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An International Journal is About Biological Diversity and Conservation With Refree

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Diversity of soil fungi exposed to fresh and stored Olive Mill Wastewater

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Abstract

Olive Mill Wastewater (OMW) management is one of the most challenging environmental problems in Mediterranean countries. Its recycling in soil is an alternative of valorization mean of interest. The effect of OMW on growth of soil fungi, a principal element of biodegradability in soil, was investigated in this study. In a field trial, OMW application to soil at 8 l/m² and 16 l/m² caused an increase in abundances of soil fungi during the 6 months following the spreading. In a microcosm essay, growth of soil fungi was better in fresh OMW than in stored OMW becoming after storage more antimicrobial and phytotoxic. In fresh OMW sterilized then inoculated by soil microflora, survivors of soil fungi were constituted mainly by yeasts which showed an increase of abundances from 5.09 10^4 CFU/ml to 5.02 10^8 CFU/ml after 15 days of incubation at 20°C. In stored sterilized then inoculated OMW, yeasts showed a fast reduction then a survival at low levels. Soil moulds were a sensitize group to OMW even fresh or stored. This group presented a fast reduction of abundances then disappearance. It could be concluded that OMW spreading in high amounts would conflict soil fungi's homeostasis and that spreading of OMW which was stored for a prolonged period should be avoided.

Key words: *Olive Mill Wastewater, fungi, soil, Olive Mill Wastewater storage*

1. Introduction

The effluent of olive oil production units called olive mill wastewater (OMW) is blackish wastewater characterized by a low pH (3.5 to 5.5), a high load of organic matter (COD of 45 to 220 g O_2/l) and phenolic compounds (0.5 to 24 g/l) (Paraskeva et Diamadopoulos, 2006). OMW valorization is a major problem for Mediterranean countries producing nearly 95% of the world olive oil production (Tomati et al., 2001). In these countries, OMW is generally stored in ponds or directly discharged in sewers or rivers what lead to environmental and socioeconomic problems. In Morocco, OMW discharge is causing a deterioration of surface and groundwater quality (Boukhoubza et al., 2008). Consequently, the cost of water potabilization increases and the risk of formation of carcinogenic chlorophenols occurs during chloration of waters contaminated by phenols. On the other hand, OMW released into sewers will cause dysfunction of wastewater treatment stations located downstream.

Although many physicochemical and biological treatments were suggested for OMW, their practical application is generally limited by the high cost of the treatment because of the high OMW production estimated to 30 000 m^3/year (Casa et al., 2003). OMW recycling in soil is a way of valorization that seems promising because it is low cost in comparison with the other possibilities (Cabrera et al., 1996) and because it respects the natural OMW destiny in nature. Indeed, ripe olives constituted to nearly 50% by olive vegetable water fall naturally in the soil and are biodegraded on it. Because OMW natural destiny is soil, OMW recycling in soils need to have a particular interest on studies interested to OMW treatment. Moreover, along with its acidity and phenols load, OMW is rich of fertilizing

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elements such as organic matter, N, P, K and Mg (Casa et al., 2003; Rinaldi et al., 2003). OMW doesn't contain high loads of heavy metals nor pathogenic microorganisms.

Studies interested to OMW spreading to soils have well focused on the impact of spreading on physicochemical properties of soil (Di Giovacchino et al., 2001; Gamba et al., 2005; Mekki et al., 2006 ; Sierra et al., 2007 ; Jarboui et al., 2008). These studies revealed that spreading is beneficial to physicochemical characteristics of soil when applied doses are moderate and suitable with soil characteristics. When spreading is made at high doses, negative aspects such as immobilization of soil nitrogen have been noticed (Sierra et al., 2007).

However, less interest was given to understand the microbial aspects of OMW spreading to soil (Mekki et al., 2006) while microorganisms are a key element in biodegradability processes in soil. Studies interested to the microbial aspect of OMW spreading were generally limited to determination of soil respiration (production of CO_2) and at less extent the abundances of microbial groups. These studies showed that OMW spreading at reasonable doses in controlled conditions leads to an enhancement in soil microflora abundances (Mekki et al., 2006) and soil respiration (Kotsou et al., 2004; Gamba et al., 2005). However, spreading high amounts could cause a decrease in soil microorganisms' abundances and soil respiration (Mechri et al., 2007). OMW antimicrobial activity was mainly linked to OMW high amount of phenolic compounds which can vary from 0.5 g/l to 24 g/l depending on culture conditions in orchards, degree of ripeness of olive fruit, climatic conditions, storage conditions and olive oil extraction process (Ramos-Cormenzana et al., 1997; Casa et al., 2003 ; D'Annibale et al., 2004).

The aim of this work is to study the growth of soil fungi in OMW in presence and in absence of soil inert fraction. Growth will be tested in fresh and stored OMW since the effect of OMW storage before spreading is a factor generally neglected on OMW spreading experiments (Mechri et al., 2007). In this work we will check if the increase of soil microflora abundances observed in field experiments is caused actually by OMW. On the other side, we are looking for detecting the most sensitive fungi to OMW and to follow their growth in OMW. This study would highlight the protective function of the inert fraction of soil to microorganisms while OMW application to soil.

2. Material and Methods

2.1. OMW origin and characterization

In this study, fresh and stored OMW were used. Fresh OMW was just produced from the mill. Stored OMW was produced the previous year and was stored in closed tanks of 30 liters of capacity during 1 year at 4°C. Fresh and stored OMW were procured from the same olive mill press located in Fez-Dokkarat-Morocco.

Fresh and stored OMW were characterized for pH, COD (Chemical oxygen demand), Total phenols and phytotoxicity toward maize seeds germination, before and after their sterilization. COD was determined by a COD meter HACH according to the standard micromethod (Rodier, 1996). Total phenols were quantified by means of Folin-Ciocalteu colorimetric method (Box, 1983). For total phenols, the absorbance was determined at λ=750 nm. Toxicity of OMW toward maize (*Zea mays*) seeds germination was determined according to Casa et al. (2003). Maize seeds were disinfected (rinsing by NaOH 1%), washed, dried, then distributed in sterilized and papered plates as 64 seeds per plate of 9 cm of diameter. OMW was added to plates as 10 mm. Distilled water was added to control plates. Plates were then incubated in darkness at 4°C during 48 hours (vernalization) then at 20°C during 6 days. At the end of the 8 days of incubation, germinated seeds were counted in the different plates. Seeds are considered germinated when the embryo perforates the seed's epidermis. Each essay was done in quadruplicate.

2.2. Study site and sampling

The study area consisted in a field of Saïs valley-Morocco, a site containing 42% of Moroccan mills. The weather typical Mediterranean, semiarid to arid, with an average rainfall of 450 mm $year^{-1}$ and an average annual temperature of 18–20 °C. The field was divided to three plots of 5 m². Plots C, P_1, and P_2 were amended in April 16th with 0, 8, and 16 l/m² of Fresh untreated OMW, respectively. The soil is a lime constituted by 51.16± 5.88 % of sand, 32.56± 3.92 % of silt and 16.25± 1.96 % of clay. Soil characteristics are presented on table 1.

Table 1. Soil characteristics

Parameter	Value
pH (25°C)	7.82±0.04
Conductivity (25°C) (ms/cm)	0.21±0.01
Humification degree (%)	10.68 ±2.96
Viable microbiota (CFU/g of dry soil)	4.05 (10^5) ±7.77
Yeasts (CFU/g)	0.04 (10^4) ±0.008
Moulds (CFU/g)	0.09 (10^4) ±0.03

Since one month from the OMW spreading, soil samples were collected from four random locations in each plot in the top 10 cm of soil layer which is the most relevant to microflora activity (Mekki et al., 2006). For each plot, microbial abundances were followed monthly for a period of 6 months since spreading. All soil samples, taken from each plot were mixed, air-dried, sieved with a mesh size of 2 mm and stored at 4°C until use.

2.3. Microbial abundances determination

The determination of abundances of soil total viable microbiota (bacteria, archae, and fungi), yeasts and moulds was done by indirect enumeration of CFU (colony forming units) in solid mediums. 5 g of soil was suspended in 100 ml of physiologic solution (NaCl 0.85 %) added by 100 µl of Tween 20 (polyoxyethylenesorbitan monolaurate) then agitated during 30 min. Tween 20 would allow dissociation of microflora from soil particles. 10-fold dilutions in sterile physiologic solution (NaCl 0.85 %) were prepared and used to inoculate specific media plates, three plates for each dilution. Viable microbiota abundances were determined in TSA medium (Tryptone-Soja-Agar) (Biokar Diagnostics, France), yeasts in YPG medium (Yeast extract- peptone- glucose) added by ampicillin (50 µg/ml) and chloramphenicol (25 µg/ml) and moulds in Malt extract agar (Biokar Diagnostics, France). Inoculated plates were incubated at 28°C. After 1, 3 and 7 days, abundances of bacteria, yeasts and moulds were determined, respectively.

2.4. Growth of soil microflora in fresh and stored OMW, in microcosms

For all growth essays, OMW was used without any dilution. OMW was first filtered many times through glass wool in order to avoid preferential orientations within microcosms. Microcosms were sterilized glass pyrex Erlenmeyers of 250 ml of capacity. OMW was sterilized by autoclaving (110 °C during 20 min) for constitution of microcosms where OMW is intended to be sterile. OMW (sterile or not sterile) was distributed in erlenmeyers at a rate of 100 ml each. Microcosms were prepared in duplicate.

To prepare inoculum of soil microflora, 50 ml of sterile nutritive broth (10 g tryptone, 5 g meat extract, 5 g NaCl in 1000 ml of distilled water) were inoculated by 2 g of soil then incubated 16 hours at 28 °C under moderate agitation (150 rpm). After incubation, the culture was aseptically centrifuged at 4500 g during 15 min in sterile 15 ml tubes full to 10 ml of their volume. The supernatant was eliminated and the precipitate was suspended in sterile physiologic solution (NaCl 0.85 %) then the suspension was centrifuged. This washing was repeated three times and after the last centrifugation, the base was suspended in 5 ml of sterile physiologic solution, and the inoculum was so constituted. The average abundances of viable microbiota, yeasts and moulds in the inoculum are respectively 1.5 10^7 CFU/ml, 9.8 10^5 CFU/ml and 5.6 10^5 CFU/ml. 2 ml of the inoculum were added to each microcosm. Microcosms prepared for different essays were as follow:

- Fresh OMW not sterilized and not inoculated by soil microflora;
- Fresh OMW not sterilized and inoculated by soil microflora;
- Fresh OMW sterilized and inoculated by soil microflora;
- Stored OMW not sterilized and not inoculated by soil microflora;
- Stored OMW not sterilized and inoculated by soil microflora;
- Stored OMW sterilized and inoculated by soil microflora.

Microcosms were incubated in darkness at 20 °C. Microbial abundances of total microbiota, yeasts and moulds were followed-up for a period of 15 days and were determined by indirect enumeration of CFU as previously cited. Abundances were determined in the days: d_0 (just after inoculation), d_1, d_4, d_6, d_9, d_{12} and d_{15}. For this, 1 ml sampled from each microcosm and was used to prepare 10-fold dilutions in a 0.85% NaCl solution to inoculate plates of suitable media. Plates were then incubated at 28 °C.

2.5. Statistical analyses

Statistical analyses were conducted using prism pad, version 4 software. Student test was used to compare means ((P<0.05). ANOVA one way allowed testing significance of the difference between two growth profiles. The microbial abundances in growth essays underwent a logarithmic transformation (log 10) before their presentation on graphs. The evolution of abundances of the studied microbial groups was compared to the Monod theory: $\mu=\mu_{max}S/K_s+S$ (µ: growth rate; µmax: maximum growth rate; S: limiting substrate concentration; Ks: concentration of substrate for which the growth rate is half-maximum.

3. Results

3.1. Effect of OMW spreading on abundances of soil microflora

Microbial counts of total microbiota, yeasts and moulds were followed during 6 months since OMW spreading. OMW spreading at 8 l/m² and 16 l/m² caused an increase in abundances of the studied groups (Figure 1). The load of increase in abundances depended on the microbial group and on the dose spread. For viable microbiota which gives information about the totality of soil microflora, when the dose spread was 8 l/m² (P_1) the abundances increased progressively since the spreading and reached a maximum value of 8.76 10^6 CFU/ g of soil after three months from spreading while the control had a value of 4.01 10^5 CFU/ g of soil (Figure 1a).The same tendency was obtained for yeasts and moulds and the maximum of abundances was obtained after three months for yeasts and after four months for moulds (Figure 1b and Figure 1c). When the dose spread was 16 l/m², abundances of viable microbiota, yeasts and moulds started increasing lately in comparison with the lower dose 8 l/m² (Figure 1a).

The increase in abundances of the studied microbial groups was followed by a decrease what should be due consumption of OMW organic matter. The profile of growth follows the Monod theory: $\mu=\mu_{max}S/K_s+S$ (µ: growth rate; µmax: maximum growth rate; S: limiting substrate concentration (OMW organic matter); Ks: concentration of substrate for which the growth rate is half-maximum. OMW organic matter is mainly constituted by carbohydrates, aliphatics, phenolic compounds and fats (El Hajjouji et al., 2008).

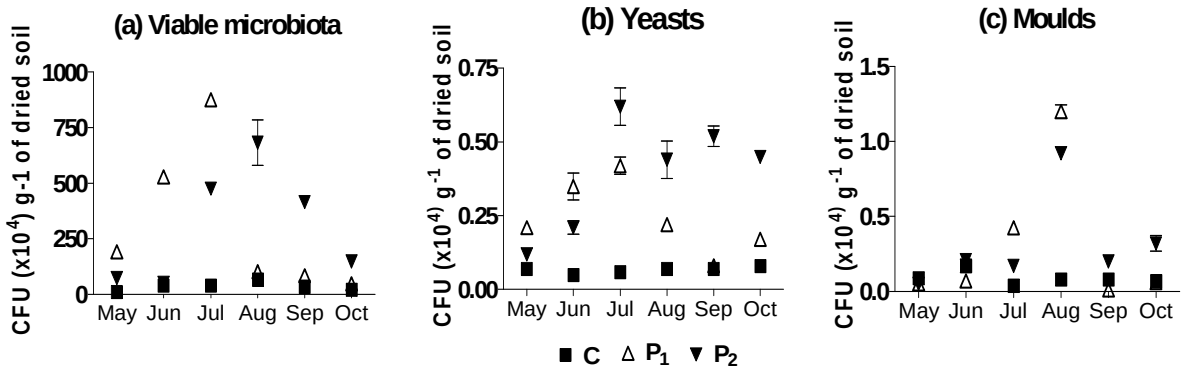

Figure 1. Effect of OMW spreading to soil at 8 l/m² (P_1) and 16 l/m² (P_2) on abundances of soil viable microbiota (a), yeasts (b) and moulds (c)

3.2. Effect of storage on OMW characteristics

OMW storage for 1 year at 4°C caused a significant decrease (p<0.05) of 16.38% of phenolic compounds and 15.31% of COD (Table 2). OMW stored 1 year at 4°C became 100% toxic to maize seeds germination in comparison with fresh OMW which was toxic for only 38.05% (Table 2). OMW pH was not significantly affected by storage.

Table 2. Effect of storage for 1 year at 4°C on OMW characteristics. Letters (a,b) indicate statistical difference at 0.05 level.

	Before storage	After storage
pH	4.70 ± 0.11a	3.98 ± 0.55a
Total phenols (g/l)	18.92 ± 0.98a	15.82 ± 1.21b
COD (gO2/l)	130.6 ± 2.46a	110.68 ± 9.44b
Phytotoxicity (% of germination)	61.95 ± 5.43a	0.00 ± 0.00b

3.3. Effect of sterilization on OMW characteristics

OMW sterilization had as a main consequence a significant decrease of COD and phenolic compounds for fresh OMW (Table 3A). For stored OMW, we only obtained a decrease in phenolic compounds without decrease of COD (Table 3B). Sterilization didn't have any significant effect on OMW pH and toxicity toward maize seeds germination. As shown in Table 3A and Table 3B, sterilized OMW was characterized by a low pH unusual to soil microflora (soil pH= 7.82) and by a high load of phenolic compounds and organic matter.

