.Doğan. **Ir.-Tur.**

***M. ciliata*** L. subsp. ***ciliata***

B4 Anıttepe, Around Atatürk's mausoleum, 880 m, 29/6/1993, *Akaydın* 1699.

***Stipa holosericea*** Trin

B4 Mamak, Kayaş, 1000 m, 19/7/1993, *Akaydın* 2095. Det: M. Doğan. **Ir.-Tur.**

***S. arabica*** Trin. et Rupr.

B4 Cebeci, Topraklık, 960 m, 15/6/1994, *Akaydın* 3021. Det: M. Doğan. **Ir.-Tur.**

***S. hohenackeriana*** Trin. et Rupr. var. ***hohenackeriana***

A4 Keçiören, Hacıkadın slopes, 980 m, 19/6/1993, *Akaydın* 1336. **Ir.-Tur.**

***S. lessingiana*** Trin. et Rupr.

B4 Anıttepe, Around Atatürk's mausolcum, 880 m, 29/6/1993, *Akaydın* 1677 b.

***Phragmites australis*** (Cav.) Trin. ex Steud.

B4 Söğütözü, 880 m, 10/10/1993, *Akaydın* 2471. **Euro.-Sib.**

***Eragrostis minor*** Hostt

A4 Cebeci, Akköprü, 960 m, 15/6/1994, *Akaydın* 3024.

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

B4 Mamak, 970 m, 7/8/1993, *Akaydın* 2351.

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

B4 Balgat, edges of Konya Highway, 950 m, 23/7/1995, *Akaydın* 4333.

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

B4 Keçiören, Kalaba, 850 m, 19/8/1995, *Akaydın* 4541. Det: M. Doğan.

***S. verticillata*** (L.) P.Beauv..

B4 Keklikpınarı, 1100 m, 23/7/1995, *Akaydın* 4341.

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

B4 Mamak, around the houses, 1000 m, 4/6/1994, *Akaydın* 2963. **Ir.-Tur.**

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

A4 Keçiören, Bağlum roadsides, 970 m, 24/7/1993, Akaydın 2154.

***Bothriochloa ischaemum*** (L.) Keng

B4 Mamak, Mutlu District, 970 m, 7/8/1993, *Akaydın* 2351. Det: M. Doğan.

## DISCUSSION

3600 wild plant samples were collected as a result of the field survey from March 1993 to 1995. The identification of these samples revealed that there exist 995 species and 147 supspecies and varietas belonging to 385 genera and to 76 families.

This floristic study is the first to be carried out in an urban area. The basic aim of this study is to compare the results of the urban study with those of field survey carried out in natural areas near the urban site. The study also investigates the effects of urbanization on flora.

In the first study concerning the flora of the city of Ankara (4), 586 species were identified, whereas in the present study, 995 species have been identified, representing an increase of 70%. This difference may be due to several factors: Krause's failure to collect certain species, the spread into the area of new species from outside the area, and/or anthropogenic effects.

When contrasted with Krauses's study, the greatest increase seen in *Asteraceae* (+74), *Fabaceae* (+45), *Poaceae* (+39), *Brassicaceae* (+23), and *Apiacae* (+19). 47 (8%) of the species identified by Krause were not found by the researcher. This may be due to: the disappearence of certain ecosystems such as the Incesu and Ankara Streams as a result of urbanization, the transformation into urban areas of former natural areas such Etlik, Keçiören, Dikmen, and Çankaya. 120 (20%) of the species in the literature (7,8) and herbarium records (ANK, HUB and GAZI), could not be found (12).

In terms of total number of species and rich families, when compared with nearby natural areas (Table 1), the total number of species is twice that in other studies. The reasons for this are the fact that the study area is larger than the others, as well as various partially-protected ecosystems. In terms of rank of richness, the most important difference is seen in Poaceae. This difference can be attributed to the reasons mentioned above.

**Table 1. Comparison of the richest families with the other studies**

(Species numbers and percentage)

| Studies | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Total number of Species | 995 | 425 | 419 | 402 |
| | Asteraceae | Asteraceae | Fabaceae | Asteraceae |
| | 130 (13.0) | 65 (15.2) | 53 (12.6) | 54 (13.4) |
| | Fabaceae | Fabaceae | Asteraceae | Fabaceae |
| | 99 (9.9) | 44 (10.3) | 42 (10) | 39 (9.7) |
| | Poaceae | Brassicaceae | Lamiaceae | Lamiaceae |
| | 81 (8.1) | 36 (8.4) | 35 (8.3) | 33 (8.2) |
| | Brassicaceae | Lamiaceae | Poaceae | Brassicaceae |
| | 68 (6.8) | 36 (8.4) | 26 (6.2) | 26 (6.4) |
| | Lamiaceae | Poaceae | Rosaceae | Rosaceae |
| | 63 (6.3) | 26 (6.1) | 22 (5.2) | 26 (6.4) |
| | Caryophyllaceae | Apiaceae | Caryophyllaceae | Apiaceae |
| | 48 (4.8) | 18 (4.2) | 19 (4.5) | 21 (6.2) |
| | Apiaceae | Boraginaceae | Brassicaceae | Boraginaceae |
| | 46 (4.6) | 18 (4.2) | 18 (4.2) | 17 (4.2) |
| | Boraginaceae | Ranunculaceae | Boraginaceae | Ranunculaceae |
| | 44 (4.4) | 18 (4.2) | 16 (3.8) | 15 (3.7) |
| | Scrophulariaceae | Liliaceae | Apiaceae | Scrophulariaceae |
| | 39 (3.9) | 16 (3.7) | 15 (3.5) | 15 (3.7) |
| | Ranunculaceae | Scrophulariaceae | Scrophulariaceae | Liliaceae |
| | 31 (3.1) | 14 (3.2) | 15 (3.5) | 15 (3.7) |

1. Flora of Ankara City
2. Flora of Beytepe Campus
3. Flora of Beynam Forest
4. Flora of İdris Mountain

When the richest genera are compared with other studies (Table 2), the genera occupying the highest rank are the same in all studies. While *Alyssum* has a greater number of species in urban areas than in non-urban ones, the case of such steppe species as *Centaurea*, *Consolida*, and *Hieracium* is just the opposite.

**Table 2. Comparison of richest genera with the other studies**

(Species number and percentage)

| Studies | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Total number of species | 995 | 425 | 419 | 402 |
| | Astragalus | Astragalus | Astragalus | Astragalus |
| | 23 (2.3) | 16 (3.7) | 23 (5.4) | 11 (2.7) |
| | Salvia | Salvia | Salvia | Salvia |
| | 17 (1.7) | 9 (2.1) | 8 (1.9) | 10 (2.4) |
| | Alyssum | Centaurea | Verbascum | Centaurea |
| | 17 (1.7) | 9 (2.1) | 7 (1.6) | 7 (1.7) |
| | Ranunculus | Ranunculus | Silene | Silene |
| | 16 (1.6) | 7 (1.6) | 7 (1.6) | 7 (1.7) |
| | Veronica | Veronica | Alyssum | Trifolium |
| | 14 (1.4) | 5 (1.1) | 6 (1.4) | 6 (1.4) |
| | Silene | Euphorbia | Centaurea | Veronica |
| | 12 (1.2) | 5 (1.1) | 6 (1.4) | 6 (1.4) |
| | Centaurea | Consolida | Hieracium | Crataegus |
| | 12 (1.2) | 5 (1.1) | 6 (1.4) | 6 (1.4) |
| | Euphorbia | Teucrium | Ranunculus | Alyssum |
| | 12 (1.2) | 5 (1.1) | 5 (1.1) | 5 (1.2) |

1. Flora of Ankara City
2. Flora of Beytepe Campus
3. Flora of Beynam Forest
4. Flora of İdris Mountain

In terms of phytogeographical elements (Table 3), the first rank is occupied by Irano-Turanian elements 276 (27.7%), followed by Mediterranean elements 76 (7.6%), and Euro-Siberian elements 62 (6.2%). As is the case in the other studies, this is due to the fact that the study area is located within the Irano-Turanian area. While the Euro-Siberian elements occupy second rank in the other studies, this rank is occupied by Mediterranean elements in this study. This is due to the fact that the urban area studied is not rich in forest ecosystems.

**Table 3. Comparison of the distribution of the phytogeographical elements with the other studies** (Species number and percentage)

| Studies | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Total number of species | 995 | 425 | 419 | 402 |
| Irano- Turanian Elemet | 276 (27.7) | 126 (29) | 121 (29) | 89 (21.7) |
| Mediterranean Element | 76 (7.6) | 15 (4) | 30 (7) | 24 (5.9) |
| Euro-Siberian Element | 62 (6.2) | 22 (5) | 32 (8) | 29 (7.1) |
| Multiregional | 581 (58.3) | 262 (62) | 236 (56) | 260 (64.6) |

1.Flora of Ankara City
2. Flora of Beytepe Campus
3.Flora of Beynam Forest
4. Flora of İdris Mountain

In terms of endemism ratios (Table 4), 146 endemic species (14.6%) were identified, a higher ration than in the ohter studies. These results indicate that from the point-of-view of endemism, urban areas may be as interesting as non-urban ones, in fact, maybe even more interesting. The majority of endemic species are found in certain valleys and protected areas such as Hacikadin Valley. These species have been classified in terms of being endangered (13).

**Table 4. Comparison of endemism ratio with other studies**

| Studies | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Total number of species | 995 | 425 | 419 | 402 |
| Number of endemic species | 146 | 61 | 40 | 54 |
| Ratio of endemism (%) | 14.6 | 14 | 10 | 13.2 |

1.Flora of Ankara City
2. Flora of Beytepe Campus
3.Flora of Beynam Forest
4. Flora of İdris Mountain

One of the results of this study is related to the distribution of the species: 38 species were identified in A4 square, and 92 in B4, totalling 130 (14,15). An interesting finding is the presence of 12 species in A4 and B4 squares, which were previously only recorded in distant squares (16). All of these results contribute to making the urban area rich and interesting in terms of floristic structure.

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# POSTFIRE CHANGES IN SOIL PROPERTIES OF *Pinus brutia* TEN. FORESTS IN MARMARİS NATIONAL PARK, TURKEY[1]

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**Abstract**

This study was conducted to determine long-term postfire changes in physical and chemical properties of soils of *Pinus brutia* Ten. forests in Marmaris National Park, Turkey. The synchronic method was used: three sites burned in different years (2, 6 and 22 years ago) and a control site which had not burned at least 45 years were selected to form a successional gradient. Chemical (organic material %, nitrogen %, exchangeable cation content, electrical conductivity, pH) and physical (soil texture structure) analyses of soil samples collected from different soil layers (0-10 cm, 10-20 cm, 20-30 cm) were performed. It was detected that postfire soil chemical properties change after fire, but return its prefire levels in a short period of time and this result fits the general idea on postfire soil properties in Mediterranean environments. There was not any important change in soil texture after fire. Soil pH was very low in 22-year-old site because of the soil erosion occured immediately after fire. Since postfire changes in soil properties may facilitate or restrict plant regeneration, it is important to have an information on postfire soil properties of the burned area to decide a postfire management strategy.

**Keywords:** Fire, Marmaris National Park, Soil chemistry, Soil texture

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## Introduction

Prolonged summer-droughts (1), nutrient-deficient soils (2, 3) and wildfires (4, 5) are the most important evolutionary selective forces in Mediterranean-type ecosystems. Mediterranean vegetation has been shaped by all of these traits which are evaluated as natural parts of these ecosystems (5).

In general, postfire regeneration of Mediterranean-type communities is rapid (6-12). But, changes in soil chemical and physical properties induced by fire may affect this regeneration of the plant species (3, 13). The most common problem of the soils of postfire Mediterranean environments is soil erosion (14). With removing of the plant cover after fire (14-17) and increasing water repellency by fire (18), the burned areas become open to soil erosion by rains and by winds (14, 19, 20). Studying soil properties of the burned areas in such ecosystems is an important issue, because the results of ecosystem and landscape ecology studies have a leading potential to determine the postfire management strategies (21).

The effect of fire on soil properties has been well documented in several habitat and community types (15). But, postfire soil properties have not been studied widely in burned *Pinus brutia* Ten. stands. Although there are a few studies that describe the effect of fire on soil characteristics (22, 23), the change of soil properties during a postfire succession has not been studied in these stands. The aim of the present study was to determine long-term postfire changes in physical and chemical properties of soils of *Pinus brutia* Ten. forests in Marmaris National Park, Turkey.

## Methods

### Study Area

The study area was Marmaris National Park, which is located in Muğla province in the southwestern of Turkey (Figure 1). The climate was typically Mediterranean, with dry summers and wet winters. The study area has been subjected to frequent fires; therefore the National Park is an ideal area for postfire ecological studies.

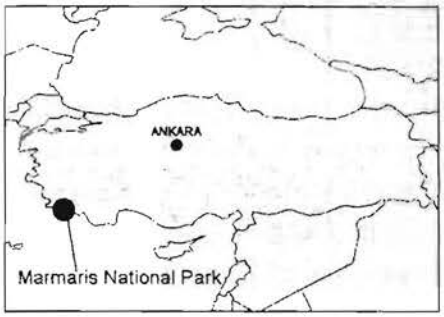


**Figure 1.** Location of Marmaris National Park in Turkey.

It was used the synchronic method: three burned sites (in different years; 1999, 1995 and 1979) and a control site (had not burned at least 45 years) were selected to form a successional gradient. So, it was possible to follow changes in soil parameters during a whole successional process. The study sites were on the same geological material (ophiolithic rocks) and were located very close to each other (Table 1).

**Table 1.** Location and some other features of the study sites.

| Site area | Location | Aspect | Last burned | Burned |
|---|---|---|---|---|
| **1999 site** | N 36°50'11" E 28°18'10" | W-NW | June 1999 | 109 ha |
| **1995 site** | N 36°51'16" E 28°17'14" | SE-E | June 1995 | 205 ha |
| **1979 site** | N 36°49'37" E 28°19'34" | NW-N | September 1979 | 13600 ha |
| **Control site** | N 36°50'47" E 28°17'24" | NW-N | ~45 years ago | ? |

## Collecting and Analysis of Soil Samples

Two replicates of soil samples were collected from three soil layers (0-10 cm, 10-20 cm and 20-30 cm). Chemical and physical analyses of the these samples were carried out in Central Anatolian Forestry Research Institute (Ministry of Forestry) laboratories by using the techniques defined in Anonymous (1984) and Tüzüner (1990). At the end of these analyses, organic material (%), nitrogen (%) and exchangeable cation content, electrical conductivity and soil reaction (pH) values and texture structure of the soil samples were determined. The texture triangle based on sand %, silt % and clay % values was used to determine soil type (26, 27).

Since the soil samples were collected in October 2001, the results are based on 2nd, 6th and 22nd postfire years, respectively for 1999, 1995 and 1979 study sites.

## Results

Soil organic matter %, nitrogen (N) %, conductivity values and exchangeable cation content values were higher in 1999 site and in Control site than other study sites (1995 and 1979 sites). Organic matter %, N % and conductivity values decrease with increasing soil depth in all of the study sites (Table 2). The highest pH value was in near-surface (0-10 cm) soil layer of the 1999 site and contrary to other sites, pH values decreased with soil depth in this site. The lowest pH values were in 1979 site (Table 2).

It was detected that sand, silt and clay percentages of the soil samples from all of the study sites were not different. Consequently, there was no difference in soil texture properties and in soil types of the study sites except 1995 site according to texture triangle results (Table 3).

## Discussion

Postfire changes in soil properties may be a factor that facilitate postfire plant regeneration. For example, the first germinations and vegetative growth are induced by increased soil temperatures (a result of the increase in absorbance of sunlight) (23), and by increased available nutrition for plants with emergence of the ash layer (15, 28-30). Therefore, if someone will decide to a postfire management strategy, it is important to have an information about postfire soil properties of the burned area.

Our results on postfire changes in soil properties of *Pinus brutia* forests support the general idea of that postfire soil chemical properties change after fire, but return its prefire levels in a short period of time (22, 23). Such a discuss may also be generalized to all of the Mediterranean environments beyond *Pinus brutia* stands, since the soils under other vegetation types has same postfire regeneration properties (13, 31).

It is known that percentage of organic matter in the soil increase in burned areas and soil conductivity has high values because of the bases found in the ash (22, 31). These parameters which are changed immediately after fire can return to their prefire values in three years in *Pinus brutia* ecosystems (22, 23) and in one year in a *Quercus coccifera* garrigue (31). Leaching and eroding of exchangeable cations ($Ca^{2+}$, $Mg^{2+}$, $Na^{+}$, $K^{+}$) from the upper soil layers, and increased decomposing of organic matter by increased microorganism activity after fire may be main reasons of this rapid recovery (22, 32, 33).

**Table 2.** Soil chemical properties of the study sites according to soil depth (mean±SE).

| | Organic matter (%) | Total N (%) | pH | EC* (mS) | Exchangeable cations (ppm) | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | $Ca^{2+}$ | $Mg^{2+}$ | $Na^{+}$ | $K^{+}$ |
| **1999 site** | | | | | | | | |
| 0-10 cm | 8.33±0.85 | 0.42±0.04 | 6.98±0.04 | 0.20±0.01 | 6292±484 | 1375±430 | 59.8±18.4 | 253.5±11.7 |
| 10-20 cm | 4.12±0.65 | 0.21±0.03 | 6.70±0.05 | 0.10±0.02 | 3872±0.00 | 1714±139 | 55.2±23.0 | 202.8±7.80 |
| 20-30 cm | 1.87±0.58 | 0.09±0.03 | 6.61±0.10 | 0.08±0.00 | 3388±484 | 2143±569 | 23.0±0.00 | 187.2±23.4 |
| **1995 site** | | | | | | | | |
| 0-10 cm | 3.30±0.30 | 0.16±0.02 | 6.47±0.03 | 0.09±0.00 | 3388±0.00 | 1169±418 | 48.3±25.3 | 144.3±3.90 |
| 10-20 cm | 2.04±0.14 | 0.10±0.01 | 6.58±0.02 | 0.08±0.02 | 3146±242 | 1871±272 | 32.2±9.20 | 144.3±19.5 |
| 20-30 cm | 1.84±0.54 | 0.09±0.03 | 6.60±0.11 | 0.06±0.01 | 2662±726 | 2857±1271 | 23.0±0.00 | 148.2±23.4 |
| **1979 site** | | | | | | | | |
| 0-10 cm | 6.17±3.16 | 0.31±0.16 | 6.12±0.05 | 0.11±0.00 | 3388±484 | 1029±12.0 | 32.2±4.60 | 171.6±39.0 |
| 10-20 cm | 4.08±1.90 | 0.20±0.10 | 6.28±0.05 | 0.08±0.01 | 3388±0.00 | 1169±139 | 32.2±4.60 | 167.7±27.3 |
| 20-30 cm | 3.16±0.85 | 0.16±0.04 | 6.38±0.08 | 0.07±0.00 | 2904±0.00 | 902.4±139 | 32.2±4.60 | 144.3±11.7 |
| **Control site** | | | | | | | | |
| 0-10 cm | 11.4±5.98 | 0.57±0.30 | 6.49±0.03 | 0.38±0.22 | 6292±2420 | 1792±60.0 | 39.1±11.5 | 163.8±31.2 |
| 10-20 cm | 4.01±1.43 | 0.20±0.07 | 6.72±0.06 | 0.16±0.03 | 4840±968 | 2525±998 | 57.5±34.5 | 171.6±46.8 |
| 20-30 cm | 3.04±0.83 | 0.15±0.04 | 6.68±0.05 | 0.10±0.00 | 4114±1210 | 2543±388 | 36.8±13.8 | 171.6±46.8 |

* EC; electrical conductivity.