Table 3. Effect of sterilization on characteristics of fresh (A) and stored (B) OMW. Letters (a,b) indicate statistical difference at 0.05 level.

(A)

	Before sterilization	After sterilization
pH	4.64 ± 0.05a	4.74 ± 0.07a
Total phenols (g/l)	17.49 ± 0.13a	12.45 ± 0.09b
COD (gO_2/l)	124.42 ± 1.95a	105.06 ± 0.33b
Phytotoxicity (% of germination)	59.35 ± 6.67a	57.00 ± 3.51a

(B)

	Before sterilization	After sterilization
pH	3.98 ± 0.55a	4.28 ± 0.02a
Total phenols (g/l)	15.82 ± 1.21a	10.49 ± 0.18b
COD (gO_2/l)	110.68 ± 9.44a	108.75 ± 5.86a
Phytotoxicity (% of germination)	0.00 ± 0.00a	0.00 ± 0.00a

3.4. Growth of soil microflora in OMW, in microcosms

Raw OMW, fresh or stored, had its own indigenous microflora (Figure 2a, Figure 3a). Since its incubation at 20°C, fresh OMW grew rich out of yeasts (Figure 2a). Indeed, after one day of incubation, abundances of OMW yeasts significantly increased from 2.04 10^6 CFU/ml to 2.95 10^7 CFU/ml. No increase of abundances was obtained for moulds.

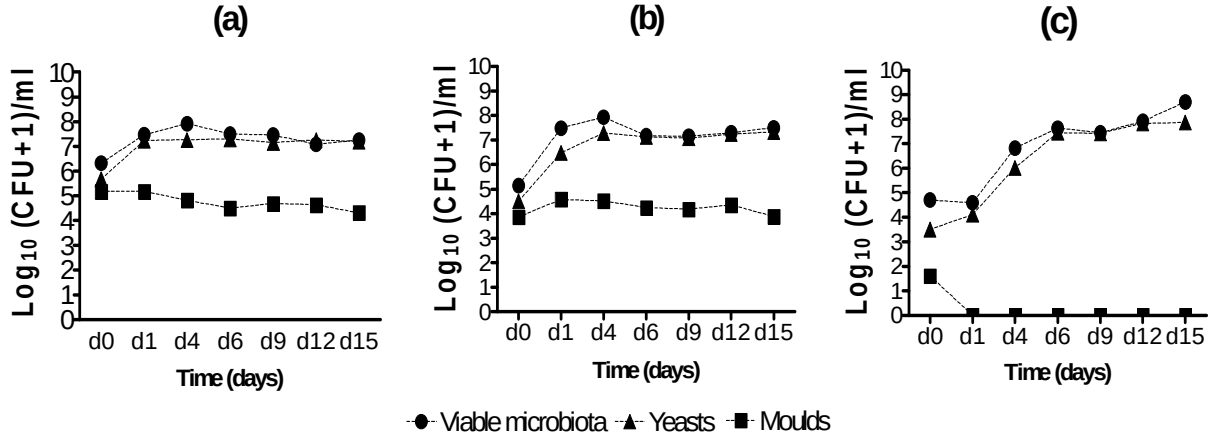

Figure 2. Growth of soil viable microbiota, yeasts and moulds in fresh OMW, in microcosms; (a): fresh OMW not sterilized and not inoculated by soil microflora, (b): fresh OMW not sterilized and inoculated by soil microflora, (c): fresh OMW sterilized and inoculated by soil microflora.

Raw sterilized OMW, fresh or stored, was a biotope where groups of soil microflora could grow (Figure 2c, Figure 3c). In fresh sterilized and inoculated OMW (Figure 2c), soil yeasts survived and showed an important and fast increase of abundances. The profile of growth of soil yeasts in OMW showed a phase of latency of nearly one day, a phase of exponential growth which lasted nearly 6 days during which the growth rate reached a maximum ($\mu=\mu_{max}$) and a stationary phase during which there is compensation between multiplication and mortality of microorganisms ($\mu\approx0$). In stored OMW, growth of soil yeasts showed a profile of fast reduction then survival at low level.

Soil Moulds were a sensitive group to both fresh and stored OMW (Figure 2c and Figure 3c). Indeed, just after inoculation of fresh sterilized OMW with soil microflora, soil moulds abundances were lower than 10 CFU/ml. Soil moulds disappearance was faster when inoculated OMW is the stored one and disappearance happened immediately after contact between inoculum and OMW (Figure 3c).

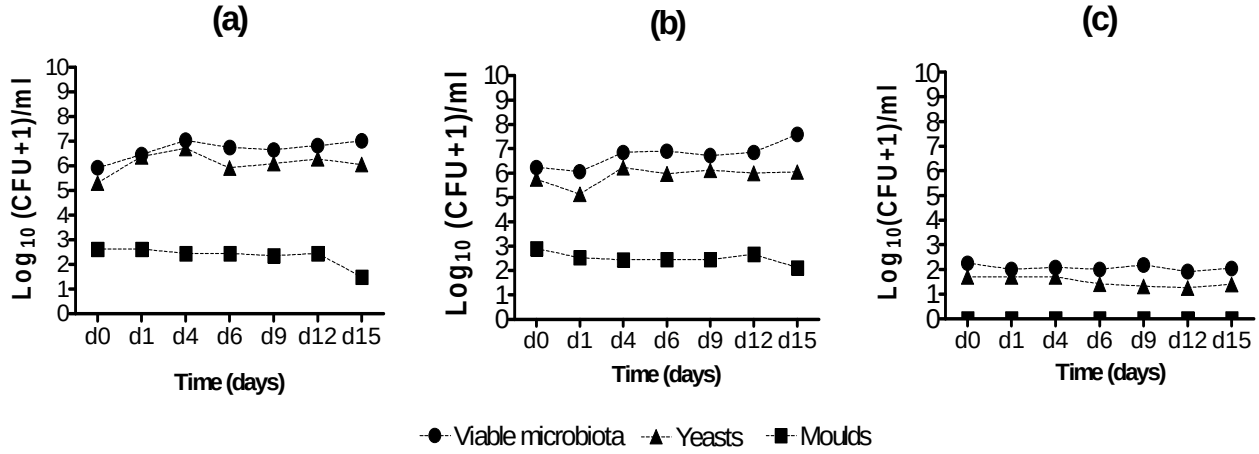

Figure 3. Growth of soil viable microbiota, yeasts and moulds in OMW stored 1 year at 4°C, in microcosms; (a): stored OMW not sterilized and not inoculated by soil microflora, (b): stored OMW not sterilized and inoculated by soil microflora, (c): stored OMW sterilized and inoculated by soil microflora.

4. Conclusions

OMW spreading to field at doses 8 l/m² and 16 l/m² caused an increase in abundances of total microbiota, yeasts and moulds what agree with previous findings (Kotsou et al., 2004; Gamba et al., 2005; Mekki et al., 2006). The increase in abundances started after a phase of latency which was longer when the spread dose was higher. The latency phase could be a phase of adaptation of microorganisms to the new substrate which is OMW applied to soil (Tomati and Galli, 1992) or could be a consequence of unavailability of OMW organic matter to microflora under adsorption or reaction with soil (Mekki et al., 2006). Some compounds in OMW especially phenols and organic acids may inhibit the soil microorganisms especially in the high doses and neutralize the favorable influence of OMW high nutrient content (Ramos-Cormenzana et al., 1997; Mekki et al., 2006 ; Sierra et al., 2007; Capasso et al., 1995). The increase of abundances was temporary and followed the Monod Law what was also reported by Kotsou et al. (2004) showing that the microbial abundances in soil receiving OMW increase to reach a top then start decreasing.

OMW storage at 4°C during 12 months caused a reduction of OMW phenols and organic matter what would be mainly assured by OMW indigenous psychrophilous microorganisms (Vavilin et al., 2000). A reduction of the load of phenols and COD of OMW after storage was reported. OMW storage under field conditions for 3 months has as result a reduction of 10% of COD and 20.3% of phenolic compounds (Saadi et al., 2007). According to previous studies, a reduction of OMW load of organic matter and phenolic compounds is linked to a reduction of OMW toxicity (Casa et al., 2003; D'Annibale et al., 2004). This was not in agreement with our findings showing that the toxicity of stored OMW increased. A prolonged storage of OMW is favorable for the transformation of oxidation stat of phenolic compounds what could increase their toxicity (Field et Lettinga, 1989). However, OMW storage under field conditions for less than four months was considered as a pretreatment (Borja et al., 1995 ; Marrara et al., 2002). According to our results, a prolonged storage of OMW at low temperatures should be defective to its interest as fertilizer.

OMW sterilization caused a significant diminution of COD and phenolic compounds for fresh OMW (Table 3A) and only a reduction of phenolic compounds without COD for stored OMW. This result should be explained by the fact that for stored OMW, available organic matter that could be easily oxidized during sterilization was consumed during storage, so that we did not obtain a reduction of COD after sterilization. This result should also show that the COD measurement is not relevant for phenolic compounds because even that we obtained a decrease on their load the COD was not reduced.

Raw OMW, fresh or stored, had its indigenous microflora having enzymatic devices allowing these microorganisms to grow in OMW as an only source of carbon (El Hajjouji et al., 2008). After incubation of fresh OMW at 20°C, abundances of indigenous yeasts increased but not those of moulds what showed that OMW would constitute a more adequate biotope for survival of OMW yeasts than moulds. Soil yeasts showed an exponential growth profile in sterilized OMW. This result show that soil yeasts are r-selected species involving first in metabolization of OMW available organic matter (Kotsou et al., 2004). Yeasts are efficient in biodegradation of labile organic matter of OMW constituted mainly by sugars, urea and aliphatic acids (El Hajjouji et al., 2008). It was demonstrated that yeasts isolated from different habitats are able to grow and multiply in OMW (Lanciotti et al., 2004 ; BenSassi et al., 2007). In stored OMW, growth of soil yeasts showed a profile of fast reduction then survival at low level which is one of the typical growth profiles in stressful media (Inamori et al., 1992).

Soil Moulds were a sensitive group to both fresh and stored OMW. OMW antimicrobial activity toward moulds was previously announced. Tardioli et al. (1997) showed that the soil common moulds *Scopulariopsis brevicaulis* and *Cladosporium cladosporioides* are unable to grow in OMW for a dilution higher than 50%. Rubia et al. (2008) demonstrated that the OMW phenolic compound tyrosol is highly inhibiting the development of moulds mycelium. On the other hand, OMW acidity and its high load of antioxidant phenolic compounds and fats should be inhibitor to germination of moulds spores. A reduction in moulds abundances after spreading a high dose of OMW was reported (Mekki et al., 2006a), however, a disappearance of moulds from soil amended by OMW was never reported, as we know. OMW spreading at high amounts should be avoided in practices of OMW spreading to protect soil moulds' homeostasis since this group set up a paramount role in lignin degradation in soil (Evelyn et al., 2005). OMW toxicity toward soil moulds would lead us to note that during an OMW spreading to soil, the increase in moulds' abundances (Tardioli et al., 1997 ; Mekki et al., 2006 ; Mechri et al., 2007 ; Figure 1) would correspond to an increase in abundances of OMW's moulds added to soil. Increases of moulds abundances during OMW spreading would also be due to multiplication of soil moulds if it's admitted that the inert fraction of soil play a protective part to its microorganisms. Indeed, it is reported that sediment's granules are a protective microbiotope for microorganisms against physical and biological aggressions of the medium (Davies et al., 1995) and that survival of a microbial population is better in presence of a support allowing fixing microorganisms (Maunoir et al., 1990). Also, it is demonstrated that moulds are more performing when they are cultivated in immobilized conditions rather than in free culture (Kim and Shoda, 1999).

Evolution of abundances of soil microbial groups following inoculation of fresh, not sterilized OMW (Figure 2b) did not show a profile which is plurality of profiles of abundances obtained in not sterilized not inoculated OMW (Figure 2a) and sterilized inoculated OMW (Figure 2c). This result would be explained by intervention of other biological phenomena such as competition between OMW microorganisms and soil microorganisms in favor to OMW microorganisms since competition is considered as a primordial factor controlling growth of microorganisms in a biotope (Brandi et al., 1996).

From this study, we can conclude that OMW has an indigenous population of fungi where yeasts are more abundant than moulds. Soil yeasts are able to grow and multiply in fresh not diluted OMW without addition of nutrients or treatment except sterilization. Soil moulds are a sensitive group to OMW antimicrobial activity. The antimicrobial activity of OMW and its toxicity toward maize seeds germination is highly important when OMW is stored 1 year at 4°C. From this study, we can recommend that OMW spreading to soil should be an interesting way of its valorization, since after spreading we obtained an increase in abundances of total microbiota, yeasts and moulds recycling the OMW. However, spreading high doses or a long time stored OMW is not recommended since it could threaten soil fungi homeostasis.

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References

Ben Sassi, A., Ouazzani, N., Walker, G., Ibnsouda, S., El Mzibri, M., Boussaid, A. 2007. Detoxification of olive mill wastewaters by Moroccan yeast isolates. Biodegradation. 19. 337-346.

Borja, R., Martin, A., Alonso, V., Garcian I., Banks, C.J. 1995. Influence of different aerobic pre-treatment on the kinetics of anaerobic digestion of olive mill wastewater. Water Research. 19. 489-495.

Boukhoubza, F., Ait Boughrous, A., Yacoubi-Khebiza, M., Jail, A., Hassani, L., Loukili Idrissi, L., Nejmeddine, A. 2008. Impact of olive oil wastewater on the physicochemical and biological quality of groundwater in the Haouz plain, south of Marrakesh (Morocco). Environmental Technology. 29. 959-974.

Box, J.D. 1983. Investigation of the Folin-Ciocalteau phenol reagent for the determination of polyphenolic substances in natural waters. Water Research. 17. 511-522.

Brandi, G., Sisti, M., Schiavano, G., Salvaggio, L., Albano, A. 1996. Survival of *Aeromonas hydrophila*, *Aeromonas caviae* and *Aeromonas sobrio* in soil. Journal of Applied Bacteriology. 81. 439-444.

Cabrera, F., Lopez, R., Martinez-Bordiu, A., Dupuy de Lome, E., Murillo, J.M. 1996. Land treatment of olive mill waste water. International Biodeterioration and Biodegradation. 38. 215-225.

Capasso, R., Evidente, A., Schivo, L., Orru, G., Marciallis, M.A., Cristinzio, G. 1995. Antibacterial polyphenols from olive mill waste waters. Journal of Applied. Bacteriology. 79. 393-398.

Casa, R., D'Annibale, A., Pieruccetti, F., Stazi, S.R., Giovannozzi Sermanni, G. G., Lo Cascio, B. 2003. Reduction of the phenolic components in olive-mill wastewater by enzymatic treatment and its impact on durum wheat (*Triticum durum* Desf.) germinability. Chemosphere. 50. 959-966.

D'Annibale, A., Casa, R., Pieruccetti, F., Ricci, M., Marabottini, R. 2004. *Lentinula edodes* removes phenols from olive mill waste water: impact on durum wheat (*Triticum durum* Desf.) germinability. Chemosphere. 54. 887-894.

Davies, C., Long, J., Donald, M., Ashbolt, N. 1995. Survival of fecal microorganisms in marine and fresh water sediments. Applied and Environmental Microbiology. 61. 1888-1896.

Di Giovacchino, L., Basti, C., Costantini, M.L., Ferrante, M.L., Surrichio, G. 2001. Effects of olive mill waste water spreading on soil cultivated with maize and grapevine. Agricultura Mediterranea. 131. 33-41.

El Hajjouji, H., Ait Baddi, G., Yaacoubi, A., Hamdi, H., Winterton, P., Revel, J.C., Hafidi, M. 2008. Optimisation of biodegradation conditions for the treatment of olive mill wastewater. Bioressource Technology. 99. 5505-5510.

Evelyn, H., Michael, P., Christina, D., Gert, B., Sophie, Z.B. 2005. Composition of the microbial communities in the mineral soil under different types of natural forest. Soil Biology and Biochemistry. 37. 661-671.