**Table 3.** Soil texture properties of the study sites according to soil depth (mean±SE).

| | Sand (%) | Silt (%) | Clay (%) | Soil type |
|---|---|---|---|---|
| **1999 site** | | | | |
| 0-10 cm | 46.0±1.5 | 27.5±2.5 | 26.5±4.0 | Loam |
| 10-20 cm | 43.0±3.5 | 23.5±2.5 | 33.5±6.0 | Clay Loam |
| 20-30 cm | 41.0±5.5 | 23.5±2.5 | 35.6±8.0 | Clay Loam |
| **1995 site** | | | | |
| 0-10 cm | 50.2±0.25 | 24.4±0.85 | 25.3±0.50 | Sandy Clay Loam |
| 10-20 cm | 44.2±3.8 | 21.0±0.35 | 34.8±4.0 | Clay Loam |
| 20-30 cm | 41.0±3.5 | 17.6±0.35 | 41.4±3.2 | Clay |
| **1979 site** | | | | |
| 0-10 cm | 41.0±1.0 | 33.3±0.0 | 25.8±1.0 | Loam |
| 10-20 cm | 36.0±0.0 | 29.3±1.0 | 34.8±1.0 | Clay Loam |
| 20-30 cm | 41.0±1.0 | 27.3±0.0 | 31.8±1.0 | Clay Loam |
| **Control site** | | | | |
| 0-10 cm | 47.0±5.0 | 30.3±1.0 | 22.8±4.0 | Loam |
| 10-20 cm | 41.5±6.5 | 26.8±1.5 | 31.8±5.0 | Clay Loam |
| 20-30 cm | 40.0±6.0 | 26.8±1.5 | 33.3±4.5 | Clay Loam |

Exchangeable cations stored in plant tissues and in debris are returned to soil by fire and consequently, soil fertility increase in the first postfire years (22, 23, 30, 34). Exchangeable cations found in ash also increase soil pH immediately after fire, therefore the soil become more basic (22, 23, 31, 32, 35). It was pointed out that with postfire time exceeds, these high soil pH values decrease and return to their prefire values in three years (23). This is due to leaching and eroding of cations which increase immediately after fire (22). Moreover, formation of some organic (acetic acid, humic acid) and some inorganic ($HNO_3$, $H_2SO_4$, $H_3PO_4$) acids during decomposing of organic matter is another factor that decrease pH (27, 31). So, it is usual that high pH values returns their lower prefire values in a short period of time by increased microorganism activity and increased organic matter decomposition.

Even two years after fire, it was found in the present study that electrical conductivity, percentage of total N, percentage of organic matter, pH and amounts of exchangeable cations were higher, and this results fit other studies mentioned above on postfire changes of soil chemical properties in *Pinus brutia* ecosystems (22, 23). All of these parameters except pH values in 1979 site firstly decreased with time by probably the effect of erosion and leaching of exchangeable cations, and then began to increase with increasing vegetation cover and slowing erosion rate.

According to the results, pH values in 1979 site were very lower than the control and 1995 sites which have normal soil pH values (Table 2). It is known that most of the area burned in 1979 fire in Marmaris subjected to soil erosion since any forestry practice could not apply (22). This may be mainly due to the vastness of the burned area (Table 1). Additionally,

Tavşanoğlu (2002) showed that after the 1979 fire in September, very high amounts of rainfall was fallen during two months according to Meteorological data.

Vegetation cover (14, 37) and dead material (38) may be important factors in preserving soils from erosion. With falling of the heavy rains immediately after fire in the 1979 site which have not such a protecting cover on the ground, exchangeable cations might be removed from soil. It is known that the greatest losses of soil take place in the 4 months after fire (34). As mentioned above, a reason of decreasing in soil pH is removal of exchangeable cations from soil by rains (22, 27). This may be explain the presence of a more acidic soil in 1979 site.

Although soil pH can return to its prefire level in three years after fire in *Pinus brutia* ecosystems (23), if such a mechanism did not operate as not in 1979 site, there would be dramatic results on regeneration of plant species, especially of seeders. Thus, the poor establishment of *P. brutia* in 1979 site may be mainly due to the lower soil pH levels (36).

Although there was a change in soil chemical properties after fire, soil texture was not changed considerably by the effect of fire. Since physical changes in soil texture after fire are negligible except where soil heating is extreme (3), fire may not responsible from the little difference in soil texture of 1995 site and this difference may be due to site heterogeneity. It was pointed out that potassium found much more in soils with a thinner texture (27). So the main reason of that amount of potassium ion ($K^+$) was lower in the near-surface soil layers (0-20 cm) in 1995 site may be presence of a rougher soil texture in this site.

It is known that percentage of organic matter and percentage of total N decrease but pH values increase with going deep inside the soil (22, 23). Our results support such a change in the soil. But we detected that only pH values decrease with increasing soil depth (Table 2). This was due to the effect of the ash layer which is abundantly found in the near-surface soil layers.

As discuss, even if there was a change in soil chemical properties after fire, these properties may return their prefire levels in a short period of time and this event point out a rapid regeneration of soil properties. Because of higher soil fertility would produce higher survival and growth after fire (30), the first postfire years in which soil fertility is relatively high are important for regenerating plant species in nutrient-poor Mediterranean soils.

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# DIFFERENTIAL LINKAGE DISEQUILIBRIA AND THE GENE FREQUENCY ANALYSIS OF *Adh* AND *αGpdh* LOCI IN A NATURAL *Drosophila melanogaster* POPULATION FROM NORTHERN ANATOLIA OF TURKEY

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**Abstract:**

Different diseqeulibria at *αGpdh* and *Adh* loci were detected between sexes in a natural *Drosophila melanogaster* population from province of Ordu in Northern Anatolia. The almost identical patterns of gene frequency and the similar magnitudes of genetic distances in both sexes exclude selection as a possible cause for the different disequilibria observed. A sampling effect similar to genetic drift, or an emergent effect of migration is favored in ligth of the presence of a difference in one of the gametic type.

**Key Words:** *D. melanogaster*, *Adh*, *αGpdh*, linkage disequilibrium

## Introduction

Allozymes have gained much attraction and debate since the groundbreaking work of Lewontin and Hubby (1), for the possibilities they offer in quantifying genctic variation in natural populations and in the association of that variation with various selective mechanisms (2). The use of allozyme variation in determination and interpretation of the hidden genetic variation seems to cause spurious assumptions, especially with loci having a high number of alleles (3). But it is still worthwhile to use allozyme data for statistical inferences of populations when the given loci are known to have a few common alleles on which some sort of selection may be operating (3). In this respect, gene frequency changes among populations and between the samples substructured, say, on sex (as in this study, see below) could still be

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considered to track microevolution. One of the most active area of gene frequency evolution has been the determination of the linkage disequilibrium levels between allozyme loci, to infer various aspects of population structure, and more importantly, selection (2). Complex multilocus evolution through linkage relations (termed comprehensively 'gametic phase disequilibrium', implicating the joint effect of multiple loci being not a mere description of pyhsical linkage on chromosomes) is frequently found to occur in shaping the genetic variation in nature (4). There is a highly dimensional body of theory dealing with linkage disequilibrium (gametic phase disequilibrium) in selection processes(5).

Alcohol dehydrogenase (*Adh*) and glycerophosphate dehydrogenase (*αGpdh*) loci of *Drosophila melanogaster* are located on the left arm of the 2nd chromosome, and both have two common allozyme variants (F : Fast and S : Slow, after their electrophoretical mobilities) with subtiantial frequencies in natural populations (6). *Adh* frequencies have distinct geographical distribution pattern; the $Adh^S$ allele frequency decreases with increasing latitude from tropics to temperate regions, with an almost complete absence in most northern populations (7). Multicontinental regularity of that pattern highly suggests the presence of selection on this locus or other polymorphisms linked to it physically or functionally (7, and references therein). *Gpdh* also shows latitudinal frequency changes but not as sharp as the *Adh* (6, and references therein). Putative selection agencies for *Adh* could be invoked for its rôle in alcohol tolerance and utilization when the environment in which females lay eggs has relatively higher alcohol concentrations (8). For α*Gpdh*, various selective scenarios have been forwarded ranging from differential efficiencies in lipid metabolism to fligth output capacities (6). Markedly, there may occur interaction between *Adh* and α*Gpdh* leading to significant disequilibria in natural populations (7,9). Disequilibrium between these loci can be caused by physical connection through a cosmopolitan inversion, *In(2L)t*, and a metabolic connection in lipid metabolism related to $NAD^+$/*NADH* balances (10,7). Whatever the cause, linkage diseuilibrium may effect the evolution of *Adh* and *αGpdh* substiantally (7,11).

Here in the present study we show the existence of different disequilibria at *Adh* and α*Gpdh* between sexes in a natural population of *D. melanogaster*. Our results also include the gene frequency analyses and the genetic distances on these two loci between sexes. In this way different disequlibrium values are considered at a level of sample identity of sexes. Calculated individual and two locus heterozygosities are used in the description of sex differences, as well.

**Materials And Methods**

*a .Population*

A sample of population of D. *melanogaster* in the province of Ordu, a city of Northern Anatolia of Turkey was collected in November 1999. Flies were caugth by a mixed fruit bait bottle containing several fermenting fruits. After establishing the laboratory population, wild collected males and females were used for genotyping of *Adh* and α*Gpdh* loci (both of which are located on chromosome II) via electrophoresis.

*b. Electrophoresis of the individual flies*

Electrophoresis was of the standard PAGE system developed for the combination of the *ADH* and *GPDH* by Van Delden and Kamping (12). Individual flies were homogenized in demineralized water and 3µl of each homogenate was run on the gel. Running buffer was a mix of 0.0205 M Veronal, 0.003 M EDTA and 0.075 Tris at pH 8.4. Reaction buffer per gel consisted of 400 mg Glycreophosphate, 20 mg NAD+, 20 mg MTT, and 1mg PMS all dissolved in 60 ml of 0.2 M Tris-HCl solution at pH 8.5. After 2.5 hs of running gels were palced in a plastic container containing the reaction buffer and put into an incubator shaker operated at 30 °C for 10 mins. After the *GPDH* bands had appeared, 200 µl Isopropanol (propan-2-ol) was added into the total mix in the container and the gel allowed for 5 mins in the shaker for the appearance of *ADH* bands. When the gel had been clearly stained for the *Adh* and α*Gpdh* electromorphs, they were photographed for scoring using an image analyzer software.

*c. Statistics and genetic distances*

After gene and genotype frequencies were calculated arithmetically, both males and females of the sample were tested for Hardy-Weinberg equilibrium at *Adh* and *αGpdh* loci. The testing was Exact, using a modified version of exact probability test by Haldane (13). Disequlibrium values for each sex was calculated as D with a maximun likelihood approach for the inclusion of a reliable estimation of double heterozygotes (14). Significancy of D was tested accordingly to the $\chi^2$ approximation method by Hill (15) assuming the D is zero for each sex. Single and two locus genetic distances were calculated as Nei's standard (16), in which the distance is $D = -ln\ (I)$, where $I$ is the identity between two samples calculated for the given loci (16).

**Results And Discussion**

Number of indiviuals per sex was almost identical and this allowed reliable cross inferences between the sexes. Table 1 shows the summary of the basic gene frequency analysis for both loci. There are no significant differences between loci within sexes in gene frequencies (Table 1). For *Gpdh*, the alleles had nearly equal frequencies irrespective of sex; the *Adh* had alleles in considerably different frequencies, but this patterns holds for both sexes (Table 1). In particular $Adh^S$ frequency is considerably low, with a value in males less than half of that in females. But the point is that $Adh^S$ frequency is relatively low in both sexes and this well agrees with the almost universal finding that $Adh^S$ frequency decreases in northernly populations (7). But the differences in $Adh^S$ frequency between sexes are remarkable by the heterozygote deficiency at this locus in males (Table 1). This is an apparent indication that the sexes were differentially modulated with respect to *Adh* (see below). We tested each locus for Hardy-Weinberg equilibrium by a very powerfull exact test (see 13 for details) and found no significant deviations in both sexes (Table 1, Probabilities).

Table 1. Gene frequencies and Heterozygosities (H) at $\alpha$*Gpdh* and *Adh* Loci and Hardy-Weinberg Deviation Probabilities (P)

| | | | | Heterozygosity[a] | | | |
|---|---|---|---|---|---|---|---|
| Sample | N | Gene | Frequency | Observed | Expected | H[b] | P |
| | | $\alpha Gpdh^F$ | 0.479 | | | | |
| | 24 | $\alpha Gpdh^S$ | 0.521 | **0.541** | 0.499 | | *0.305* |
| | | $Adh^F$ | 0.854 | | | 0.013 | |
| | | $Adh^S$ | 0.146 | **0.292** | **0.249** | | *0.602* |
| | | $\alpha Gpdh^F$ | 0.540 | | | | |
| | 25 | $\alpha Gpdh^S$ | 0.460 | **0.520** | **0.249** | | *0.312* |
| | | $Adh^F$ | 0.940 | | | 0.017 | |
| | | $Adh^S$ | 0.060 | **0.120** | **0.113** | | *0.156* |

[a] on individual loci: bolded marginals for each loci
[b] on two loci

Close similarity of the two sexes can also be confirmed using Nei's standard genetic distances (16). Table 2 shows the identities and the distances (D) as the function of these identities. Both sexes are rather identical on individual loci distances and the distance calculated for two loci (Table 2). This strongly confirms the results of gene frequency analysis above.

Table 2. Genetic distances between sexes on α*Gpdh* and *Adh* frequencies

| Gene | Identity (I) | Distance (D) | Distance (D)[a] |
|---|---|---|---|
| α*Gpdh* | 0.992 | 0.008 | 0.021 |
| *Adh* | 0.994 | 0.006 | |

[a] calculated with both loci

The most remarkable feature of our study is that different disequilibria were detected in sexes. Table 3 presents the gamete frequency profiles at α*Gpdh* and *Adh* loci for both sexes and the diequilibrium values calculated each. The disequilibrium of female sex is significant i.e., there is a considerable departure from two-locus random assocation of the alleles at α*Gpdh* and *Adh*. One working hypothesis about it would be that differential selection may be operating in females with respect to the putative joint fitness effect of α*Gpdh* and *Adh* in this particular population. But no sexual selection is known operating on α*Gpdh* and *Adh*. The situation is cleared up when considering the frequency of the gametic type, $\alpha Gpdh^F\ Adh^S$, in both sexes; in males the frequency of that type is less than half of that in females (Table 3). This class ( $\alpha Gpdh^F\ Adh^S$) is the only class with which a cosmopolitan inversion, *In(2L)t*, can occur in a population of D. *melanogaster* (17). Therefore a negative selection scheme on this inversion could be invoked to explain the different linkage disequilibrium on basis of $Gpdh^F\ Adh^S$ decrease in males. But this is invalid observing there is no indication of sexual selection on *In(2L)t* ( for selection on this inversion other than on sex, see 7). Moreover, we could only perform inversion analysis with males and the inversion frequency calculated is quite low (not shown), hence indicating the weak interpretability of the presence of the *In(2L)t* of the frequency of the $\alpha Gpdh^F\ Adh^S$ gametic type in males. If it could have been assumed that both disequilibria would be due to the presence of the inversion in sexes, this would not explain why a significantly different disequilibrium should occur in females.

Table 3. Gamete Frequencies and Disequilibrium (D) at α*Gpdh* and *Adh* Loci

| Gamete | Frequency | D | D[I] |
|---|---|---|---|
| α*Gpdh*F $Adh^F$ | 0.333 | | |
| α*Gpdh*F $Adh^S$ | 0.146 | -0.0276 | |
| α*Gpdh*S $Adh^F$ | 0.521 | | |
| α*Gpdh*S $Adh^S$ | 0.00 | | |
| | | | - 0.0499* |
| α*Gpdh*F $Adh^F$ | 0.480 | | |
| α*Gpdh*F $Adh^S$ | 0.060 | -0.0761* | |
| α*Gpdh*S $Adh^F$ | 0.460 | | |
| α*Gpdh*S $Adh^S$ | 0.00 | | |

*P<0.05

[I] calculated from pooled data of females and males

We conclude that the different linkage disequilibrium in females is hardly explainable on grounds of selection operating on α*Gpdh* or *Adh*, or any known polymorphism related for the occasional disequilibria seen to occur between them (i.e., *In(2L)t*, see, 7.). The most probable cause for this differential disequilibria, we think, would be sampling that is similar to genetic drift in effect. It is known that different genetic frequencies in sexes may be brougth about by sampling, too ( 14). Another possible cause with credibility not much less than that of sampling would be migration. Both approaches could be feasible in ligth of the finding that one of the gametic type (i.e., $\alpha Gpdh^{F}$ $Adh^{S}$) is in relative excess (or absence) in a sex. Finally, we see the importance of a resampling in the same region with a detailed scheme including, perhaps repeatibility through seasons.

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# A SIMPLE ELECTROPHORETICAL WAY TO DISTINGUISH BETWEEN *Drosophila melanogaster* AND ITS SIBLING *D. simulans*

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**Abstract:**

In this study, a simple and reliable mean of species separation via electrophoresis at an allozyme locus in mixed samples between *Drosophila melanogaster* and its sibling *D. simulans* is presented. Electrophoretical work in mixed and geographicaly distant fly samples showed that the locus glycerophosphate dehydrogenase (*αGpdh*) was quite efficient in separation between these two closely related species together with the distinctive marker locus alcohol dehydrogenase (*Adh*). The *ADH* (alcohol dehydrogenase) enzyme activity profiles were also significantly distinct and can therefore be referred to as supplementary data in electrophoretical analysis for species discrimination.

**Key Words**: Electrophoresis, *Drosophila melanogaster*, *Drosophila simulans*, siblings.

## Introduction

The *melanogaster* species group of *Drosophila* has had its phylogeny constructed from variety of standpoints. The phylogenetic data range from biogeographical regards (1), banding patterns of polytens (2, 3) to DNA-DNA hybridisation and DNA sequence comparisons (4-6). The emerging topology is quite robust on account of its being a product of

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a multilevel approach but problem arises if one attempts to distinguish closely related species for practical use. Surely, one couldn't afford resorting every time to various approaches to make a coherent picture of species relatedness in order to determine the species concerned. Researchers are often familiar with the very problem when siblings of any group in particular are considered. The *Drosophila melanogaster* subgroup within the *melanogaster* species group has a triad of very closely related species (1), a member of which is *Drosophila simulans* which is the concern of the present study with respect to its almost indistinguishable morphological resemblance to its sibling *Drosophila melanogaster*. Since the discovery and elegant description by Sturtevant (7,8) that *D. melanogaster* has a closely related sibling, *D. simulans*, both species are known to be cosmopolitan and coexistent (1,9). The external male genitalia exhibits almost only one satisfactory character with which the two species may be distinguished. In living flies or laboratory preparations of the male external genitalia, the posterior process of the tergite appears like clam-shell in *D.simulans*, and like a small hook in *D.melanogaster* (8).

Contrastingly there is no reliable and highly error-free character to separate females of both species, though some but painstaking efforts on bases of eye sizes (10, and references therein), egg morphology (11), and abdominal pigmentation patterns (12). One alternative could be to asses genetic polymorphism levels of the species and differentiate them by the interspecific genetic variation. There indeed exists a wide array of genetic methods for species discrimination, and the most easily performable for immediate purposes is the allozyme electrophoresis which may give correlated results with other criteria (13). The basic observation with electromorph is that at least one locus is fixed for alternative alleles between closely related species, and the structural changes in encoded proteins due to species divergence can be visualized on the gel (13). In the latter respect *ADH* is a diagnostic enzyme between *D. melanogaster* and *D. simulans* because of clearly distinctive bands of electromorphs (14).

Here in the present study a clear-cut pattern of fixation at a locus, $\alpha$*Gpdh*, is added to this ADH information, which could facilitate to separate *D. melanogaster* individuals from those of *D. simulans* in mixed samples, irrespective of sex differences.Population samples are two from Israel (Tel-Aviv; one mixed another pure *melanogaster*) and one from Australia comprising totally of *simulans*. Results of *ADH* enzyme activities of Israeli samples are also presented in comparative manner, including them to give a auxilliary support for the radically different pattern of electrophoresis between the two siblings. It should not be taken that the electrophoretical be validated using other analytical approaches, such as activity pattern of the enzyme loci in the electrophoresis. It is only an attempt to add higher but not undispensable dimension to the analysis. The *Adh* and $\alpha$*Gpdh* polymorphisms can be viewed in the same electrophoretical system in their common dependence of cofactor need to determine their

allelic distribution in particular samples (15), and because they both have two widespread alternative mobility variants (Fast : F and Slow : S, namely) distributed in natural populations of *D. melanogaster* (16). Advantage of these facts are higly taken and random samples from two distantly located fly populations are used.