Field, J.A., Lettinga, G. 1989. The effect of oxidative coloration on the methanogenic toxicity and anaerobic biodegradability of phenols. Biological Wastes. 29. 161-179.

Gamba, C., Piovanelli, C., Papini, R., Pezzarossa, B., Ceccarini, L., Bonari, E. 2005. Soil microbial characteristics and mineral nitrogen availability as affected by olive oil waste water applied to a cultivated soil. Communications in Soil Science and Plant Analysis. 36. 937-950.

Inamori. Y., Murakami, K., Sudo, R., Kurihara, Y., Tanaka, N. 1992. Environmental assessment method for field release of genetically engineered microorganisms using microcosm systems. Water Science and Technology. 26. 2161-2164.

Jarboui, R., Sellami, F., Kharroubi, A., Gharsallah, N., Ammar, E. 2008. Olive mill wastewater stabilization in open-air ponds: Impact on clay-sandy soil. Bioresource Technology. 99. 7699-7708.

Kim, J. K., Shoda, M. 1999. Purification and characterisation of a novel peroxidase from *Geotrichum candidum* Dec 1 involved in decolorization of dyes. Applied and Environmental Microbiology. 65. 1029-1035.

Kotsou, M., Mari, I., Lasaridi, K., Chatzipavlidis, I., Balis, C., Kyriacou, A. 2004. The effect of olive oil mill wastewater (OMW) on soil microbial communities and suppressiveness against *Rhizoctonia solani*. Applied Soil Ecology. 26. 113-121.

Lanciotti, R., Gianotti, A., Baldi, D., Angrisani, R., Suzzi, G., Mastrocola, D., Guerzoni, M.E. 2004. Use of *Yarrowia lipolytica* strains for the treatment of olive mill wastewater. Bioresource Technology. 96. 317-322.

Marrara, G., Tamburino, V., Zimbone, S.M. 2002. Storage and land application of olive mill wastewater: experiences in Calabria. In: Proceedings of the ASAE Annual International Meeting/CIGR XVth World Congress, July 28– 31, Chicago, Illinois, USA.

Maunoir, S., Philip, H., Ambaud, A. 1990. Stimulation of psychrophilic methanation with a septic tank biological activator. Water Research. 24. 195-205.

Mechri, B., Echbili, A., Issaoui, M., Braham, M., Ben Elhadj, S., Hammamia, M. 2007. Short-term effects in soil microbial community following agronomic application of olive mill wastewaters in a field of olive trees. Applied Soil Ecology. 36. 216-223.

Mekki, A., Dhouib, A., Sayadi, S. 2006. Changes in microbial and soil properties following amendment with treated and untreated olive mill wastewater. Microbiological Research. 161. 93-101.

Paraskeva, P., Diamadopoulos, E. 2006. Technologies for olive mill wastewater (OMW) treatment: a review. Journal of Chemical Technology and Biotechnology. 81. 1475-1485.

Ramos-cormenzana, A., Juarez-Jimenez, B., Garcia-pareja, M.P. 1997. Antimicrobial activity of olive mill waste waters (Alpechin) and biotransformed olive mill waste water. International Biodeterioration and biodegradation. 38. 283-290.

Rinaldi, M., Rana, G., Introna, M. 2003. Olive mill wastewater spreading in southern italy: effects on a durum wheat crop. Field Crops Research. 84. 319-326.

Rodier, J. 1996. L'analyse de l'eau, 8^{éme} édition. Dunod, Paris, France.

Rubia, T.D.L., Lucas, M., Martinez, J. 2008. Controversial role of fungal laccases in decreasing the antibacterial effect of olive mill waste-waters. Bioresource Technology. 99. 1018-1025.

Saadi, I., Laor, Y., Raviv, M., Medina, S. 2007. Land spreading of olive mill wastewater: Effects on soil microbial activity and potential phytotoxicity. Chemosphere. 66. 75-83.

Sierra, J., Marti, E., Garau, M., Gruanas, R. 2007. Effects of the agronomic use of olive mill wastewater: Field experiment. Science of the Total Environment. 378. 90-94.

Tardioli, S., Ba`nne`, E.T.G., Santori, F. 1997. Species-specific selection on soil fungal population after olive mill waste-water treatment. Chemosphere. 34. 2329-2336.

Tomati, U., Galli, E. 1992. The fertilising value of waste waters from the olive processing industry. Humus, its structure and role in agriculture and environment. J. Kubat ed. Elsevier, pp. 117-126.

Tomati, U., Zito, V., Sandovar, A., Gaton, P., Ruiz, M. 2001. An European regulation about olive mill waste industry. In: Proceedings of 11th International Symposium on Environmental Pollution and its Impact in the Mediterranean Region, Cyprus, October 6–10, C5, pp. 184.

Vavilin, V.A., Lokshina, L.Y., Ritov, S.V., Kotsyurbenko, O.R., Nozhevnikova, A.N. 2000. Description of two-steps kinetics in methane formation during psychrophilic H_2/CO_2 and mesophilic glucose conversion. Bioresource Technology. 71. 195-209.

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Comparative Investigation of the Morphological Characteristics of Species belonging to the *Centaurea* L. Section *Phalolepis* (Cass.) DC.

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Abstract

In this study, taxonomical, morphologic, morphometric and statistically properties of 9 endemic species belonging to *Phalolepis* (Cass.) DC. section of the genus *Centaurea* L. (*Centaurea cadmea* Boiss., *C. aphrodisea* Boiss., *C. amaena* Boiss. & Bal., *C. lycia* Boiss., *C. luschaniana* Heimerl, *C. wagenitzii* Hub.-Mor., *C. tossiensis* Freyn & Sint., *C. hieropolitana* Boiss., *C. antalyense* A. Duran & H. Duman) were comparatively investigated. Comprehension the study, after collecting the samples belonging to these species, their morphological characteristics were identified, detailed figures were drawn and relation between morphologic characters analyzed by statistically methods. At the end of investigations, it was determined that these species have morphological characteristics different from known descriptions of them until now. In respect of results, prepare a new identification key for species belonging to section. According to discriminant analysis, morphological differences between the species were important statiscally.

Keywords: *Centaurea L., (Compositae), Phalolepis (Cass.) DC., Taxonomy, Morphology*

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Centaurea L. Cinsi *Phalolepis* (Cass.) DC. Seksiyonuna Ait Türlerin Morfolojik Özelliklerinin Karşılaştırmalı Olarak İncelenmesi

Özet

Bu çalışmada, Türkiye'de yayılış gösteren *Centaurea* L. (Compositae) cinsi *Phalolepis* (Cass.) DC. seksiyonuna ait endemik 9 tür (*Centaurea cadmea* Boiss., *C. aphrodisea* Boiss., *C. amaena* Boiss. & Bal., *C. lycia* Boiss., *C. luschaniana* Heimerl, *C. wagenitzii* Hub.-Mor., *C. tossiensis* Freyn & Sint., *C. hieropolitana* Boiss., *C. antalyense* A. Duran & H. Duman) taksonomik, morfolojik, morfometrik ve istatiksel bakımdan karşılaştırmalı olarak araştırılmıştır. Bu çalışma kapsamında türlere ait örnekler toplanarak morfolojik yapıları belirlenmiş, ayrıntılı şekilleri çizilmiş ve morfolojik karakterler arasındaki ilişki istatistiksel yöntemlerle analiz edilmiştir. Yapılan incelemeler sonunda, morfolojik olarak türlerin şu ana kadar bilinen deskripsiyonlarından farklı özelliklere sahip oldukları belirlenmiştir. Morfolojik ve morfometrik bulgular ışığında seksiyona ait türler için yeni bir teşhis anahtarı hazırlanmıştır. Ayırım analizine göre, türler birbirlerinden morfolojik olarak anlamlı bir şekilde ayrılmışlardır. Morfolojik karakterlerin birbirleriyle anlamlı ilişkiler içinde oldukları belirlenmiştir.

Anahtar kelimeler: *Centaurea* L., (Compositae), *Phalolepis* (Cass.) DC., Taksonomi, Morfoloji

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1.Giriş

Compositae familyasının önemli cinslerinden biri olan *Centaurea* L. cinsi dünyada Asya, Kuzey Afrika, Amerika ve Avrupa kıtasında yaklaşık 700 tür ile yayılış göstermektedir.(Brummitt, 2004; Tutin et al., 1976). Compositae familyası hem vejetatif hemde generatif parçaları bakımından eşsiz morfolojik yapılara, polinizasyon ekolojisine, kimyasal bileşenlere ve fitocoğrafyaya sahip taksonlar içermektedir (Meo, 2009)

Centaurea cinsi Türkiye Florası'nda ise *Astragalus* ve *Verbascum* cinslerinin ardından tür sayısı bakımından 3. sırayı almaktadır (Davis ve Hedge, 1975; Boissier, 1888; Davis, 1985). Yeni eklenenlerle birlikte Türkiye' de yaklaşık 195 *Centaurea* türü yetişmektedir. (Davis vd., 1988; Güner vd., 2000; Wagenitz, 1975; Wagenitz, 1997; Wagenitz vd., 1998; Duran ve Duman, 2001; Türkoğlu vd., 2003; Uzunhisarcıklı vd., 2005; Aytaç ve Duman, 2005; Wagenitz vd., 2006; Vural vd., 2006; Uzunhisarcıklı vd., 2007; Kaya ve Vural, 2007; Uysal vd., 2007; Uysal, 2008; Uysal ve Köse, 2009; Hamzaoglu ve Budak, 2009). *Centaurea* L. cinsinin endemizm oranı yaklaşık % 60' dır. Endemizm oranının bu kadar yüksek olması bu cinsin gen merkezinin Türkiye olduğu görüşünü sağlamlaştırmaktadır.

Wagenitz ve Hellwig, 2000 yılında yaptıkları çalışmada önceden *Centaurea* cinsine ait olan *Psephellus, Psephelloideae, Hyalinella, Aetheopappus, Amblyopagon, Heterolophus, Czerniakovskya, Odontolophoideae, Odontolophus, Xanthopsis, Uralepis* ve *Sosnovskya* seksiyonlarını gerçekleştirdikleri morfolojik, anatomik, palinolojik ve karyolojik araştırmalar sonucu *Psephellus* Cass. cinsine aktarmışlar; ve bu cinsle birlikte toplam 35 tür (Özellikle Türkiye ve İrandan) *Centaurea* cinsinden ayrılmıştır (Wagenitz ve Hellwig, 2000).

Ülkemizde *Centaurea* cinsine ait seksiyonlar ile ilgili bu şekilde kapsamlı çalışmalar Çelik (Çelik, 2003) ve Uysal (Uysal, 2006) tarafından yapılmıştır. Yine Çelik ve arkadaşları tarafından yapılmış çeşitli *Centaurea* türleri ile ilgili istatistiksel olarak karşılaştırılmalı morfolojik, anatomik ve ekolojik çalışmalar mevcuttur (Uysal vd., 2005; Çelik vd., 2005, Çelik vd., 2008; Çelik vd., 2008; Çelik vd., 2008)
Centaurea cinsinin farklı türlerinin farklı yörelerde, değişik isimler ve değişik amaçlarla kullanılmaktadır.
Bu çalışmada ülkemizin önemli cinslerinden biri olan *Centaurea*' nın *Phalolepis* (Cass.) DC. seksiyonuna ait endemik 9 türün, morfolojik, morfometrik ve istatistiksel özellikleri karşılaştırılarak, taksonomik özelliklerin belirlenmesi amaçlanmış ve birbirleriyle olan yakınlık dereceleri saptanmaya çalışılmıştır. Çalışmalarımız sonucunda türe ait morfolojik ve morfometrik karakterler Türkiye Florası (Wagenitz, 1975)'ndaki türün betimi ile karşılaştırılarak değerlendirilmiş, yeni karakterler çıkarılarak taksonomik problemleri olan cinse, grubuna, türün sistematiğine ve aynı zamanda Türkiye Florası'na katkı sağlanması amaçlanmıştır.

2.Materyal ve Yöntem

2.1.Bitkisel Materyal

Centaurea cinsi *Phalolepis* seksiyonuna ait türler doğal yayılış alanları olan Antalya, Denizli, Afyon, Zonguldak, Denizli, Kayseri, İzmir, Burdur, Kastamonu ve Bartın illeri olmak üzere 10 ile ait 26 lokaliteden toplanmıştır. Bitkilerin bir kısmı numaralanıp herbaryum örneği haline getirilmiş ve Anadolu Üniversitesi Eczacılık Fakültesi Herbaryumu'na (ESSE) ve Anadolu Üniversitesi Fen Fakültesi Herbaryumu 'na (ANES) yerleştirilmiştir.

Örneklerin Toplandığı Lokaliteler;
Centaurea cadmea: **A3 Zonguldak:** Devrek-Eğerci yolu, Yeşilöz köyü kavşağı, kayalık, 330 m, 19 vi 2004, K 41^{o} 05' 42.4", D 31^{o} 50' 06.2" **A4 Bartın:** Ulus, Ulukaya şelalesi, kayalık, 275 m., 6 ix 2005, K 41^{o} 40' 07.4'', D 32^{o} 45' 59.8'' **C2 Denizli:** Honaz, Milli Park yolu, kayalıklar, 804 m, 24 vi 2004, K 37^{o} 44' 58.2", D 29^{o} 16' 07.3" (Tip lokalitesi)
Centaurea aphrodisea: **B2 İzmir:** Ödemiş, Bozdağ, Kayak merkezi yolu, kayalık, 1200 m, 25 vii 2004, K 38^{0} 21' 07.8" D 28^{0} 05' 19.6" **C2 Aydın/Denizli:** Geyre-Tavas yolu, yol kenarı, taşlık yamaçlar, 1022 m, 25 vi 2004, K 37^{0} 39' 53.0" D 28^{0} 51' 52.7" (Tip lokalitesi) **C2 Denizli:** Başkarcı köyü, İsrail şelalesi, Piknik alanı, kayalık yamaçlar, 933 m, K 37^{0} 55' 42.6'' D 29^{0} 08' 07.4''
Centaurea amaena**: B5 Kayseri:** Yılanlı dağı çıkışı, yol kenarı, kayalık, 1194 m, 14 vii 2004, N 380 42' 55.4" E 350 25' 18.2"
Centaurea lycia: **C3 Antalya:** Antalya-Korkuteli yolu, 20. km, yol kenarı, kayalık, 538 m, 2 vi 2003, K 37^{0} 01' 35.7" D 30^{0} 27' 39.6" **Antalya:** Kozdağı, Tahtalı dinlenme yeri yolu, kayalık yamaçlar, 1130 m, 5 vii 2003, K 36^{0} 53' 51.5" D 30^{0} 22' 21.5" **Antalya:** Saklıkent yolu, tesislere 9 km kala, taşlık yamaç, 1142 m, 5 vii 2003 **Burdur:** Kızılkaya-Korkuteli yolu, Dik kayalıklar, 844 m, 2 vii 2005, K 36^{0} 18' 32.6'' D 30^{0} 21' 26.9''
Centaurea luschaniana**: C3 Antalya:** Elmalı-Korkuteli arası, Karaman beli, kayalık, 1300 m, 5 vii 2003, K 36^{0} 56' 52.5" D 30^{0} 09' 43.8" **Antalya:** Elmalı-Korkuteli yolu, yol kenarı, kalker kayalar, 1156 m, 4 vii 2003, K 36^{0} 45' 09.6" D 29^{0} 54' 22.6" **Antalya:** Korkuteli-Elmalı arası 30. km, 1308 m, 4 vii 2003, K 36^{0} 56' 37.7" D 30^{0} 07' 04.4" **Antalya:** Korkuteli-Elmalı arası, 14. km, kayalık, 1265 m, 3 vii 2005, K 36^{0} 58' 17.3'' D 30^{0} 09' 05.7''