**Materials And Methods**

*a. Sampling of fly populations*

Two populations were sampled in December 1999 in Tel-Aviv, Israel, one from a rat culture room having garbage for food in Tel-Aviv University (henceforth called Israel-2), and another in a more natural environment of a house garden outside the campus (Israel-1). Australian sample was collected in May 2000 in Waite in a natural environment. All samples had fly numbers sufficient for analyses. Because Israeli samples had not arrived as adults, the offspring of adults from the numeruous eggs in the original collection vials were used in the analyses. Waite sample was consisted mainly of wild collected adult flies in arrival. In all analyses 2$^{nd}$ generation offspring were used for all the populations.

*b. Electrophoresis*

Electrophoresis was of the standard PAGE system developed for the combination of the *ADH* and *GPDH* by Van Delden and Kamping (15). Individual flies were homogenized in demineralized water and 3µl of each homogenate was run on the gel. Running buffer was a mix of 0.0205 M Veronal, 0.003 M EDTA and 0.075 Tris at pH 8.4. Reaction buffer per gel consisted of 400 mg Glycreophosphate, 20 mg NAD+, 20 mg MTT, and 1mg PMS all dissolved in 60 ml of 0.2 M Tris-HCl solution at pH 8.5. After 2.5 hs of running gels were placed in a plastic container containing the reaction buffer and put into an incubator shaker operated at 30 °C for 10 mins. After the *GPDH* bands had appeared, 200 µl Isopropanol (propan-2-ol) was added into the total mix in the container and the gel allowed for 5 mins in the shaker for the appearance of *ADH* bands. When the gel had been clearly stained for the *Adh* and α*Gpdh* electromorphs, they were photographed for scoring using an image analyzer software.

*c. ADH enzyme activity*

For *ADH* (E.C.1.1.1.1) activity method of Oudman et al. (17) was modified for individual activity measurement and subsequent *Adh* genotyping. Each fly specimen was

individually cold homogenized in Glycine-NaOH buffer (0.05 M Glycine-NaOH, 10 mM EDTA at pH 9.5.). In measurement 0.05 ml of each homogenate was put into 85 ml of Glycine-NaOH buffer. A final reaction volume was reached by adding 0.1 ml of reaction buffer (NAD+ and 200 µl Isopropanol in Glycine-NaOH buffer) to this mix. *ADH* activity was assayed spectrophotometrically for 90 secs at 30 °C and 340 nm wavelength. Per individual activity was expressed as an average of three replicate measurements per individual fly. *Adh* genotypes were resolved on PAGE with the 3µl of the activity homogenates left. Only Israeli samples were assayed for activity.

*d. Statistics*

For population (sample) specific *ADH* activities, D. *melanogaster* and D. *simulans* activities were compared to gain additional information of species differentiation. Activities were log-transformed and simple t-statistics were calculated to determine significant differences between population samples.

**Results and Discussion**

All samples were electrophoresed accordingly to the method by Van Delden Kamping (15) and the results show exclusive patterns for species discrimination. One population from Israel, Israel-1, had high number of D.*simulans* but also included D. *melanogaster* individuals not less in number than that of *simulans* (Table 1). Clearly enough, all Israel-1 *simulans*es were SS at *Adh* and FF of *Gpdh*. The same does occur in Waite (Australia) sample, all members of which turned out to be *simulans*, and is quite distantly located compared to Israel (Table 1). It is known that *ADH* has distinctive electrophoretical bands in D. *melanogaster* and D. *simulans* with apparent difference between mobility classes (i.e., between the alleles and the genotypes on the gel, accordingly) (14). The same was present in the study as well. The *ADH* mobilities (here only for SS in *simulans*) was quite distinct reflecting the encoded protein divergence between the species (shown only for the *simulans* in Waite, Figure 1). The typical observation was that *ADH*- SS individuals hardly moved from the origins(wells) which had the individual homogenates (Figure 1). The *de novo* feature is that the other locus, α*Gpdh*, showed a fixed pattern of alleles in which all of *simulans* individuals from Israel and Waite were FF (Table 1). The *melanogaster* individuals over all samples were all polymorphic for α*Gpdh* (Table 1, not shown quantitatively). That this pattern at α*Gpdh* is apparent from within a mix sample to the samples one of which is comparatively quite distant gives support that α*Gpdh* can be used unambiguously for separation between D.*melanogaster* and its sibling D. *simulans*. There is one final particular

feature of the electrophoretical data to be stressed; the Isarel-2 sample (a pure *melanogaster* collection) has relatively high number of *Adh*FF genotypes (Table 1). This is not unusual when considered that sample came from a place with possibly fermenting garbage, as the FF genotypes of *ADH* is the most efficiently active form of the enzyme responding increasing levels of toxic alcohols in the breeding environment of D. *melanogaster* (18). The mean activity of *ADH*- FF in Israel-2 sample is higher than both FF and FS of Israel-1 *melanogaster* individuals, and FS of Israel-2 is sligthly larger than that of Israel-1, confirm this (see below).

Table 1. Samples and the Species with Their *Adh* and α*Gpdh* Genotypes on Electrophoresis.

| | | Genotype | |
|---|---|---|---|
| Population Samples | Number of Flies | *Adh* | α*Gpdh* |
| Israel-1 (*simulans*) | 28 | SS | FF |
| Israel-1 (*melanogaster*) | 14 | FF | Polymorphic |
| Israel-1 (*melanogaster*) | 7 | FS | Polymorphic |
| Israel-2 (*melanogaster*) | 34 | FF | Polymorphic |
| Israel-2 (*melanogaster*) | 7 | FS | Polymorphic |
| Waite (*simulans*) | 49 | SS | FF |

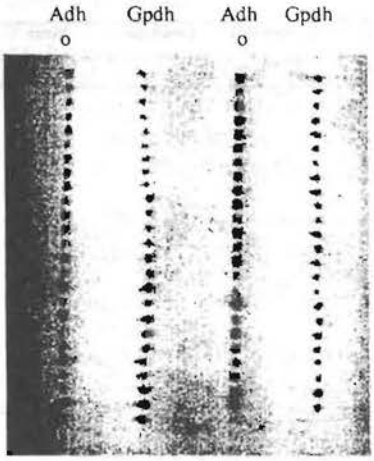


Figure 1. Adh and αGpdh genotypes on the gel of Waite (Australia) showing the complete fixation at both loci. Bands are showing fixation at Adh (S allele) and αGpdh (F allele) loci. O: the origin of individual homogenate loading.

Alcohol dehydrogenase activities were also measured to give an additional dimension in species separation. The picture emerged is quite informative in this respect; D. *simulans* individuals of Israel-1 sample were all SS and the mean *ADH* enzyme activity was found to be much smaller than the *melanogaster* activities irrespective of genotypic class, that

is, the effect was apparent whether the comparison was made with FF or FS of D. *melanogaster* (Table 2). It may be opposed that the difference between a low activity class such as SS and high or intermediate classes (i.e., FF and FS, respectively) is dully expected without regard for species divergence (see Van Delden, 18). It could be true otherwise but here the activity of SS *simulans*es was too low to be included in the range of *ADH*-SS activities detected in natural populations of D. *melanogaster* (see Van Delden, 18, for the magnitudes of activity classes in this species). Besides, in all pairwise comparisons the differences in mean activities between D.*simulans* and D.*melanogaster* are highly significant ($P<0.001$) without reference to genotype state of activity classes (Table 2). Therefore it is strongly suggested that *ADH* activity profiles could substantially contribute to the species distinction performed by other methodologies. Another distinct observation with the activies which deserves attention is the high *Adh*F allele frequency and higher mean *ADH*-FF activity in the Israel-2 sample, compared to *melanogaster* flies of Israel-1. This may indicate the presence of ongoing selection on the *Adh* loci in Israel-2 sample as it came from a possibly high alcohol environment. In that case selection would have been directional increasing the frequency of the F allele.

Table 2. Differences in mean *ADH* activities of the genotypes in the samples of D.*melanogaster* and D.*simulans*.

| Population Samples | Code | Number of Flies | Genotype | Mean Activity[a] | SE[b] | Comparison | $t_s$ |
|---|---|---|---|---|---|---|---|
| Israel-1 (*simulans*) | I | 28 | SS | 0.1180 | 0.019 | I-II | 13.64 *** |
| Israel-1 (*melanogaster*) | II | 14 | FF | 0.6701 | 0.043 | I-III | 7.49 *** |
| Israel-1 (*melanogaster*) | III | 7 | FS | 0.4996 | 0.069 | I-IV | 20.37 *** |
| Israel-2 (*melanogaster*) | IV | 34 | FF | 0.8005 | 0.026 | I-V | 8.89 *** |
| Israel-2 (*melanogaster*) | V | 7 | FS | 0.5189 | 0.052 | II-IV | 2.68 ** |

** $P<0.01$

*** $P<0.001$

[a] activity is expressed as μ mol/ml.min per fly

[b] SE : Standard error of the mean

In conclusion, the finding in this study that electrophoretical variation at α*Gpdh* locus can go well with the other loci such as *Adh* in discrimination between *D. melanogaster* and *D. simulans* individuals in mixed samples migth be very usefull, considering the coexistence of both species in wild and their almost identical morphologies. Additionally, the *ADH* enzyme activity differences between *D.melanogaster* and *D. simulans* is so great that

the mean activities could be easily provided to check species status in naturally mixed samples. The finding that *Adh* may undergo selection in an alcoholic environment supports the similar works in the area and deserves particular concern which was outside the scope of the present work. In the example of the problem of separation between *D.melanogaster* and its sibling *D. simulans* the data show the effieciency and reliability of the electrophoresis in revealing species distinction in population samples. Hopefully, this work could contribute to the difficult task of the determination of Turkey *Drosophilidae* undertaken (19).

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# ADSORPTION BEHAVIOUR OF COPPER (II) ION FROM AQUEOUS SOLUTION ON POLY(4-VINYL PYRIDINE)

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**Abstract**

The adsorption behaviour of poly(4 – vinyl pyridine) towards copper (II) ion in aqueous solutions was studied by a batch equilibriation technique. Influence of treatment time, pH of the solution and metal ion concentration on the adsorption were investigated. 45 minutes of adsorption time was found sufficient to reach adsorption equilibrum for the copper (II) ion. The optimum pH was found to be 4,5. The adsorption saturation value was reached at 1.27 mmol ions per gram poly(4 – vinyl pyridine) against 3.15 mM copper (II) ions. It was observed that the adsorption isotherm of Cu (II) fits Freundlich – type isotherms.

**Key words:** Adsorption, metal ions, copper, 4 – vinyl pyridine.

## Introduction

A number of metal ions are known to contaminate the industrial effluents, water suplies as well as mine waters. Such metal ions include mercury, lead, copper, cadmium, nickel, cobalt, iron, zinc, manganese, gold, silver, platinum, etc. which are toxic and/or precious. Many methods have been proposed and are being used for removal of heavy metal ions from industrial effluents. Conventionally, precipitation of metal ions from solutions as well as ion exchange technique are the popular methods. However, synthetic ion-exchange resins are very expensive. Many unconventional methods are, therefore, being thought of this purpose.

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Activated carbon, metal oxides, agricultural products such as peanut skins, onion skins, wool, chemically modified woods, silicagel, cellulosic and polymeric materials, [1-18] have been used as adsorbant for the adsorption of toxic heavy metal ions.

Recently, studies concerning the use of fibrous materials for the adsorption of metal ions have been carried out. In the previous work, the adsorption behaviour of pure poly(ethylene terephthalate) (PET) fibers was studied toward Cu (II), Co (II) and Fe (II) ions in aqueous solutions by a batch equilibriation technique by Yiğitoğlu et al.[19] Methacrylic acid grafted poly(ethylene terephthalate) fibers [20] and 4 - vinil piridin (4 - VP) grafted poly(ethylene terephthalate) fibers [21] have also used as an adsorbant for the removal of copper(II) ion from an aqueous solution. It has been observed that within those studies the reactive fibers are stable and regenerable by acid without losing their activity. Rivas and Moreno-Villoslada [4] have been studied with poly(ethylene amine) and poly[1-(2 hidroksi ethyl) aziridine] as adsorbant, searched adsorbant capacity of homopolymers toward Cu (II), Cd (II), Co (II), Cr (II), Ni (II), Zn (II) and Fe (II) ions.

In the present study, we have aimed to investigate usability of poly(4-VP) for the removal of copper(II) ions from aqueous solution.

## Experimental

### Materials

Analytical grade of $CuSO_4.5H_2O$ was used without purification. pH values were controlled with Briton-Rabinson buffer solutions. 0.01M HCl were used into desorption study. 4-vinly pyridin (4 – VP) was purified by vacuum distillation at 2 mmHg at 65 °C. $Bz_2O_2$ was twice precipitated from chloroform in methanol and dried in a vacuum oven for 2 days. Other reagents were used as supplied. All reagents were Merck products.

### Polymerization procedure

Polymerization was carried out in a thermostatted 100 mL tube under reflux. The mixture containing monomer and $Bz_2O_2$ at required concentrations in 2 mL aceton was made up to 20 mL with deionized water. The mixture was immediately placed into the water bath (7305 polyscience) adjusted to the polymerization temperature. Poly (4 – VP) was washed with distilled water for 4 h to remove the unreacted monomer. Poly (4 – VP) was then

vacuum – dried at 50 °C for 72 h and weighed. The granule of poly (4 – VP) was sieved to 300-600 μm.

**Adsorption procedure**

Volume of 30 $cm^3$ of copper(II) ion solution (0.47 mmol/L) adjusted to desired pH was added onto 0.05 g of poly(4-VP) in 100 mL erlen-mayer. The contents were shaken at 150 rpm for a predetermined period of time at 20 °C using orbital shaker (Nuve Model, ST-402). After filtration of the solution the copper ion concentration of the filtrates was measured by a Philips PU 9285 model flame atomic absorption spectrometer equipped with deuterium lamp background correction, hollow cathode lamps (HCL) and air-acetylene burner was used for the determination of the metals. The Adsorption capacity of the poly(4-VP) was evaluated by using the following expression:

$$q=(C_o-C)V/m \qquad (1)$$

where q is the amount of ion adsorbed onto unit mass of the poly(4-VP) (mmol/g), $C_o$ and C are the concentration of the ion in the initial solution and in aqueous phase after treatment for a certain period of time (mmol/L); V is the volume of the aqueous phase (L); and m is the amount of poly(4-VP) (g), respectively. Metal ion was recovered by treating with 30 mL 0.01M HCl for five minutes, then analyzed by the method mentioned above. The desorption percent was calculated by using the following equations:

$$\% \text{ Desorption} = \frac{\text{Amount of Cu(II) ions (mmol) in the desorption solution}}{\text{Adsorbed amount of Cu (II) ions (mmol) by adsorbant}} \times 100 \qquad (2)$$

**Results And Discussion**

The effect of the pH on the adsorption amount of copper (II) ions on poly(4 – VP) was investigated in the batch process at the following conditions: ion concentration was 0.47 mmol/L, temperature was 20°C and adsorption time was 1,5 hour. Figure 1 shows the relationship between pH and adsorption amount. It is clear from the figure that increasing the pH value of the copper(II) aqueous solution from 3,5 to 4.5, the adsorption amount increases significantly and reaches a maximum value at pH 4,5, beyond that point decreases sharply. In the rest of the study, experiments were carried out at pH 4,5.

At low pH values as it was reported in our previous works [19-20], the high hydrogen ion concentration at the interface electrostatically repels positively charged metal ions, preventing their approach to the adsorbant surface. Low adsorption values are in line with expectations.

As seen from Figure 2, adsorption equilibrium is within 45 minutes.It was observed that treatment time is shorter than treatment time was obtained in the our other research [19-21]. The reason of decreases in the adsorption time shoul be that poly(4 – VP) has more active site and functional group.

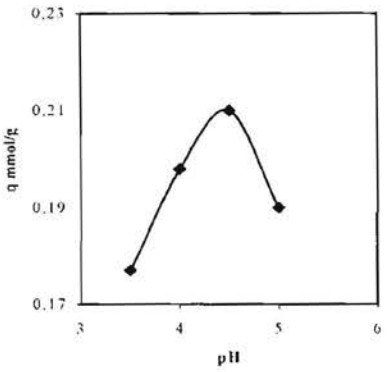


Figure 1. Effect of pH on the adsorption of Cu ($[Cu^{2+}]$=0.47mM, Time=1.5hours, t=20°C)

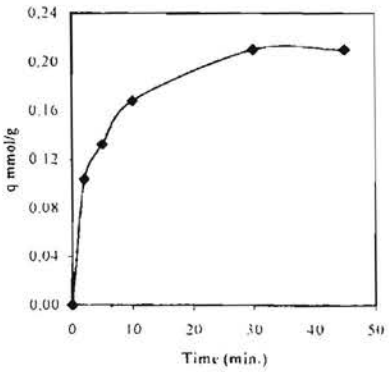


Figure 2. Variation of adsorption with time ($[Cu^{2+}]$=0.47mM, pH=4.5, t=20°C)

Adsorption equation may be stated [20] by using the following equation :

$$\text{Log}\frac{C_t}{C_o} = -\frac{k}{2.303}t \qquad (3)$$

Where t is the adsorption time; k an adsorption rate constant; $C_t$ the concentration amount of copper(II) ions at time t and $C_o$, the initial concentration of copper(II) ions.

According to the adsorption equation, the experimental data of Figure 2 can be converted into the plot of $\log(C_t/C_o)$ versus t as Figure 3. Thus, the adsorption rate constants of the poly(4-VP) calculated from the slopes of the plot as $4.6\times10^{-4}$ $s^{-1}$. It is clearly seen that the adsorption of

cooper (II) ions from aqueous solutions on poly(4 – VP) obeyed a first order kinetics. The relationship between ion concentration and adsorption amount was represented in Figure 4.

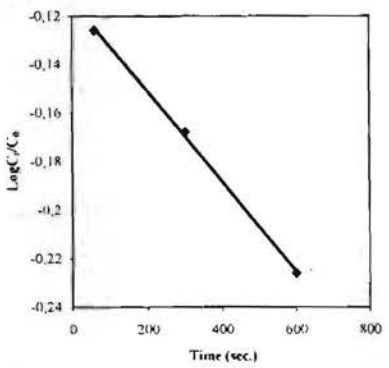


Figure 3. Metal uptake kinetics

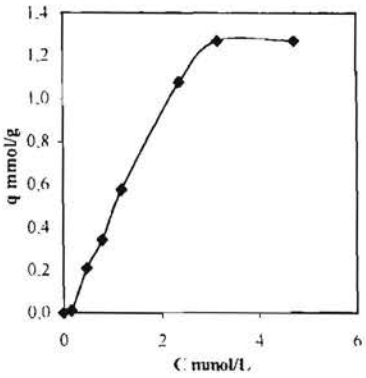


Figure 4 Effect of initial metal concentration (pH=4,5, time=45 min , t=20°C)

It is clear from the figure that as the concentration of the ions increased adsorption increased, then levelled off. The Adsorption saturation value was reached at 1.27 mmol ions per adsorbant against 3.0 mmol copper(II) ions per liter. The result shows that the poly(4-VP) is capable of great adsorption capacity with comparing some adsorbants are listed in Table 1.

Table 1 : Cu (II) ions uptake capacities of some adsorbants

| Adsorbants | *Capacity [mg Cu (II)/g adsorbant]* | References |
|---|---|---|
| Stiren-divinyl benzen copolymers | 37,2 | 2 |
| Modified silicagel | 5.0 | 5 |
| Dyed cellulosic materials | 20,0 | 6 |
| Polyamine immobilized on Polystyrene | 33,0 | 7 |
| Poly (vinylamine) | 0.5 | 8 |
| Chelating resinn from thiourea and formaldehyde | 44,5 | 9 |
| Chitosan crown ethers | 60,4 | 10 |
| Poly (ethylene terephatalate) fibers | 1.9 | 19 |
| Grafted of Methacrylic acid onto poli(ethylene terephthalate) fibers | 375 | 20 |
| Grafted of 4 – VP onto poli(ethylene terephthalate) fibers | 62 | 21 |
| Poly (4 – VP) | 82 | Present work |

However, the metal ion binding abilities of adsorbant could be further analyzed. The adsorption ability of an adsorbant can be described by two parameters, that is, saturation constant k, (mmol/g) and equilibrium binding constant n. These constants can be calculated from the adsorption isotherm data according to Freundlich equation:

$$\text{Log } q = \text{Log } k + \frac{1}{n} \text{ Log } C_e \qquad (4)$$

Where $C_e$ is the concentration (mmol/L) of the ions remained in the solution at equilibrium and q is the amount of ions adsorbed onto unit mass of the poly(4 – VP) (mmol/L). Thus a plot of Log q versus Log $C_e$ should give straight line having a slope of $1/n_s$ and intercept of 1/k. Therefore, the relevant experimental data were treated and it was observed that the relationship between Logq and Log$C_e$ is linear, indicating that the adsorption behaviours follow the Freundlich adsorption isotherm (Figure 5). The k and n values are 0.79 mmol/g and 1.11 respectively. The correlation coefficient was found as 0,9799.