***Centaurea wagenitzii*: C3 Antalya:** Adrasan, Sazak yolu, Kızılçam altı, 18 m, 23 v 2004, K 36^0 18' 52.4" D 30^0 28' 00.0" **C3 Antalya:** Adrasan, sahilin güneybatı kıyısı, yürüyüş yolu, maki, 3 m, 9 vi 2004, K 36 ^{0} 17' 53.8" D 30^0 28' 25.6" **C3 Antalya:** Adrasan, güneybatı yamaçlar, maki, 13 m, 3 vii 2005, K 36^0 17' 54.1'' D 30^0 28' 26.5''
***Centaurea tossiensis:* A4 Kastamonu:** Tosya-Kastamonu arası, yol kenarı, orman açıklığı, 1048 m, 5 ix 2005, K 41^0 11' 25.0'' D 34^0 01' 40.7'' **A4 Kastamonu:** Daday, Hasanağa-Çayözü arası, taşlık yamaç, 1035 m, 5 ix 2005, K 41^0 35' 05.7'' D 33^0 30' 00.7''**A4 Kastamonu:** Kastamonu-Araç arası, Ahlatçık köyü yol ayrımı, orman açıklığı, 1154 m, 6 ix 2005
***Centaurea hieropolitana:* B2 Afyon:** Dazkırı-Çardak arası, Sarıkavak köyü, Gölet çevresi, 974 m, 2 vii 2003, N 37 ^{0} 53' 29.4" E 29^0 48' 32.4" **C2 Denizli:** Pamukkale, Travertenlerin ön tarafı, 318 m, 24 vi 2004, N 37^0 55' 20.4" E 29^0 07' 00.7" **B2 Afyon:** Dazkırı çıkışı, step-Peganum harmala birliği, 870 m, 24 vi 2004, N 37^0 53' 56.7" E 29^0 51' 08.9"
***Centaurea antalyense:* C3 Antalya:** Akseki, Güzelsu yolu, Serebel kuyusu çevresi, *P. brutia* altı, 1090 m, 6 vii 2003. Sadıklar-Güzelsu yolu, Sedir ormanı altı, 1077 m, 3 vii 2055, K 36^0 54' 46.1'' D 31^0 48' 48.3''

2.2. Morfolojik

Toplanan örneklerin tanınmasında Davis'in Flora of Turkey and East Aegean Islands adlı eserinden ve doğadan toplanan canlı örneklerden yararlanılmıştır. Türün ayrıntılı deskripsiyonu ve çizimleri, herbaryum materyaline dayanarak yapılmıştır. Morfometrik karakter ölçümleri yapılarak kantitatif ve kalitatif veriler elde edilmiştir. Elde edilen morfometrik veriler Flora of Turkey ile karşılaştırmalı olarak Tablo 3'de verilmiştir. Taksonun morfolojik özelliklerini belirlemek amacıyla çiçekli bitki genel görünüş çizilmiş, bazal yaprak, gövde yaprağı, kapitulum, verimli tubulat çiçek, steril tubulat çiçek, fillari ve aken şekilleri ilave edilmiştir. Morfolojik çizimlerde Wild M5 A steromikroskobun resim çizme tübünden yararlanılmıştır.

2.3. Populasyonların Yapısal Özellikleri

Populasyonların yapısal özelliklerini ortaya koymak için istatiksel analiz yöntemleri uygulanmıştır. Türlerin morfolojik benzerliklerine göre gruplandırmak için kümeleme (Cluster) analizi uygulanmıştır. Kümeleme (Cluster) analizinde tüm değişkenlerin ilk önce z değerleri hesaplanmış, daha sonra bu değerler kullanılarak analiz yapılmıştır. Türlerin morfolojik özelliklerine göre ayırmak için ayırım (Diskriminant) analizi kullanılmıştır. Morfolojik karakterlere göre ayırım analizinde belirlenen morfolojik karakterlerin her bir lokaliteden yapılan ölçümlerinin ortalamaları kullanılmıştır. Ayrıca her bir değişkenin standart hataları, standart sapmaları, minumum-maksimum değerleri ve varyansları belirlenmiştir. İki ve tek lokaliteden toplanan örneklerde (*C. amaena* ve *C.antalyense*) analizler istatiksel olarak anlamlı bir değer taşımadığından analizlere katılmamıştır. Her iki istatistiksel sınamada, orijinal sayım değerleri yerine, örneklenen toplumların normal dağılımdaki hali ile değerlendirilmesini mümkün kılan Arc sin $\sqrt{P}$ açısal dönüşüm değerlerinden yararlanılmıştır. Formülde "P" oransal değerleri simgelemektedir. Tüm bu analizler SPSS 10.0 paket programında gerçekleştirilmiştir.

3. Bulgular

3.1. Morfolojik bulgular

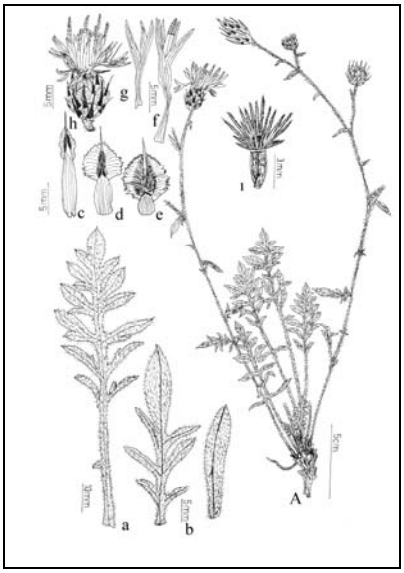
***Centaurea cadmea* Boiss.,** Diagn. ser. 1(4):16 (1844)

Bitki çok yıllık, odunsu köklü, 1-2 verimsiz sürgünlü, dik veya yükselici, 20-41 cm, üstte dallanmıştır. Gövde tomentose. Kökler 4-13 x 0,5-1 cm. Yapraklar tomentose, taban yaprakları bir veya iki kez lopları ayanın orta damarına kadar 1-2 pinnatisect, 35-226 mm boyundadır. Terminal segmentler ovat- lanceolat, 2-7 mm enindedir. Median gövde yaprakları bir veya iki kez lopları ayanın orta damarına kadar 1-2 pinnatisect, 1-4 lateral loplu. 13-50 mm boyunda, terminal segment linear-lanceolat, 1,5-7 mm eninde. Üst yapraklar basit, linear. İnvolukrum 8-15 x 7-16 mm ve ovoid 'den globose'ye kadardır. İç phyllari 11,3-15 mm, median phyllari 6,5-13 mm, dış phyllari 4-7 mm boyundadır. Appendage büyük, phyllarilerin alt kısmını örter, oblong'dan orbikular'a kadar şekilli, aşağı doğru decurrent, hyaline kenarlı ve kahve rengi sert merkezi kısımlı, lacerate, uçta 0,9-3 mm, spinule. Kapitulum saplı, dıştaki çiçekler radyant, steril, daha büyük, mor renkli, korolla uçta 3-5 dişlidir. İçtekiler verimli, hermafrodit, küçük ve beyazımsı pembe renkli, korolla tüpsü ve uçta 5 dişlidir. Stamenler 4 adet, anterler birleşik, filamentler singenesis. Anter tüpleri mor renklidir. Akenler tüylü, koyu kahverengi, 2,3-3,2 x 0,8-1,4 boyutlarındadır. Papuslar scabrous, iki halka halinde, papus dış halka 2,2-5,5 mm, iç halka 0,3-1 mm boyundadır (Şekil 1). Çiçeklenme 6. ve 7. kaya yarıklarında yetişmektedir.

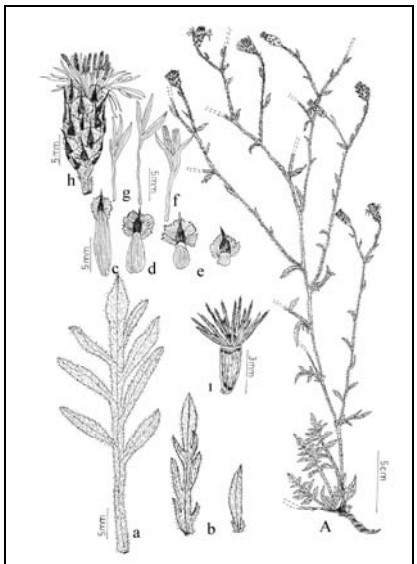
***Centaurea aphrodisea* Boiss.,** Diagn. ser. 1 (4):17 (1844) Syn: *C. alba* L. var. (f?) *aphrodisea* (Boiss.) Gris., Spic. 2:232 (1844)

Bitki çok yıllık, erect, tomentose tüylü, 28-71 cm, üstte dallanmıştır. Kökler 4-23 x 0.4-1.3 cm. Yapraklar tomentose, taban yapraklarının lopları bir veya iki kez ayanın yarısının 2/3' sine kadar 1-2 pinnatipartit, 34-112 mm boyunda, terminal segment eliptik- lanceolat, 1.4-5 mm enindedir. Median gövde yapraklarının lopları ayanın yarısının

2/3’ sine kadar pinnatipartit, 1-2 lateral loplu, 7-48 mm boyunda, terminal segment linear, 1.2-3.5 mm enindedir. Terminal yapraklar basit, linear- lanceolat. İnvolukrum 8-12.1 x 4-6 mm, silindirik-ovoid, meyvede iken huni şeklindedir. İç phyllari 9.5-12 mm, orta phyllari 6-9.7 mm, dış phyllari 3.2-6.5 mm. Appendage büyük, phyllarilerin taban kısmını örter, orbicular, aşağı doğru dekurrent, hyaline ve kenarları lacerate, sarımsı veya açık kahverengi, sert merkezi kısımlı, uçta 0,5-2,6 mm, mukroludur. Kapitulum saplı, dıştaki çiçekler verimsiz, radyant, mor renkli, içtekiler verimli ve hermafrodit, küçük ve beyaz renklidir. Korolla tüpsü ve uçta 3-5 parçalıdır. Stamenler 4 adet, anterler birleşik, filamentler serbesttir. Anter tüpleri mor renklidir. Akenler glabrescent, 2.9-3.9 x 1.2-1.9 mm, papuslu, papuslar scabrous, iki serili, papus dış halka 1.4-3.7 mm, papus iç halka 0.2-1.3 mm boyundadır (Şekil 2). Çiçeklenme Haziran-Ağustos. Kaya çatlaklarında ve tepe sırtlarında yetişmektedir



Şekil 1. *C .cadmea*



Şekil 2. *C. aphrodisea*

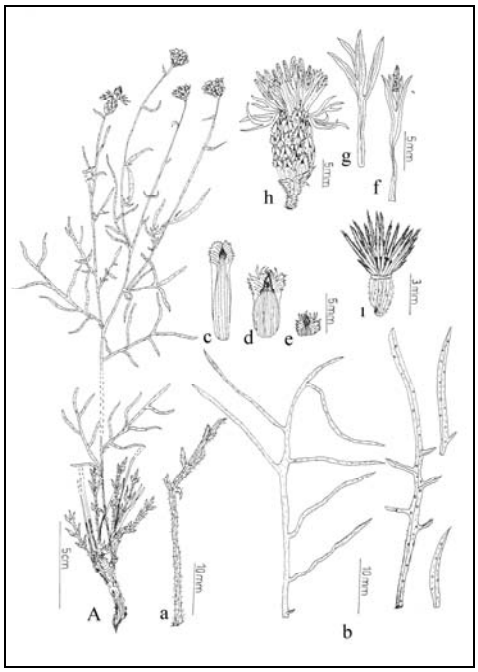
A: Genel görünüş, **a:** Taban yaprağı, **b:** Gövde yaprağı, **c:** İç involukrum braktesi, **d:** Orta involukrum braktesi, **e:** Dış involukrum braktesi, **f:** Verimli tüpsü çiçek, **g:** Verimsiz tüpsü çiçek, **h:** Kapitulum, **ı:** Aken.

***Centaurea amaena* Boiss. & Bal. in Boiss.,** Diagn. ser. 2(6):112 (1859)

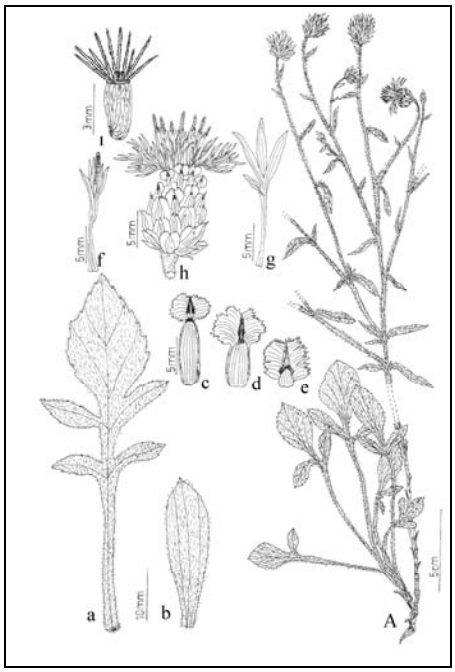
Bitki çok yıllık, ascending, hemen hemen glabrous, 49-51 cm boyundadır. Kökler 10-36 x 0,5-2,5 cm. Taban yaprakları seyrek tomentose, 20-40 x 0,9-1,5, lopları ayanın yarısının 2/3’ sine kadar pinnatipartit, 1-5 lateral loplu, loplar linear, üstteki gövde yaprakları basit veya tabanda 2 lopludur. Gövde yaprakları 25-70 x 1-2 mm. İnvolukrum ovoid, 8-12,5 x 5-9 mm. İç phyllari 9,7-12,5 mm, median phyllari 6-10 mm, dış phyllari 2,9-6,5 mm. Appendage; orbicular, büyük, phyllarilerin taban kısmını örter, aşağı doğru decurrent, küçük kahverengi merkezi kısımlı, kenarları fimbria lacerat, tepeye yakın kısımda 1-2 mm’ lik saçaklı, uçta 0,1-0,6 mm mukroludur. Kapitulum saplı, dış çiçekler verimsiz, radyant, beyazımsı pembe, içtekiler verimli, hermafrodit, küçük ve beyazımsı pembedir. Korolla tüpsü ve uçta 5 dişlidir. Stamenler 4, anterler birleşik, filamentler serbesttir. Akenler tüylü, 3,5-4 x 1,3-2 mm, papuslu, papuslar scabrous, iki serili, dış halka 3-4,6 mm, iç halka 0,2-1,1 mm. (Şekil 3). Çiçeklenme Haziran-Temmuz aylarındadır. Kayalık yamaçlarda ve 1200 m civarı yüksekliklerde yetişir

***Centaurea lycia* Boiss.**, Diagn. ser. 1 (10):109 (1849).

Bitki çok yıllık, erect, tomentose, 32–66 cm. Kökler 10-21 x 0,4-1 cm. Yapraklar tomentose, taban yaprakları lyrat, terminal segment eliptik-ovat, lateral segmentler oblanseolat, 40-185 x 9-26 mm. Gövde yaprakları spathulate, bazen tabanda 1-2 lateral loplu, 8-40 x 1,5-10 mm. İnvolukrum 9-17 x 4,7-17 mm, ovoid şekillidir. İç phyllari, 9,8-17 mm, median phyllari 5,7-14 mm, dış phyllari 2,2-5,5 mm. Apendage büyük, phyllarilerin taban kısmını örter, aşağı doğru decurrent, orbicular, kenarlar hyaline ve dentat, orta kısmı ser ve açık kahverengi, uçta 0,1-1 mm mukroludur. Kapitulum saplı, dıştaki çiçekler verimsiz, zayıfça radyant, mor renkli, içtekiler verimli ve hermafrodit, mor renklidir. Korolla tüpsü, uçta 4-5 parçalıdır. Stamenler 4 adet, anterler birleşik ve filamentler serbesttir. Anter tüpü mor renklidir. Stilüs anter tüpünden uzundur. Akenler tüylü, 2,9-3,7 x 1,1-1,6 mm, papuslu, papuslar scabrous, iki serili, dış halka 2-4 mm, iç halka 0,2-1,5 mm. (Şekil 4). Çiçeklenme Haziran-Temmuz. Kayalık yamaçlarda ve 500-1800 m aralıklarında yetişir.



Şekil 3 *C. amaena*



Şekil 4. *C. lycia*

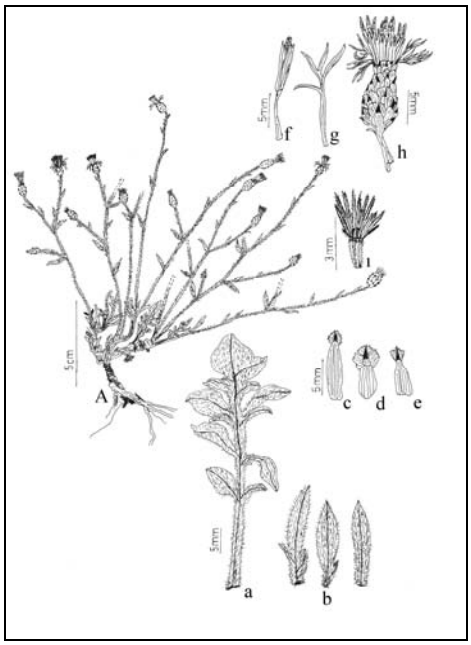
A: Genel görünüş, **a:** Taban yaprağı, **b:** Gövde yaprağı, **c:** İç involukrum braktesi, **d:** Orta involukrum braktesi, **e:** Dış involukrum braktesi, **f:** Verimli tüpsü çiçek, **g:** Verimsiz tüpsü çiçek, **h:** Kapitulum, **ı:** Aken.

Centaurea luschaniana **Heimerl** in Denkschr. Akad. Wiss. Wien, Math.-Nat. Kl. 50 (2):113 (1885).

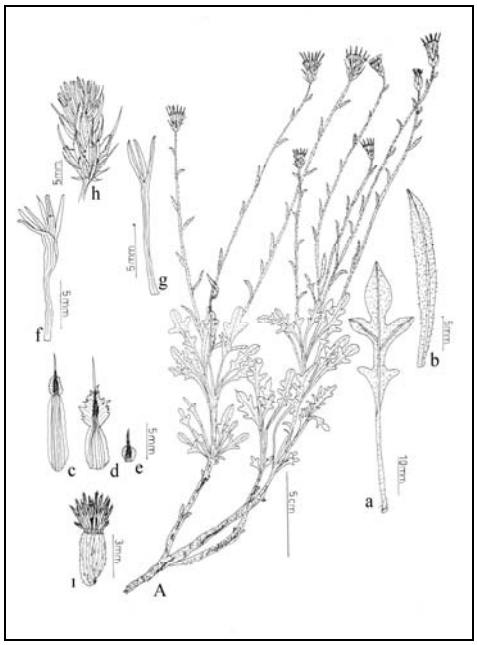
Bitki çok yıllık, erect, tomentose tüylü, 8-26 cm (ortalama 16,5 cm) boyundadır. Kökler 4,5-30 x 0,5-1,5 cm (ortalama 13,06 x 0,89 cm) ölçülerindedir. Yapraklar tomentose tüylü, taban yaprakları lyrat, lopları ayanın yarısının 2/3'sine kadar pinnatipartite şekilli, terminal segment ovat, lateral segmentler linear- lanceolate olup, 25-64 x 3-11 mm (ortalama 45,6 x 7,02 mm) ölçülerindedir. Gövde yaprakları linear- lanceolate, bazen tabanda 2 loplu, 4-19 x 1-4 mm (ortalama 10,1 x 1,99 mm) dir. İnvolukrum 5-11 x 3,5-8 mm (ortalama 8,23 x 4,74 mm), silindirik, tohumdayken funnel-shaped. İç phyllari 7,5-11 mm (ortalama 9,2 mm), median phyllari 4-7,3 mm (ortalama 5,46 mm), dış phyllari 1,5-4 mm (ortalama 3,02 mm) dir. Appendage phyllarilerin taban kısmını örter. Aşağı doğru decurrent, orbicular, kenarları hyaline ve lacerate, orta ksımı açık kahverengi, uç kısmında 0,1-0,25 mm (ortalama 0,11 mm) mukroludur. Kapitulum saplı, dıştaki çiçekler verimsiz, radyant, pembemsi mor renkli, içtekiler küçük, verimli, erdişi (hermafrodit) ve pembemsi mor renklidir. Korolla tüpsü, uçta 4-5 parçalıdır. Stamenler 4 adet, anterler birleşik, filamentler serbesttir. Anter tüpü mor renkli olup, stilüs anter tüpüyle hemen hemen aynı boydadır. Akenler tüylü, 2,5-3,5 x 1-1,6 mm (ortalama 3,03 x 1,3 mm), papuslu, papuslar scabrous, iki serili, dış halka 1,5-3 mm (ortalama 2,27 mm), iç halka 0,5-1 mm (ortalama 0,76 mm)dir (Şekil 5). Çiçeklenme Haziran, Temmuz aylarındadır. Kayalarda ve kayalık yamaçlarda yetişmektedir.

Centaurea wagenitzii **Hub.-Mor.** in Bauhinia 3:315, t. 17 (1967).

Bitki çok yıllık, dallanmış odunsu köklü ve çok sayıda basit gövdelidir. Çiçekli gövde erect, tomentose tüylü, 10-30 cm (ortalama 20,56 cm) boyundadır. Kökler 16-41 x 0,3-1,2 cm (ortalama 24,5 x 0,67 cm)'dir. Yapraklar gençken tomentose tüylü, daha sonra hemen hemen glabrescent. Taban yaprakları lyrate lopları ayanın 2/3'nden daha az pinnatifite kadar şekilli, 30-55 mm (ortalama 41,6 mm) boyunda, terminal segment eni 2,5-6,5 mm (ortalama 4,29 mm)'dir. Gövde yaprakları basit, linear- lanceolat, 5-18 x 1-2 mm (ortalama 13,1 x 1,58 mm)'dir. İnvolukrum 9-16,5 x 4,5-10 mm (ortalama 13,56 x 6,16 mm), ovoid-oblong şekillidir. İç phyllari 11,5-16 mm (ortalama 14,15 mm), median phyllari 7,5-14 mm (ortalama 11,75 mm), dış phyllari 3-8 mm (ortalama 5,14 mm)'dir. Appendage büyük, oblong, phyllarilerin taban kısmını örter ve belirsiz bir şekilde aşağı doğru decurrent. Kenarları zarımsı, fimbriate, orta kısmı koyu kahverengi olup, uç kısmında 2-6,3 mm (ortalama 4,18 mm) mukrolu. Kapitulum saplı, çiçekler kükürt sarısı renkli, dıştakiler verimsiz ve radyant değil, içtekiler ise verimli ve hermafrodittir. Korolla tüpsü, uçta 3-5 parçalıdır. Stamenler 4 tane olup, anterler birleşik, filamentler serbesttir. Anter tüpü mor renkli ve stilüsten kısadır. Akenler tüylü, 3-4,1 x 1,2-2,1 mm (ortalama 3,37 x 1,67 mm), papuslu, papuslar scabrous, iki serili, dış halka 1-2,2 mm (ortalama 1,59 mm), iç halka 0,2-1,5 mm (ortalama 0,87 mm)'dir (Şekil 6).Çiçeklenme Mayıs ve Haziran. Maki vejetasyonunda yayılış göstermektedir.



Şekil 5. *C. luschaniana*.



Şekil 6. *C. wagenitzii*.

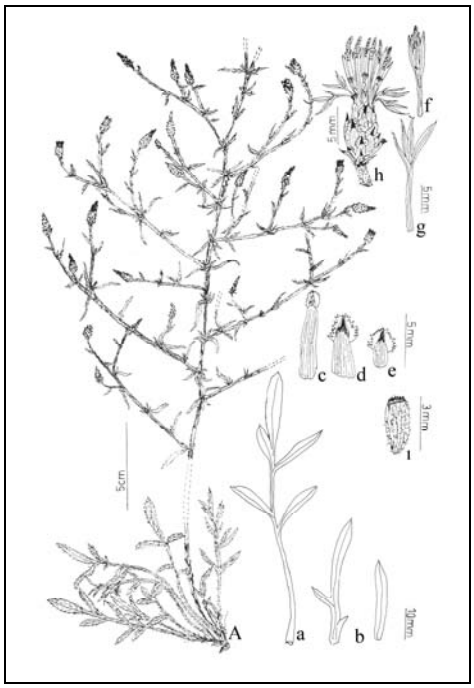
A: Genel görünüş, **a:** Taban yaprağı, **b:** Gövde yaprağı, **c:** İç involukrum braktesi, **d:** Orta involukrum braktesi, **e:** Dış involukrum braktesi, **f:** Verimli tüpsü çiçek, **g:** Verimsiz tüpsü çiçek, **h:** Kapitulum, **ı:** Aken

Centaurea tossiensis **Freyn & Sint.** İn Öst. Bot. Zeitschr. 44:258 (1894). Syn: *Acosta tossiensis* (Freyn & Sint.) Holub in Preslia 45:143 (1973)

Bitki çok yıllık, çok sayıda kapitulalı ve dallanmış gövdelidir. Çiçekli gövde erect, glabrous ve 18-60 cm (ortalama 37,65 cm) boyundadır. Kökler 12-31 cm x 0,3-0,6 cm (ortalama 15,3 x 0,45 cm) ölçülerindedir. Yapraklar arachnoid, hemen hemen glabrescent. Taban yaprakları lopları ayanın 2/3'sine kadar derin pinnatipartite, lateral lopları linear, 40-120 mm x 1-6 mm (ortalama 76,9 x 2,24 mm)'dir. Gövde yaprakları lopları ayanın 2/3'sine kadar derin pinnatipartite, glabrous, 9-32 mm x 1-2,5 mm (ortalama 17,6 x 1,51 mm) olup, üst yapraklar basit ve linear. İnvolukrum 7,5-10 mm x 3,4-4,7 mm (ortalama 9,05 x 4,16 mm) ve silindirik şekillidir. İç phyllari 7,8-10 mm (ortalama 8,93 mm), median phyllari 3-7 mm (ortalama 4,82 mm), dış phyllari 1,5-3,5 mm (ortalama 2,35 mm). Appendage triangular ve küçük, phyllarilerin taban kısmını örtmez. Kenarları zarımsı, aşağı doğru decurrent, tam veya üst kısmı küçük dişlidir. Uçta 0,1-0,2 mm mukro bulunur. Kapitulum saplı, çiçekler mor renkli, dıştakiler verimsiz ve hafifçe radyant, içtekiler verimli ve hermafrodit. Korolla tüpsü ve uçta dişlidir. Stamenler 4 adet olup anterler birleşik, filamentler serbesttir. Anter tüpü mor renkli ve stilüsten kısadır. Akenler tüylü, 2,5-3,2 x 1,2-1,6 mm (ortalama 2,94 x 1,35 mm) olup, papus yoktur (Şekil 7). Çiçeklenme temmuz ve Ağustos. Orman açıklıklarında ve taşlık yamaçlarda yetişir.

Centaurea hieropolitana **Boiss.** , Daign. Ser.1(4):15 (1844)

Bitki tek yıllık, ascending veya erect, tomentose, 15-45 cm (ortalama 28,7 cm) boyundadır. Kökler 3,7-12 x 0,15-0,4 cm (ortalama 6,76 x 0,26 cm) boyutlarındadır. Yapraklar tomentose tüylü, taban yaprakları lyrate, 33-110 x 6-12 mm (ortalama 52,5 x 8,3 mm) ölçülerindedir. Gövde yaprakları oblanceolate- spathulate, 4-37 x 1,2-8 mm (ortalama 21,7 x 4,13 mm) ölçülerinde ve bazen taban kısmında 2 lopludur. Üstteki gövde yaprakları involukrumu örter. İnvolukrum ovoid- oblong 6,5-11 x 3-7 mm (ortalama 8,98 x 4,76 mm) ölçülerindedir. İç phyllari 8,2-11 mm (ortalama 10,01 mm), median phyllari 4,5-8,2 mm (ortalama 6,42 mm), dış phyllari 2-4 mm (ortalama 3,16 mm)'dir. Appendage, phyllarilerin taban kısmını örter, circular şekilli, kenarları hyaline, aşağı doğru decurrent, orta kısmı açık kahverengi ve tepede emerginat. Mukro bulunmaz. Kapitulum saplı, dıştaki çiçekler verimsiz, radyant ve daha büyük olup, mor renklidir. İçtekiler küçük, hermafrodit ve pembemsi beyaz renklidir. Korolla tüpsü, uçta 5 parçalıdır. Stamenler 4 adet, anterler birleşik, filamentler serbesttir. Anter tüpü üstte mor alta doğru beyaz renklidir. Akenler tüylü, 1,9-2,8 x 0,6-1,4 mm (ortalama 2,3 x 1,04 mm), papuslu, papuslar scabrous, iki serili, dış halka 1,2-3 mm (ortalama 1,95 mm), iç halka 0,2-0,8 mm (ortalama 0,5 mm) dir (Şekil 8). Çiçeklenme Mayıs-Haziran. Step vejetasyonunda ve nadas tarla içlerinde yetişir.



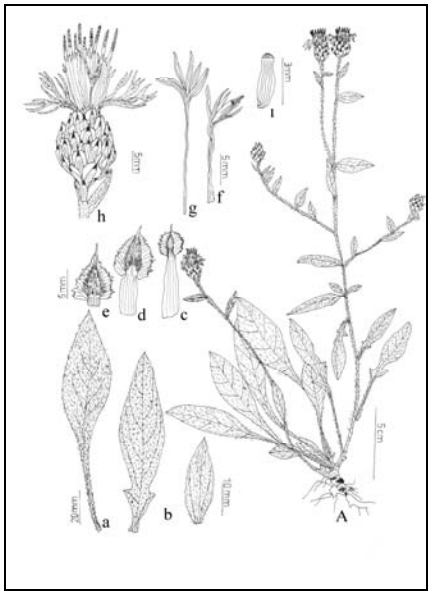
Şekil 7. *C. tossiensis*.

Şekil 8. *C. hieropolitana*.

A: Genel görünüş, **a:** Taban yaprağı, **b:** Gövde yaprağı, **c:** İç involukrum braktesi, **d:** Orta involukrum braktesi, **e:** Dış involukrum braktesi, **f:** Verimli tüpsü çiçek, **g:** Verimsiz tüpsü çiçek, **h:** Kapitulum, **ı:** Aken

***Centaurea antalyense* A. Duran & H. Duman** Ann. Bot. Fennici, 39: 43-48 (2001).

Bitki çok yıllık, erect, alt kısımda tomentose yukarı doğru glabrous, 16-41 cm (ortalama 26,15 cm) boyundadır. Kökler 5,3-17,5 x 0,3-0,7 cm (ortalama 10,2 x 0,53 mm) ölçülerindedir. Taban yaprakları tomentose, lanceolate-spatulate şekilli, 35-125 x 7-25 mm'dir (ortalama 83,3 x 13,88 mm). Gövde yaprakları glandular-punktat ve bazen tomentose veya kısa scaborus tüylü, lanceolate şekilli, bazen tabanda 2 loplu, 18-80 x 4-10,4 mm (ortalama 33,9 x 6,63 mm) ölçülerindedir. İnvolukrum 12-14,5 x 8-11,5 mm (ortalama 13,5 x 9,6 mm), ovoid şekillidir. İç phyllari 10,7-14 mm (ortalama 12,5 mm), median phyllari 5,6-11 mm (ortalama 8,5 mm), dış phyllari 3,5-6 mm (ortalama 4,7 mm) boyundadır. Appendage büyük, orbicular şekillidir ve phyllarilerin alt kısmını örter. Kenarları hyaline, dentate, orta kısmı açık kahverengi ve aşağı doğru decurrent değildir. Uç kısmında 0,7-2,1 mm (ortalama 1,3 mm) boyunda mukro taşır. Kapitulum saplı, dıştaki çiçekler steril, daha büyük, radyant ve mor-leylak renklidir. İçteki çiçekler verimli, hermafrodit ve beyaz renklidir. Korolla 5-6 parçalıdır. Akenler glabrous, 2,7-4,1 x 0,6-1 mm (ortalama 3,31 x 0,84 mm) ve papussuzdur (Şekil 9). Çiçeklenme Haziran-Temmuz. *Cedrus libani* ve *P. brutia* ormanı altında yetişir.