Usually, the effect of temperature on the adsorption process is fulfiled in the researches. Thus that subject was tried to investigate. But it was observed that poly(4 – VP) is soluable completely in the aqueous solution beyond the 30$^0$C thus that effect could not be studied. The study of desorption of copper(II) ions were carried out and represented in Figure 6.

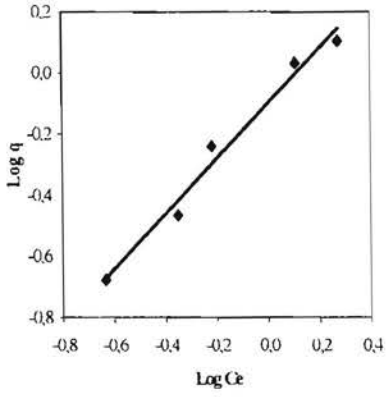


Figure 5. Freundlich adsorption isotherm

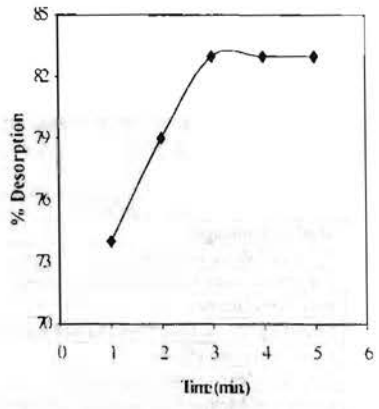


Figure 6. Variation of desorption with time

The copper(II) ions were easily desorbed from adsorbant by treating with 0,01 M HCl at room temperature with in 3 minutes. It was observed that the rate of desorption is very fast and yield of desorption is absolutely high which is around 83 percent.

## Conclusions

It was recognized that poly(4 – VP) has a great adsorption capacity, so that material is a potential for the waste water treatment for Cu (II) ions.


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# ADSORPTION BEHAVIOUR OF COPPER(II) ION FROM AQUEOUS SOLUTİON ON 4-VİNYL PYRİDİNE GRAFTED POLY(ETHYLENE TEREPHTHALATE) FIBERS

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**Abstract**

The adsorption behaviour of 4 vinyl pyridin grafted poly (ethylene terephthalate) fibers was studied towards the copper (II) ions in aqueous solutions by a batch equilibriation technique. The influence of treatment time, temperature, pH of solution, metal ion concentration and percent graft yield on adsorbed amount were investigated. One and half an hour of adsorption time was found sufficient to reach adsorption equilibrium for copper(II) ions. It was found that the adsorption isotherm of Cu(II) ions fits to Langmuir type isotherms. The highest adsorption capacity was found to be 0.973 mmol copper(II) ion per gram adsorbant. The heat of adsorption value was calculated as −9.57 kj $mol^{-1}$. It was found that the reactive fibers are stable and regenerable by acid treatment without losing its activity.

**Key words**: Adsorption, metal ions, fibrous adsorbant, 4 vinyl pyridine grafted polyester fibers

## Introduction

Sorption of metals is one method for the purification of industrial effluent. For that purpose, different adsorbants have been used in the several studies.

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Many unconventional methods are, therefore, being thought of this aim. Activated carbon, metal oxides, agricultural products such as peanut skins, onion skins, wool, chemically modified woods cellulosic and polymeric materials [1-21] have been used as adsorbant for the adsorption of toxic heavy metal ions.

Studies on fibrous reactive agents have shown many advantages over their resin counterparts. The big high specific surface areas of fibrous supports improve the accessibilities of functional groups resulting in higher reaction rate and conversion than the resin type agents. Thus studies concerning the use of fibrous materials for the adsorption of metal ions have been carried out [22-24].

The adsorption behaviour of pure poly(ethylene terephthalate) (PET) fibers was studied toward heavy metal ions in aqueous solutions by a batch equilibriation technique by Yiğitoğlu et al.[23]. Methacrylic acid grafted PET fibers were used as an adsorbant for the removal of copper(II) ions from an aqueous solution[24]. It has been observed that within those studies the reactive fibers are stable and regenerable by acid without losing their activity. In the present study we have aimed to investigate useability of 4-vinyl pyridin (4-VP) grafted PET fibers for the removal of copper(II) ions from aqueous solution.

## Experimental

### Materials

Analytical grade of $CuSO_4.6H_2O$ was used without purification. pH values were controlled with 0.1 M KCl/HCl and 0.1 M $CH_3COOH/CH_3COONa$ buffer solutions. 0.1M $HNO_3$/HCl were used into desorption study. The PET fibers (126 denier, 28 flaments) used in these experiments were provided by SASA Co. (Adana, Turkey). The fiber samples were Soxhlet – extracted for 6 h with acetone and dried at ambient temperature. 4-vinyl pyridin (4 – VP) was purified by vacuum distillation at 2 mmHg at 65 °C, Benzoyl peroxide ($Bz_2O_2$) was twice precipitated from chloroform in methanol and dried in a vacuum oven for 2 days. Other reagents were used as supplied. All reagents were Merck products.

**Polymerization procedure**

Polymerization was carried out in a thermostated 100 mL tube under reflux. The mixture containing PET fiber sample (0.3 ± 0.01g), monomer and $Bz_2O_2$ at required concentrations in 2 mL aceton was made up to 20 mL with deionized water. The mixture was immediately placed into the water bath (7305 polyscience) adjusted to the polymerization temperature. At the end of the predetermined polymerization time, fibers were removed from the polymerization medium and residual solvent ; monomer and homopoly (4 – VP) were removed by washing the PET fibers in methanol for 96 h. The grafted fibers were then vacuum – dried at 50 °C for 72 h and weighed [25]. The graft yield was calculated from the weight increase in grafted fibers as follows :

$$\text{Graft Yield (\%)} = [ (w_g - w_i ) / w_i ] \times 100 \quad (1)$$

Where $w_i$ and $w_g$ denote the weights of the original (ungrafted) and grafted PET fibers, respectively.

**Adsorption procedure**

30 $cm^3$ of copper(II) ion solution (0.79 mmol $L^{-1}$) adjusted to desired pH were added onto 0.10 g of 4-VP grafted PET fibers in 100 mL erlen-mayer. The contents were shaken at 200 rpm for a predetermined period of time at 25 °C using orbital shaker (Nuve Model, ST-402). After filtration of the solution the copper ion concentration of the filtrates was measured by a Philips PU 9285 model flame atomic absorption spectrometer equipped with deuterium lamp background correction, hollow cathode lamps (HCL) and air-acetylene burner was used for the determination of the metals. The adsorption capacity of the 4-VP grafted PET fibers was evaluated by using the following expression:

$$q=(C_o-C)V/m \quad (2)$$

where q is the amount of ion adsorbed onto unit mass of the 4-VP grafted PET fiber (mmol $g^{-1}$), $C_o$ and C are the concentration of the ion in the initial solution and in aqueous phase after treatment for a certain period

of time (mmol $L^{-1}$); V is the volume of the aqueous phase (L); and m is the amount of 4-VP grafted PET fiber used (g), respectively. Metal ion was recovered by treating with 30 mL 0.1M $HNO_3$/HCl for half an hour, then analyzed by the method mentioned above.

**Results And Discussion**

The effect of the graft yield on the adsorbed amount of copper(II) ions on 4-VP grafted PET fibers was investigated in the batch process at the following conditions: ion concentration was 0.79 mmol $L^{-1}$, temperature was 25 °C and pH was 4. As seen from Figure 1, adsorption process was affected by the graft yield. While graft percent increased from 9% to 70%, adsorbed amount increased and adsorption saturation value was reached to 0.2 mmol per gram adsorbant when used 70% grafted fibers. However the adsorption curves showed the same trend for all of grafting levels used in the study like that adsorption takes place rapidly at first then slows down and levels off.

The similar results were observed in the previous work [24] that methacrylic acid grafted PET fibers was used as adsorbant in the range of 0-47% grafted amount. It was reported that the adsorption ability of 47% MMA grafted PET fibers is higher than that of the other grafted fibers. The increase in the adsorption with increasing graft yield may be attributed to a higher surface area and more active sites.

Figure 1 also shows that the adsorption equilibrium is established within 2 h for all of grafting levels examined. Similar dependence on treatment time was obtained in the studies of other researchers [22] with different adsorption equilibrium times for the ions and adsorbants under differrent conditions.

It was observed that the adsorption of copper(II) ions from aqueous solutions on MMA grafted PET fibers obeyed a first order kinetics [24] which could be described by the following equation:

$$\text{Log}\frac{C_t}{C_o} = -\frac{k}{2.303}t \qquad (3)$$

Where t is the adsorption time; k an adsorption rate constant: $C_t$ the concentration amount of copper(II) ions at time t and $C_o$, the initial concentration of copper(II) ions.

**Table 1.** Adsorption rate constants (k) of 4-VP grafted PET fibers.

| Graft yield(%) | $kx10^4$ ($s^{-1}$) |
|---|---|
| 9 | 0.18 |
| 35 | 0.46 |
| 50 | 1.62 |
| 70 | 4.61 |

According to the adsorption equation, the experimental result of Figure 1 can be converted into the plots of $\log(C_t/C_o)$ versus t as Figure 2. Thus, the adsorption rate constants of the 4-VP grafted PET fibers calculated from the slopes of the plots are listed in Table 1. It is clearly seen that the adsorption rate constans increased with increasing percent graft yield.