Şekil 9. *C. antalyense.*

A: Genel görünüş, **a:** Taban yaprağı, **b:** Gövde yaprağı, **c:** İç involukrum braktesi, **d:** Orta involukrum braktesi, **e:** Dış involukrum braktesi, **f:** Verimli tüpsü çiçek, **g:** Verimsiz tüpsü çiçek, **h:** Kapitulum, **ı:** Aken

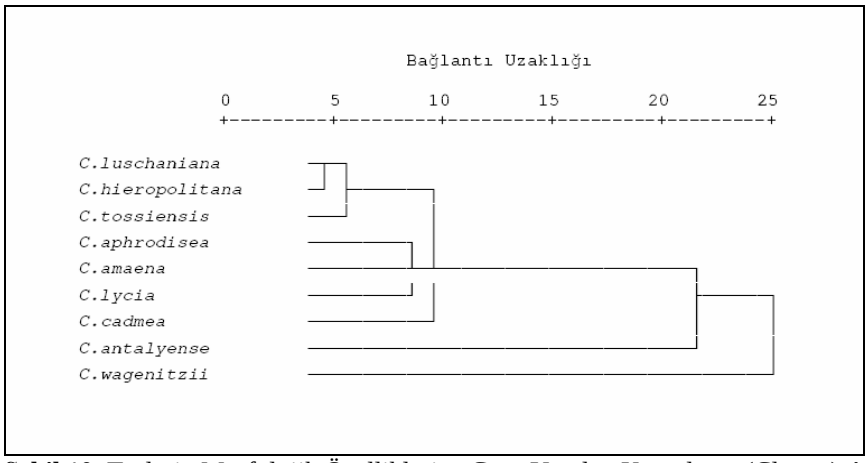
3.2. Kümeleme Analizi

Centaurea L. cinsi *Phalolepis* seksiyonuna ait türlerin morfolojik karakterlerine göre akrabalık ilişkilerini belirlemek için yapılan kümele (cluster) analizinde, *C. luschaniana* ve *C. hieropolitana* birbirine en çok benzeyen türler olarak ortaya çıkmıştır. Daha sonra *C. luschaniana* ve *C. tossiensis*, *C. aphrodisea* ve *C. amaena*, *C. aphrodisea* ve *C. lycia*, *C. aphrodisea* ve *C. luschaniana*, *C. cadmea* ve *C. aphrodisea*, *C. cadmea* ve *C. antalyense*, *C. cadmea* ve *C. wagenitzii* birbirine en çok benzeyen türler olarak belirlenmiştir (Tablo 1).

Tablo 1. Türlerin Benzerlik Katsayılarına Göre Kümeleme Analizi

Durum	Birleştirilen Kümeler		Katsayılar
	Küme 1	Küme 2	
1	*C. luschaniana*	*C. hieropolitana*	15,846
2	*C. luschaniana*	*C. tossiensis*	16,455
3	*C. aphrodisea*	*C. amaena*	17,598
4	*C. aphrodisea*	*C. lycia*	17,865
5	*C. aphrodisea*	*C. luschaniana*	18,047
6	*C. cadmea*	*C. aphrodisea*	18,192
7	*C. cadmea*	*C. antalyense*	23,558
8	*C. cadmea*	*C. wagenitzii*	26,605

Şekil 10.'deki kümeleme dendogramını incelediğimizde, *C. luschaniana*, *C. hieropolitana* ve *C. tossiensis*'in bir grup, *C. aphrodisea*, *C. amaena* ve *C. lycia*'nın bir grup ve *C. cadmea*, *C. antalyense*, *C. wagenitzii*'nin bağımsız birer grup oluşturdukları görülmektedir.



Şekil 10. Türlerin Morfolojik Özelliklerine Göre Yapılan Kümeleme (Cluster) Analizi Dendogramı

3.3. Türlerin Morfolojik Özelliklerine Göre Ayırım (Diskriminant) Analizi Yöntemiyle Populasyonların Yapısal Özelliklerinin Belirlenmesi

Centaurea cinsi *Phalolepis* seksiyonuna ait türlerin morfolojik incelemesinde sınıflandırma açısından önemli olan kök uzunluğu, kök kalınlığı, bitki boyu, taban yaprak boyu, taban yaprak eni, gövde yaprak boyu, gövde yaprak eni, involukrum boyu, involukrum eni, orta (median) involukrum braktesi (phyllari) boyu, dış involukrum braktesi (phyllari) boyu, iç involukrum braktesi (phyllari) boyu, aken boyu, aken eni, involukrum braktesi ek yapı (appendage) mukro boyu, papus dış halka boyu, papus iç halka boyu ölçülmüştür.

Morfolojik özelliklere göre yapılan ayırım (diskriminant) analizinde, türlerin sınıflandırma başarısı % 100 olarak bulunmuş ve 26 örnek kendi grupları içinde kalmıştır (Şekil 11). Bu sonuca göre türler morfolojik olarak birbirlerinden belirgin bir şekilde ayrılmaktadır. İlk iki fonksiyon değişimin % 93,3'nü açıklamaktadır. Türlerin morfolojik özelliklerine göre yapılan ayırımda, standartlaştırılmış ayırım fonksiyon katsayılarına göre 1. fonksiyonda en önemli karakter orta (median) involukrum braktesi (phyllari) boyudur. Bunu iç involukrum braktesi (phyllari) boyu, papus dış halka boyu ve papus iç halka boyu izlemektedir. 2. fonksiyonda ise, aken boyu, iç involukrum braktesi (phyllari) boyu, taban yaprak boyu ve kök kalınlığı sırasıyla türlerin ayırımında önemli karakterlerdir (Tablo 2).

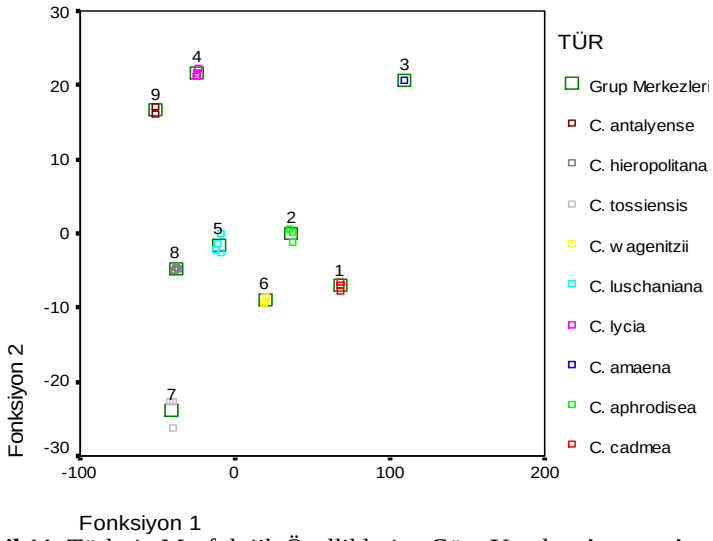
Tablo 2. Morfolojik Özelliklere Göre Yapılan Ayırım (Diskriminant) Analiz Sonuçları

Fonksiyon	Öz Değer	Varyans (%)	Toplam (%)	Kanon. Korelas	Wilks' Lambda	Khi-Kare	SD	Önem Düzeyi
1	2857,1	84,6	84,6	1,000	,000	372,577	136	,000
2	294,8	8,7	93,3	,998	,000	277,082	112	,000
3	155,2	4,6	97,9	,997	,000	208,804	90	,000
4	30,3	,9	98,8	,984	,000	148,186	70	,000
5	15,5	,5	99,3	,969	,000	106,852	52	,000
6	14,2	,4	99,7	,967	,002	73,190	36	,000
7	9,0	,3	99,9	,949	,034	40,459	22	,010
8	1,8	,1	100,0	,809	,345	12,772	10	,237

Standartlaştırılmış Ayırım Fonksiyon Katsayıları

Fonksiyon								
	1	2	3	4	5	6	7	8
KU	8,221	2,134	-,807	-,334	-1,265	-,165	-,078	,792
KK	4,381	-2,778	1,133	1,167	1,135	-,960	,529	-,783
BB	,279	,161	,454	-,510	-,600	,413	,030	-,376
TYB	-2,318	-2,986	,019	,650	1,731	,830	,373	-,315
TYE	-7,261	2,576	-,085	,548	,559	,302	,074	,028
GYB	-,639	,959	1,520	-1,086	-,045	,173	,481	,796
GYE	-3,027	2,223	-,202	-,411	-,651	-,021	-,715	-,150
İB	,316	,479	1,926	,223	-,752	,242	-,527	-,834
İE	1,513	-,374	-3,535	-,620	1,247	1,386	,462	1,324
MF	15,283	-,139	-1,194	,872	-,375	,137	,006	-,048
DF	4,403	,715	,093	-1,322	,210	-,582	-,601	-,057
İF	-10,837	-3,306	4,012	,376	,326	-,744	,304	-,321
AB	1,155	3,954	1,103	,064	,065	-,515	,432	-,076
AE	-4,404	-1,370	-,265	-,403	,558	1,698	,315	-,017
M	-2,633	-,242	,456	,864	,248	,378	-,109	,242
PD	10,630	2,459	-1,503	,332	-,591	-,090	-,436	-,243
Pİ	-10,468	,970	-,539	,151	-,559	-,151	,328	,520

KU: Kök uzunluğu, KK: Kök Kalınlığı, BB: Bitki Boyu, TYB: Taban yaprak boyu, TYE: Taban yaprak eni, GYB: Gövde yaprak boyu, GYE: Gövde yaprak eni, İB: İnvolukrum boyu, İE: İnvolukrum eni, MF: Median fillari boyu, DF: Dış fillari boyu, İF: İç fillari boyu, AB: Aken boyu, AE: Aken eni, M: Mukro boyu, PD papus dış halka boyu, Pİ: papus iç halka boyu



Şekil 11. Türlerin Morfolojik Özelliklerine Göre Yapılan Ayırma Analizinin Grafiksel Gösterimi

4. Tartışma ve Sonuç

Ülkemizdeki *Centaurea* L. cinsi *Phalolepis* (Cass.) DC. seksiyonuna ait türlerin tamamı endemik ve çok dar yayılış alanına sahip bitkilerdir. Biyolojik zenginliklerimizden olan *Phalolepis* seksiyona ait türler bu özelliklerinden dolayı, hem sistematik hem de ekonomik yönden üzerlerinde önemle durmayı gerektirmektedir. Ancak bu güne kadar bu grupla ilgili floristik ve birkaç palinolojik çalışma dışında herhangi bir çalışma yapılmamıştır. *Phalolepis* seksiyonu ilk defa bu çalışma ile ayrıntılı ve çok yönlü bir şekilde araştırılmıştır.

Bu araştırma ile türlerin morfolojik özellikleri, türlere ait populasyonların istatistiksel değerlendirmeleri ve uluslararası tehlike kategorileri ayrıntılı bir şekilde ortaya konmuştur. Flora of Turkey (Wagentiz, 1975) adlı eserde seksiyona ait türlerin morfolojik deskripsiyonları çok dar olarak verilmiştir. Türlere ait ayrıntılı deskripsiyonlar ilk defa bu çalışmada ortaya konmuştur.

C. cadmea türü morfolojik olarak varyasyonlar göstermektedir. Örneğin türün tip lokalitesi olan Denizli-Honaz dağından alınan örnek ile Zonguldak-Eğerci ve Bartın-Ulus'tan alınan örnekler arasında kapitulum ve ek yapı (appendage) özellikleri gibi önemli farklılıkları vardır. Bizim morfolojik bulgularımızla, Flora of Turkey (Wagentiz, 1975) arasında bariz farklılıklar görülmemektedir (Tablo 3).

C. aphrodisea'nın bitki boyu çalışmamızda 28-71 cm iken, florada 25-40 cm; taban yaprak eni bulgularımızda 1,4-5 mm iken, flora deskripsiyonunda 0,5-3 mm; involukrum ölçümlerimizde 8-12,1 x 4-6 mm iken, florada 10-14 x 5-10 mm; ek yapı (appendage) mukro boyu araştırmamızda 0,5-2,6 mm iken, florada 0,8-1,2; papus dış halka boyu çalışmamızda 1,4-3,7 mm iken, florada 3,5-4,5 mm olarak belirtilmiştir. Bu sonuç türün Flora of Turkey (Wagentiz, 1975)'de belirtilen morfolojik özelliklerinin doğru olmadığını göstermektedir (Tablo 3).

C. amaena Kayseri civarından sadece tip lokalitesinden bilinmektedir ve morfolojik ölçümlerimizde Flora of Turkey'e (Wagentiz, 1975) göre bitki boyunun daha büyük olduğu, involukrum eninin alt sınırının daha küçük olduğu, aken boyu ve papus dış halka boyunun daha uzun olduğu belirlenmiştir (Tablo 3).

C. lycia'nın bulgularımızda maksimum bitki boyu 66 cm olarak tespit edilmiş iken, Türkiye Florası'nda 35 cm olarak belirtilmiştir. Gövde yaprak eni ve involukrum eni de çalımamızda flora deskripsiyonuna göre büyük bulunmuştur. Diğer karakterler bakımından önemli farklılıklar saptanamamıştır (Tablo 3).

C. luschaniana Elmalı ve Korkuteli arasında birkaç lokaliteden bilinen dar yayılışlı bir türdür ve morfolojik bulgularımız Flora of Turkey (Wagentiz, 1975) ile örtüşmektedir (Tablo 3).

C. wagenitzii'nin yaptığımız morfolojik ölçümlerinde bitki boyu, involukrum boyu, involukrum eni, ek yapı (appendage) mukro boyu Flora of Turkey'de (Wagenitz 1975) belirtilen değerlere göre daha büyük, taban yaprak eni ise daha küçük çıkmıştır. Diğer karakterler için belirgin farklar saptanamamıştır (Tablo 3).

C. tossiensis tip lokalitesi Kastamonu-Tosya'da bulunan bir tür olup, çalışmamızda bitki boyu üst sınırı 60 cm iken, flora deskripsiyonunda 30 cm; gövde yaprak eni üst sınırı ölçümlerimizde 2,5 mm iken, florada 0,7 mm olarak belirtilmiştir. Morfolojik bakımdan diğer karakterler Flora of Turkey (Wagentiz, 1975) ile uyumludur (Tablo 3).

C. hieropolitana Phalolepis seksiyonundaki tek yıllık tek türdür. Morfolojik ölçümlerimizde Türkiye florasındaki deskripsiyona göre sadece bitki boyu ve involukrum boyu bariz farklılık göstermiş, diğer karakterler uyum sağlamıştır (Tablo 3).

C. antalyense 2002 yılında bilim dünyasına kazandırılmış bir tür olup Antalya-Akseki' de yayılış göstermektedir. Türün tanımlandığı deskripsiyonla yaptığımız ölçümlerle karşılaştırdığımızda taban yaprak boyu, taban yaprak eni, aken boyu ve ek yapı (appendage) mukro boyu daha büyük, involukrum ölçüleri ise daha küçük çıkmıştır (Tablo 3).

Morfolojik çalışmalar sonucunda, seksiyona ait türlerin birbirlerinden belirgin bir şekilde ayrıldıkları görülmüştür. Seksiyondaki türlerin korolla rengine bakıldığında; *C. wagenitzii*'nin sarı renkli korollaya, diğer türlerin ise mor ve pembe renkli korollaya sahip oldukları görülmektedir. Flora of Turkey (Wagentiz, 1975)'deki teşhis anahtarında önemli bir karakter olan ek yapı (appendage) mukrosunun *C. hieropolitana*'da bulunmadığı, *C. wagenitzii*' de 6 mm'ye kadar ulaştığı gözlenmiştir. Yine *Centaurea* cinsi için önemli bir karakter olan papus tüyleri *C. tossiensis* ve *C. antalyense* türlerinde yoktur. Seksiyondaki tüm türler çok yıllık iken, *C. hieropolitana* tek yıllıktır. Morfolojik bulgular ışığında seksiyona ait türler için yeni bir teşhis anahtarı hazırlanmıştır.

1. Bitki tek yıllık *C. hieropolitana*
1. Bitki çok yıllık
    2. Akenler papus taşımaz
        3. Apendajlar fillarilerin taban kısmını örtmez *C. tossiensis*
        3. Apendajlar fillarin taban kısmını örter *C. antalyense*
    2. Akenler papuslu
        4. Korolla sarı renkli *C. wagenitzii*
        4. Korolla mor veya pembe
            5. Apendaj mukro taşımaz *C. luschaniana*
            5. Apendaj mukrolu
                6. Taban yaprağı terminal lop eni 0,9-1,5 mm *C. amaena*
                6. Taban yaprağı terminal lop eni 1,5 mm'den büyük
                    7. İnvolukrum eni 6 mm'ye kadar *C. aphrodisea*
                    7. İnvolukrum eni 7 mm'den büyük
                    8. Taban yaprak terminal lop eni 2-7 mm *C. cadmea*
                    8. Taban yaprak terminal lop eni 9-26 mm *C. lycia*

Türlerin morfolojik özelliklerine göre yapılan ayırım analizinde sınıflandırma başarısı % 100'dür. Bu sonuca göre seksiyona ait türler birbirlerinden belirgin bir şekilde ayrılmaktadırlar. Türlerin morfolojik olarak birbirlerinden ayrılmalarında istatistiksel bakımdan en önemli karakterler median phyllari) boyu, iç phyllari boyu, papus dış halka boyu ve papus iç halka boyudur.

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Kaynaklar

Aytaç, Z., Duman, H. 2005. A new species of *Centaurea L. (Compositae)* from Turkey, Pakıstan Journal Of Botany, 37 (3), 563-566.

Boissier, E. 1867-1888. Flora Orientalis, 1-6, Genova.

Brummitt, R. K. 2004. Report of the Committee for Spermatophyta, 54, Taxon, 53 (3), 813-825.

Çelik, S. 2003. *Centaurea* L. Cinsi *Psehelloidea* (Bois.) Sosn. Seksiyonuna Ait Türlerin Ekolojik Özellikleri, Doktora tezi, Anadolu Üniversitesi, Fen Bilimleri Enstitüsü.

Çelik, S., Uysal, İ., Menemen, Y., Karabacak, E. 2005. Morphology, Anatomy, Ecology, Polen and Achen Structure of *Centaurea consanguinea* DC.(Sect. *Acrolophus*) in Turkey, International Journal of Botany, 1(1), 85-89.

Çelik, S., Uysal, İ. ve Menemen, Y. 2008. Morphology, Anatomy, Ecology and Palynology of Two *Centaurea* Species from Turkey, Bangladesh J. Bot. 37(1): 67-74.

Çelik, S., Özkan, K. ve Yücel, E. 2008. Morphological Variation of Two Taxonomically Distant *Centaurea* L. Species a Natural Gradient with Soil Physic and Chemistry and Plant Nutrients Effects, Asian Journal of Chemistry, Vol. 20, No. 4, 3171-3181.

Çelik, S., Yücel, E., Mendes, M., Tug, G.N., Öztürk, M. 2008. Canonical Correlation Analysis for Studyıng the Relationship Between the Basic Morphological and Some Soil Chemical Characteristics of *Centaurea mucronifera* DC. (Asteraceae), Asian Journal of Chemistry, Vol. 20, No.3, 2451-2456.

Davis, P. H. (ed.). 1965-1985. Flora of Turkey and the East Aegean Islands, 1-9, Edinburgh Univ. Press, Edinburgh.

Davis, P.H., Hedge, I.C., *The Flora of Turkey: Past, Present and Future*, Candollea, 30:331-351, Edinburgh (1975).

Davis, P. H., Mill, R. R., Tan, K. (ed.). 1988. Flora of Turkey and the East Aegean Islands (Supplement), 10, Edinburgh Univ. Press, Edinburgh.

Duran, A., Duman, H. 2001. Two new species of *Centaurea* (*Asteracae*) from Turkey, Ann. Bot. Fennici, 39, 43-48.

Güner, A., Özhatay., N., Ekim., T., Başer, K. H. C. 2000. Flora of Turkey and the East Aegean Islands (Supplement 2), 11, Edinburgh Univ. Press, Edinburgh.

Hamzaoglu, E., Budak, U., 2009. *Centaurea aksoyii* sp. Nov (Asteraceae: Cardueae) from Turkey and a contribution to the sectional taxonomy, Nordic Journal of Botany, 27(1), 16-20.

Kaya, Z., Vural, M. 2007. A new species of *Centaurea Sect. Acrocentron (Asteraceae*) from Turkey. Novon: A Journal for Botanical Nomenclature, 17 (2), 198-201.

Meo, A.A. 2009. Pollen Morphology of *Pyrethrum tatsiense* (Compositae) from Pakistan, Biodicon, 2/2, 65-67

Tutin, T. G., Heywood, V. H., Burges, N. A., Moore, D. M., Valentine, D. H., Walters, S. M. and Webb, D.

A. 1976. Flora Europaea, 1-5, Cambridge University Pres, London-New York Davis.

Türkoğlu, İ., Akan, H. ve Civelek, Ş. 2003. A new species of *Centaurea (Asteraceae: sect. Psephelloideae)* from Turkey, Bot. Jr. Linn. Soc., 143, 207-212.

Uysal, İ., Çelik, S. ve Menemen, Y. 2005. *Centaurea species* in Turkey (B): Comparative studies of two closely related species, *C. kurdica* Reichardt and *C. sclerolepis* Boiss., International Journal of Biodiversity Science and Management, 1(2), 121-128.

Uysal, T. 2006. Türkiye *Centaurea* (*Asteraceae*) Cinsi *Chirolepis* (Boiss.) O.Hoffm. Seksiyonunun Morfolojik, Karyolojik ve Moleküler Revizyonu, Doktora tezi, Selçuk Üniversitesi, Fen Bilimleri Enstitüsü.

Uysal, T., Demirelma, H., Ertugrul, K., Garcia-Jacas, N., Susanna, A. 2007. *Centaurea glabro-auriculata* (Asteraceae), a new species from Turkey, Ann. Bot. Fennici, 44(3), 219-222.

Uysal, T., 2008. *Centaurea ertugruliana* (Asteraceae), a new species from Turkey, Ann. Not. Fennici, 45, 137-142.

Uysal, T., Köse, Y.B., 2009. A New *Centaurea* L. (Asteaceae) Species from Turkey, Turkish Journal of Botany, 33(1), 41-46.

Uzunhisarcıklı, M. E., Tekşen, M. Doğan, E. 2005. *Centaurea marashica (Asteraceae)*, a new species from Turkey, Ann. Bot. Fennici, 42, 309-312.

Uzunhisarcıklı, M. E., Doğan, E. & Duman, H. 2007. A new species of *Centaurea* L. (Cardueae: Asteraceae) from Turkey, Bot. J. of Lin. Soc., 153, 61-66.

Vural, M., Duman, H., Aytaç, Z., Adıgüzel, N. 2006 *Saponaria karapinarensis, Senecio salsuginea and Centaurea tuzgoluensis*, three new species from Central Anatolia, Turkey. Belg. J. Bot., 139 (2).

Wagenitz, G. 1975. *Centaurea* L. in: Davis, P.H. (ed), Flora of Turkey and The East Aegean Islands, 5, pp.465-585, Edinburgh Univ. Press, Edinburgh.

Wagenitz, G. 1997. A new species *Centaurea (Sect. Acrolophus)* from Turkey, Ann. Naturhist. Mus. Wien, 98, B:176.

Wagenitz, G., Ertuğrul, K., Dural, H. 1998. *A new species Centaurea (Sect. Psephelloidea) from SW Turkey*, Willdenowia, 28, 157-161

Wagenitz, G., Hellwig, F. H. 2000. The genus *Psephellus* Cass. *(Compositae, Cardueae)* revisites with a brodened concept, Willdenowia, 30, 29-44.

Wagenitz, G., Hellwig, F.H., Parolly, G. Martins, L. 2006. Two new species of *Centaurea (Compositae, Cardueae)* from Turkey. *Willdenowia*, 36 (Special Issue): 423-435.

Tablo 3. *Phalolepis* Seksiyonuna Ait Türlerin Morfometrik Özelliklerinin Flora of Turkey [Wagenitz 1975] ile Karşılaştırılması

	C. cadmea		***C.aphrodisea***		***C. amaena***		***C.lycia***		***C. luschaniana***		***C. wagenitzii***		***C. tossiensis***		***C. hieropolitana***		***C. antalyense***	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1*	2
KU (cm)	-	4-13	-	4-23	-	10-36	-	10-21	-	4,5-30	-	16-41	-	12-31	-	3,7-12	-	5,5-17,5
KK (cm)	-	0,5-1	-	0,4-1,3	-	0,5-2,5	-	0,4-1	-	0,5-1,5	-	0,3-1,2	-	0,3-0,6	-	0,15-0,4	-	0,3-0,7
BB (cm)	10-35	20-41	25-40	28-71	25-35	49-51	25-35	32-66	10-30	8-26	5-15	10-30	25-30	18-60	25	15-45	5-40	16-41
TYB (mm)	-	35-226	-	34-112	-	20-40	-	40-185	-	25-64	-	30-55	-	40-120	-	33-110	40-70	35-125
TYE (mm)	2-5	2-7	0,5-3	1,4-5	0,5-1	0,9-1,5	10-30	9-26	3-10	3-11	5-12	2,5-6,5	-	1-6	-	6-12	7-10	7-25
GYB (mm)	-	13-50	-	7-48	-	25-70	-	8-40	-	4-19	-	5-18	-	9-32	-	4-37	-	18-80
GYE (mm)	-	1,5-7	-	1,2-3,5	-	1-2	2-5	1,5-10	-	1-4	1	1-2	0,5-0,7	1-2,5	-	1,2-8	-	4-10,4
İB (mm)	11-16	8-15	10-14	8-12,1	11-12	8-12,5	11-15	9-17	8-10	5-11	9-11	9-16,5	9-10,5	7,5-10	10-13	6,5-11	15-20	12-14,5
İE mm	9-12	7-16	5-10	4-6	8-9	5-9	10-12	4,7-17	5-6	3,5-8	6-7	4,5-10	3,5-4,5	3,4-4,7	4-6	3-7	10-15	8-11,5
MF mm	-	6,5-13	-	6-9,7	-	6-10	-	5,7-14	-	4-7,3	-	7,5-14	-	3-7	-	4,5-8,2	-	5,6-11
DF mm	-	4-7	-	3,2-6,5	-	2,9-6,5	-	2,2-5,5	-	1,5-4	-	3-8	-	1,5-3,5	-	2-4	-	3,5-6
İF mm	-	11,3-15	-	9,5-12	-	9,7-12,5	-	9,8-17	-	7,5-11	-	11,5-16	-	7,8-10	-	8,2-11	-	10,7-14
AB mm	3-3,5	2,3-3,2	3-4	2,9-3,9	3	3,5-4	3,5-4	2,9-3,7	2,8-3	2,5-3,5	-	3-4,1	2,7-2,8	2,5-3,2	2-2,5	1,9-2,8	2-3	2,7-4,1
AE mm	-	0,8-1,4	-	1,2-1,9	-	1,3-2	-	1,1-1,6	-	1-1,6	-	1,2-2,1	-	1,2-1,6	-	0,6-1,4	-	0,6-1
M mm	1,5-3	0,9-3	0,8-1,2	0,5-2,6	0,5	0,1-0,6	0,3-0,7	0,1-1	-	0,1-0,25	2-4	2-6,3	0,1-0,3	0,1-0,2	-	-	1-1,5	0,7-2,1
PD mm	3,5-4,5	2,2-5,5	3,5-4,5	1,4-3,7	2,5	3-4,6	3-4	2-4	2,5-3	1,5-3	2	1-2,2	-	-	2-3	1,2-3	-	-
Pİ mm	-	0,3-1	-	0,2-1,3	-	0,2-1,1	-	0,2-1,5	-	0,5-1	-	0,2-1,5	-	-	-	0,2-0,8	-	-

1: Flora of Turkey, **2:** Bulgular, **1*:** Duran, A., Duman, H. (2002) [16]
KU: Kök uzunluğu, KK: Kök Kalınlığı, BB: Bitki Boyu, TYB: Taban yaprak boyu, TYE: Taban yaprak eni, GYB: Gövde yaprak boyu, GYE: Gövde yaprak eni, İB: İnvolukrum boyu, İE: İnvolukrum eni, MF: Median fillari boyu, DF: Dış fillari boyu, İF: İç fillari boyu, AB: Aken boyu, AE: Aken eni, M: Mukro boyu, PD papus dış halka boyu, Pİ: papus iç halka boyu

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Study of sowing date and plant density affect on Black Cumin (*Cuminum carvi*) yield, in Iran

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Abstract

An experiment was conducted to evaluate the effect of sowing date and plant density on yield and yield components of Black Cumin (*Cuminum carvi* L.) under dry farming conditions. Four plant densities (50, 100, 150 and 200 plants m^{-2}) and three sowing dates (3, 13 and 23 of March) were applied. Result showed that seed yield was influenced by sowing date and plant density interaction. Early sowing date resulted in higher seed yields as evident from higher aboveground biomass, the number of umbrella per plant, the number of seed per umbrella and plant height. Harvest index and 1000-seed weight were not affected by sowing date and planting density. Earlier sown plants with density of 200 m^{-2} resulted in higher seed yields.

Key words: Sowing date; Plant density; Black Cumin; Yield; Yield components

1. Introduction

Black Cumin (*Cuminum carvi* L.) is a member of Apiaceae. This species originated in Egypt and East Mediterranean, but is widely cultivated in Iran, Japan, China and Turkey. Black Cumin has a long history of use as food flavors, perfumes and medicinal values. Essential oil has been used for bringing smell to some medicines, for sterilizing of surgical operation fiber, for producting of some veterinary and agricultural medicines and plastic (Simon et al, 1984). Black Cumin seeds have an aromatic odor and bitter taste. They are used as an essential ingredient in soup, sausages, cheese, cakes and candies (Behera, et al., 2004). Presently, Iran is an important Black Cumin exporter, constituting 20-40% of world market (Barros et al,2004). In semiarid area such as Iran, water is the most limiting factor for farming. Black Cumin can be some as fallow crop in wheat or barley fallow in dry land farming of Iran. In suitable plant density, plants completely use environmental conditions (water, air, light and soil) and inter- or intra-specific competition is minimum. Yield loss due to unfavorable sowing date has been reported in many crops such as sunflower (Barros et al,2004) and fennel (Bianco et al, 1994 and Kafi,1990). Yield components of Black Cumin include the number of plant in area unit, the number of umbrella per plant, the number of seed per umbrella and seed weight. The number of plant per unit area is the most important among yield components (Kafi,2003). Ahmed and Haque (1986) studied the effect of row spacing (15, 20, 25 and 30 cm) and time of sowing (November 1, November 20, December 10 and December 30) on the yield of black cumin in Bangladesh, they found that closer row spacing (15 cm) and early sowing (November 1) were the best for higher seed yield of black cumin (Ahmed and Haque,1986). The number of umbrella per plant has the second rank of importance in yield components. Aminpour and Karimi (1995) reported that 96% of seed yield variation was related to this yield component (Aminpour and Karimi,1995). The number of seed per umbrella is affected by environmental, field management and its number was reported from 11.3 to 16.8 under varying plant densities (Kafi,2003). The weight of Black Cumin seed varied in different experiments. Kafi (2003) reported that it was from 2.79 to 2.99 g under varying plant densities. Shortening of the growing cycle decreased the amount of radiation

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intercepted during the growing season and thus total dry weight of plant (Andrade,1995). With delayed sowing, development is accelerated because the crops encounter higher temperatures during the vegetative growth (Damato et al,1994). Ehteramian (2003) reported that delayed sowing date was better because of occurrence lack of suddenly winter chilling. Delayed sowing date decreases seed weight and the number of umbrella per plant (Ehteramian,2003). Optimum plant density and sowing date of Black Cumin in Khorasan province of Iran has not yet been investigated. This study aimed at the determination of the optimum sowing date and plant density of Black Cumin for achievement of maximum seed yields under the conditions of the west of Iran.

2. Materials and methods

The experiment was conducted in 2005 at Research Farm, Faculty of Agriculture, Tehran University, Karaj, Iran (latitude 35° 50´ N, longitude 50° 58´ E, and altitude 132 m). Long term average precipitation was 456 mm and this area is semiarid according to De Martonne classification. The soil texture at the experimental area was clayey with pH 7.64 and EC 1.3 dS m^{-1}.