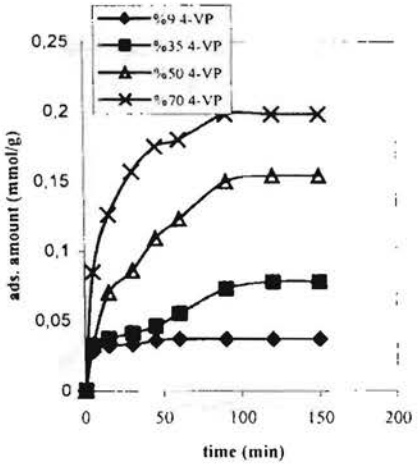


**Figure 1.** Relationship between adsorption time and adsorbed amount of copper(II) with 4-VP grafted PET fibers (ion concentration = 0.79 mmol $L^{-1}$; temperature = 25 °C; pH = 4)

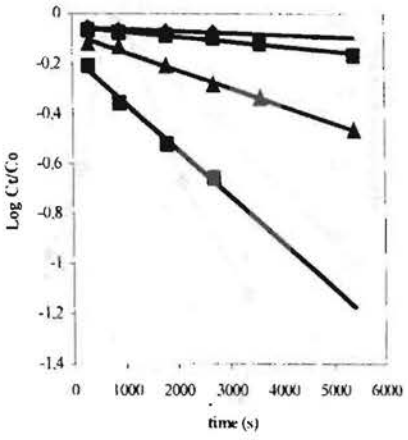


**Figure 2.** Plots of time versus $\log(C_t/C_o)$.

Figure 3 shows the relationship between pH and adsorbed amount. It is clear from the figure that increasing the pH value of the copper(II) aqueous solution from 2 to 4, the adsorbed amount increases significantly and reaches a maximum value at pH 4, beyond that point decreases sharply. In the rest of the study, experiments were carried out at pH 4.

At low pH values as it was reported in the previous works [23,24], the high hydrogen ion concentration at the interface electrostatically repels positively charged metal ions, preventing their approach to the fiber surface. Low adsorption values are in line with expectations.

The relationship between ion concentration and adsorbed amount was represented in Figure 4. It is clear from the figure that as the concentration of the ions increased adsorption increased rapidly, then levelled off. The adsorption saturation value was reached at 0.973 mmol ions per gram 4-VP grafted PET against 8.0 mmol copper(II) ions per liter.

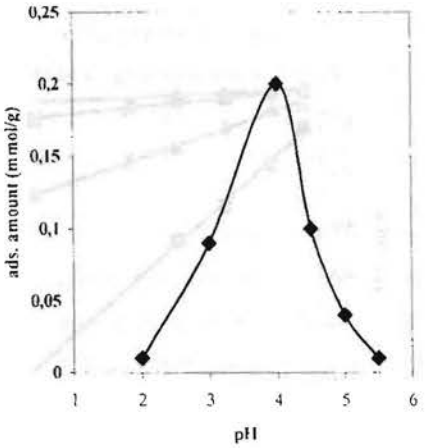


**Figure 3.** The pH dependence of copper(II) ion adsorbed by 4-VP grafted PET fibers (ion concentration=0.79 mmol $L^{-1}$, temperature=25 °C; contact time=2 h; graft yield=70%)

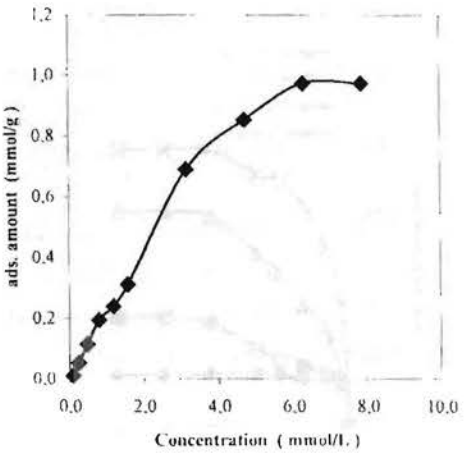


**Figure 4.** Effect of concentration of copper(II) ions on adsorption (temperature=25 °C, contact time=2 h; pH=4; graft yield=70%)

However, the metal ion binding abilities and structures of functionalized fibers could be further analyzed. The adsorption ability of an adsorbant can be described by two parameters, that is, saturation constant $K_s$ (mmol $g^{-1}$) and equilibrium binding constant $K_b$ (L $(mmol)^{-1}$) [2,20]. These constants can be calculated from the adsorption isotherm data according to Langmuir equation:

$$1/q = 1/C\ K_b\ K_s + 1/K_s \qquad (4)$$

Where C and q are the quantities of ions remained in the solution and adsorbed on the fibers at equilibrium, respectively. Thus a plot of 1/q versus 1/C should yield a straight line having a slope of $1/K_bK_s$ and intercept of $1/K_s$. Therefore, the relevant experimental data were treated and it was observed that the relationship between 1/q and 1/C is linear, indicating that the adsorption behaviours follow the Langmuir adsorption isotherm (Figure 5).

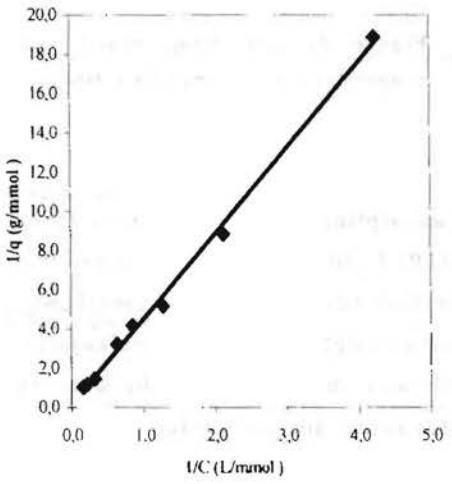


**Figure 5.** Langmuir plot of the removal of copper(II) ions on 4-VP grafted PET fibers.

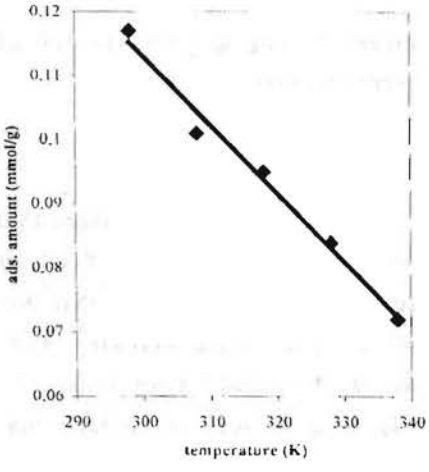


**Figure 6.** Effect of temperature on adsorption of copper(II) ions (ion concentration = 0.47 mmol $L^{-1}$, contact time=2 h; pH=4; graft yield=70%).

This suggested that the adsorption sites of 4-VP grafted PET fibers were one species. The $K_b$ and $K_s$ values are 0.04 L $(mmol)^{-1}$ and 5.66 mmol $g^{-1}$ respectively. The correlation coefficient was found as 0.997.

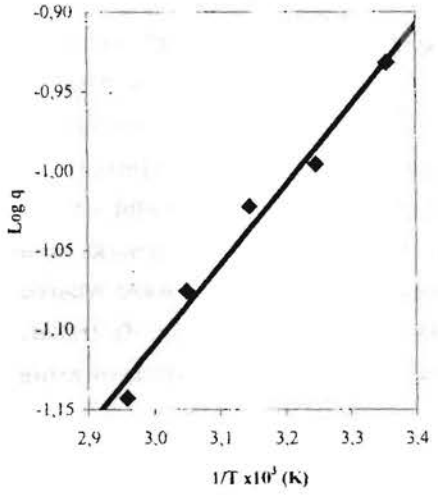


**Figure 7.** Log q versus to 1/T of copper(II) ions.

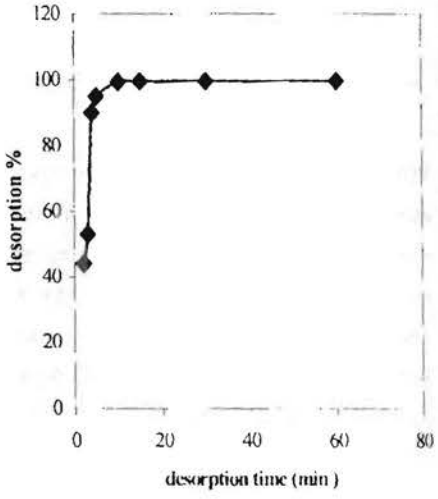


**Figure 8.** Desorption profile of copper(II) ion adsorbed PET fibers.

It has been recognized that the adsorption of copper(II) ions from an aqueous solution by 4-VP grafted PET fiber is affected by the temperature (Fig. 6) such that the adsorption being decreased remarkably as the temperature increased. The heat of adsorption value was calculated as –9.57 kj $mol^{-1}$ from Figure 7, which was obtained using the data of Figure 6. It was recognized that those value are convenient with the literature [23].

As it is reflected from the negative value of the heat of adsorption, the adsorption process is exothermic and is responsible for the decreasing in adsorption as the temperature increased. Heat of adsorption value show that the physical adsorption takes place in the process.

The study of desorption and readsorption cyle of copper(II) ions were carried out and represented in Figure 8 and Table II respectively. The copper(II) ions adsorbed were easily desorbed by treating with 0.1 M $HNO_3$/HCl at room temperature with in 10 minutes as seen from Figure 8. The desorbed 4-VP grafted PET fibers were highly effective for the readsorption of metal ions, and the adsorption ability of 4-VP grafted PET fibers were kept constant after several repitations of the adsorption-desorption cycle.

**Tablo II.** Adsorption-desorption cycles of copper(II) ions on 4-VP grafted PET fibers.(Ion concentration=6 0 mmol $L^{-1}$ ; pH=4; contact time=2; graft yield=70.0%)

| Number of cycle | Adsorbed Amount (mmol $g^{-1}$) |
|---|---|
| 1 | 0.973 |
| 2 | 0.972 |
| 3 | 0.899 |
| 4 | 0 880 |
| 5 | 0.870 |

**Conclusions**

PET fibers were grafted with 4-VP and was used as an adsorbant for copper(II) ions. The following conclusions are obtained.

1. The adsorption process was effected by the graft yield.
2. One and half an hour contact time was found sufficient to reach the adsorption equilibrium value.
3. A Langmuir type of adsorption was observed.
4. It was recognized that the reactive fibers are stable and regenerable by acid treatment without losing their activity and having a great adsorption capacity, so that material is a potential for the waste water treatment for copper(II) ions.

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## CONTENTS