Design characteristics and cultural practices. The experiment was conducted as a factorial arrangement of a randomized complete block design with four replications. Three sowing dates (3, 13 and 23 of March) were applied. Four plant densities (50, 100, 150 and 200 plants m^{-2}) were applied. Row spacing was 0.3 m and plot length was 2.1 m, plot wideness 2.1 m and plot area 4.41 m^2 .The distances between plots and between blocks was 1m and 2 m respectively. According to meteorological statistics of the area, there was no danger of chilling at this time. Experiment was conducted as dry farming. Khorasan cultivar was used. Seeding depth was 0.5 cm. Before sowing, the soil was leveled then 100 kg ha^{-1} of diamonium phosphate (DAP) fertilizer was applied. Seeding was done by hand. At 3-4 leaf stage, the seedlings were thinned with expected densities. Weeds were removed with hands. Seven insecticide was applied for the control of ants.

Plant determinations and statistical analysis. In order to determine the yield and other characters under varying plant densities and sowing dates, a number of plant samples were taken by 1 m2 quadrate (Latond, 1994). Up to 50 cm, primer and edge lines were discarded and four planting rows were harvested. All plots were evaluated on 1 m2 area. In order to measure the seed yield and total dry matter, plants were cut and after drying, dry matter and seed yield were measured. Plants were harvested at physiological maturity stage when plants yellowed. Six plants randomly were selected in each plot to measure the number of umbrella per plant and plant height. Three umbrellas in each plant (from six selected plants as mentioned above) were selected and the number of seed was calculated. Harvest index was computed as the ratio of the seed yield to aboveground dry matter at harvest. Analysis of variance (ANOVA) was used to determine significant differences. The Multiple Range Test of Duncan performed the separation of means when the *F*-test revealed the error probability to justify the difference minor. Correlation coefficients were calculated for the relationship between seed yield and several crop parameters. All statistics were performed with the program MSTATC (version 2.10) and SPSS (version 10.0).

3. Results and discussion

Seed yield. The effect of sowing date, plant density and their interaction on seed yield were significant (Table I). At the first sowing date, plants with density of 200 plants m^{-2} had the highest seed yield. However, their yield did not have significant difference compared with 150 plants m-^{2}. Under the second sowing date (D2), studied plant densities except plant densities of 150 and 200 plants m-2 did not have significant difference. Under the third sowing date (D3), plant density of 150 plants m^{-2} resulted in higher seed yield; however it did not have significant difference from plant density of 200 plants m-2. Plant densities of 50 and 100 plants m-2 had a yield reduction of 58% and 42% respectively compared with 150 plants m^{-2} (Table II). Plant density of 200 plants m^{-2} under D1 and D2 resulted in higher seed yields however this plant density did not have significant difference from 150 plants m^{-2} under D1 and 50 and 100 plants m^{-2} under D2 . Under D3, plant densities of 150 to 200 plants m-2 had the highest seed yields. El-Gengai and Abdallah (1978) and Bianco et al. (1994) reported significant effect of sowing date and plant density on seed yield of fennel (*Foeniculum vulgare* Mill.). Results obtained from the study were comparable with Ehteramian (2003) findings, but contrary to those of Damato et al. (1994). There was a positive correlation between seed yield and aboveground biomass (r=0.91**). Early sowing dates resulted in higher seed yields that can be explained by higher aboveground biomass, the number of umbrella per plant, the number of seed per umbrella and plant height (Table II). In view of the sensitivity of Black Cumin to climatic factors especially to photoperiod and temperature, it is essential that sowing should be done on time so that there is enough time for vegetative growth. Delayed sowing results in reduced vegetative growth leading to reduced number of umbrella per plant and plant height (Okut,2001, Rahimian Mashhadi,1991 and Sharratt & Gesch,2004). Under optimum plant density, plants show efficient use of available water, light and nutrient while under high plant density, there is competition among plants.

Table 1. Analysis of variance results (Mean of Square) for different traits of Black Cumin under varying sowing dates and plant densities.

Trait	sowing date	plant density	plant density * sowing date
Seed yield	429.165**	216.894**	153.101**
Aboveground biomass	4172.934**	1839.311**	611.679**
Number of umbrella per plant	109.841*	47.079	36.385
Number of seed per umbrella	3.468**	2.643**	2.576**
1000-seed weight	00.201	0.082	0.046
Harvest index	0.156	0.051	0.065
Plant height	20.976**	0.504	4.726*

* Significant at the 0.05 level; ** Significant at the 0.01 level.

Aboveground biomass. The effect of sowing date, plant density and their interaction were significant for aboveground biomass (Table I). The aboveground biomass showed an increasing trend, with increases in plant density under the first sowing date (D1), plant density of 200 plants m^{-2} had the highest aboveground biomass (Table II). There was strongly correlation (r=0.91**) between seed yield and aboveground biomass, but a negative one (r= -0.68*) between aboveground biomass and harvest index. The effect of sowing date and plant density interaction on aboveground biomass was like seed yield.

Yield components. The effect of plant density on the number of umbrella per plant was not significant (Table I), which might be due to compensatory capacity of the other yield components such as the number of seed per umbrella. With changing plant density, each plant changes the number of seed per umbrella that results in fixed number of umbrella per plant. There was no significant correlation between the number of umbrella per plant and seed yield (r=0.16ns). Ehtramian (2003) reported that correlation between seed yield and the number of umbrella per plant was r=0.22. Bianco et al. (1994) found significant effect of plant density on the number of umbrella per plant. In this research, average number of umbrella per plant was 16.56. Kafi (2003) reported that the number of umbrella per plant under varying plant densities was from 18.9 to 31.3. The results in the present study were lower than those of Tuncturk and Tuncturk (2006), Arslan and Bayrak (1987) and Okut (2001). These differences were due to probably variations in environmental conditions, genotype and soil properties. Sowing date had the significant effect on the number of umbrella per plant (Table I) that related to high sensitivity of this yield component to photoperiod and temperature, which conforms to the finding of Rahimi (1993). The highest number of umbrella per plant was achieved under the first sowing date (give actual sowing dates). Three sowing dates (3, 13 and 23 of March). Plants under second (13, March) and third (23, March) sowing dates had 25 and 18% lower umbrella number compared with the first sowing date (3, March) (Figure 1).

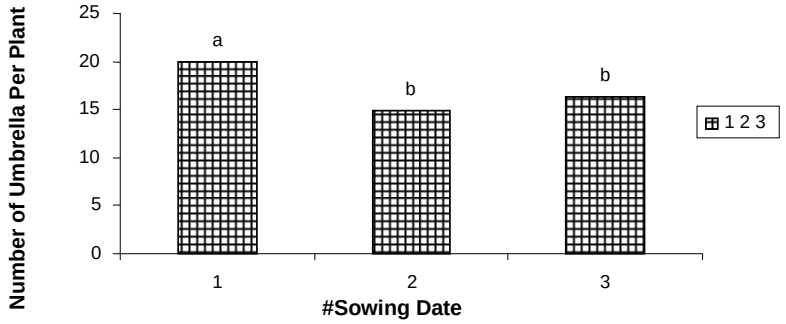

Figure 1.Mean comparisons for the number of umbrella per plant under different sowing dates Means followed by the same letter are not significantly different at *P*=0.05 (*) or *P*=0.01(**) according to Duncan Multiple Range Test (#sowing dates of 1, 2, and 3 are 3, 13 and 23 of March respectively)

The effect of sowing date and plant density and their interaction on the number of seed per umbrella was statistically (Table I). The number of seed per umbrella showed a decreasing trend, with decreases in plant densities and the plant density of 50 plants m^{-2} had the highest number of seed per umbrella and the plant densities of 100 and 150 plants m^{-2} had no significant difference for the number of seed per umbrella (Table II). Because seed set depend on providing the sufficient nutrients and environmental conditions while shift from vegetative to reproductive stage, increased plant densities result in limited availability of nutrients, light and water so the number of reproductive units decrease; at last seed number reproduction decreases. Kafi (2003) found that the number of seed per umbrella under different plant densities (40, 80 and 200 plants m-2) decreased. Our results were comparable to the finding of Kafi (2003), who noted no correlation between the number of seed per umbrella and seed yield (r=-0.006). Ehteramian (2003) reported that correlation between seed yield and the number of seed per umbrella was (r=0.75). The first sowing

date (D1) except under plant densities of 50 and 200 plants m^{-2} had the highest number of seed per umbrella in relation to D2 and D3. It is due to sensitivity of the number of seed per umbrella to photoperiod and temperature (Table II). Environmental conditions during pollination at the first stage of seed set, determine the number of seed per umbrella (16 quote properly). The effect of sowing date and plant density on 1000-seed weight was not significant (Table I), which seemed to be more dependent on genetic than environmental factors (18 quote properly). These data were in contrast results of Barros et al. (2004) and Tuncturk and Tuncturk (2006). Data indicated no correlation between seed yield and 1000-seed weight (r=0.429), but a negative one between 1000- seed weight and plant height (r=-0.677*). In this study, 1000-seed weight was 2-3 g, which was lower than that reported by Arslan and Bayrak (1987), Okut (2001) and Tuncturk and Tuncturk (2006), but similar to that of Kafi (2003).

Table 2. Mean comparisons for different traits of Black Cumin under varying sowing dates and plant densities.

	Seed yield (g m^{-2}) **			Plant height (cm)*			Aboveground biomass (g m^{-2}) **			number of seed per umbrella**		
Plant density	Sowing date[#]			Sowing date			Sowing date[#]			Sowing date		
	1	2	3	1	2	3	1	2	3	1	2	3
50	24.96 cd	27.63abc	11.47e	12.62bc	12.99 abs	12.27bc	61.95bc	67.00bc	21.9e	6.930ab	7.475a	6.740abc
100	21.46 cde	25.61 bcd	16.07de	13.46 abc	12.27 bc	12.36bc	63.75bc	47.81cd	25.71de	6.922ab	5.675cde	5.355e
150	27.73 abc	19.52cde	27.58abc	14.19ab	13.4abc	11.59cd	62.55bc	56.17bc	60.78bc	7.280a	5.185e	5.995bcde
200	36.64 a	35.36ab	18.53cde	15.01a	12.95abc	9.97d	93.7a	78.55ab	49.04cd	6.485abcd	5.570de	7.415a

Means followed by the same letter are not significantly different at P=0.05 (*) or P=0.01(**) according to Duncan Multiple Range Test. [#]Sowing dates of 1, 2, 3 are 3, 13 and 23 of March respectively.

Harvest index and plant height. The effect of sowing date and plant density on harvest index was not significant (Table I), which is due to that with changed plant density or sowing date. Changes in reproductive and vegetative parts had the same rate, as with changing the plant density or sowing date. The decrease or increase in aboveground biomass of single plant was consistent with changes in seed yield per plant (Table II). Ball et al. (2000), Behera et al. (2004) and Kafi (2003) also reported the same result. There was no correlation between harvest index and seed yield, but that of harvest index with aboveground biomass was negative (r=-0.608). The average harvest index of this study was 0.45 that was different from that reported by Ehteramian (2003). The effect of sowing date, plant density and their interaction on plant height were significant (Table I). Delayed sowing decreased plant height (Table II). The first sowing date (D1 give actual date) except under plant density of 50 and 100 plants m^{-2} resulted in higher plant height than third sowing date (D3 give actual date). It may be explained by a higher dry matter accumulation and vegetative growth due to early sowing, while delayed sowing reduced plant height due to high sensitivity to photoperiod and temperature. Under early sowing date, plant densities of 50, 100 and 150 plants m-2 had a plant height reduction of 16, 10 and 5% compared with plant density of 200 plants m-2. Such an increase in plant height with increased plant density may be explained by increasing activity of stem growth hormone due to light deficiency (10 quote properly). El-Gengai and Abdallah (1978) and Bianco et al. (1994) found that sowing date and plant density had significant effect on plant height of fennel. There was no correlation between seed yield and plant height (r=0.455), while Correlation of plant height and 1000-seed weight was negative (r=-0.677*).

4. Conclusion

Black Cumin is sensitive to plant density and sowing date. Early sowing in dry land Black Cumin was critical to increased seed yield possibly due to higher aboveground biomass, the number of umbrella per plant and plant height. Lower densities do not produce sufficient of seed per unit of area. However, the relatively small absolute differences in seed yield between some plant densities demonstrate the remarkable compensation capacity of Black Cumin between the different yield components.

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References

Ahmed, N.U. and Haque K.R., 1986. Effect of row spacing and time of sowing on the yield of black cumin (*Cuminum carvi* L.). Bangladesh. J. Agric., 1: 21-4

Aminpour, R., and Karimi M., 1995. Effect of irrigation number on water potential, yield and yield components of cumin (*Cuminum cyminum*). Master of Science Thesis of Agronomy, Isf. Univ. Technol., Isfahan, Iran.

Andrade, F.H. 1995.Analasis of growth and yield of maize, soybean grown at Balcare, Argentina. Field Crop Res. 41**:** 1-12

Arslan, N. and Bayrak A.. 1987. Effects on yield and some yield components of cumin (*Cuminum cyminum* L.) of different sowing times. *Doğa Tu Agr.And For. Jour*. 11, 2, Ankara, Turkey

Ball, R.A., Purcell L.C., and. Vories E.D. 2000. Short-season soybean production and yield compensation in response to plant population and water regime. Crop Sci. 40**:**1070–1078

Barros, J.F.C., Del Carvalho M. and Basch G.. 2004. Response of sunflower (*Helianthus annus* L.) to sowing date and plant density under Mediterranean conditions. Europ. J.Agronomy. 21**:**347-356

Behera, S., Nagarajan S. and Rao L.J.M.. 2004. Microwave heating and conventional roasting of cumin Seeds (*Cuminum cyminum* L.) and effect on chemical composition of volatiles. Food Chemistry. 87(1): 25-29

Bianco, V.V., Damato G. and Gridi A.. 1994. Sowing date, plant density and crowing cutting on yield and quality of Florence fennel seed. International Symposium on Agrotechnics and Storage of Vegetative and Ornamental Seeds. Bari, Italy

Brummell D. A. and Hall J. L.. 1980. The role of the epidermis in auxin-induced and fusicoccin-induced elongation of Pisum sativum stem segments. *Planta*.150 (5):371-379

Cirilo, A.G., and F.H. Andrade. 1994. Sowing date and maize productivity. II. Kernel number determination. Crop Sci. 34: 1044-1046

Damato, G.,.Biaco V.A and Laterza M.. 1994. First result of plant density and nitrogen rate on yield and quality of Florence fennel (*Foeniculum vulgare* Mill. var. *azotericum* Thell.) seeds. International Symposium on Agrotechnics and Storage of Vegetative and Ornamental Seeds. Bari, Italy. July

Ehteramian, K. 2003. The effects of different levels of nitrogen fertilizer and plant dating on Black Cumin (*Cuminum carvi* L.) in Kooshkak region in the Fars province. Master of Science Thesis of arid area management. Shiraz Univ., Shiraz., Iran

El-Gengai, S and Abdallah N.., 1978. The effect of date of sowing and plant spacing on yield of seed and volatile oil of fennel (*Foeniculum vulgare* Mill.). Pharmazie.9: 605- 6.

Kafi, M. 1990. Study on weed control number, row spacing and plant density on growth and yield of cumin (*Cuminum cyminum* L.). Master of Science Thesis of Agronomy, Ferdowsi Univ. Mashhad., Mashhad, Iran

Kafi, M. 2003. Black Cumin- Production and Processing. Ferdowsi Univ. Mashhad Publication. Mashhad, Iran. 195pp

Karam, F., Breidy J., Stephan C. and Rouphael J.. 2003. Evapotranspiration, yield and water use efficiency of drip irrigated corn in the Beka Valley of Lebanon. Agric. Water Manage. 63**:** 125-137.

Latond, G.P. 1994. Effect of row spacing, seeding rate and nitrogen on yield of barley and wheat under zero-till management. Can.J.Plant Sci. 74:703-711

Mollafiani, A.A. 1992. Effect of sowing date and row spacing on yield of cumin under dry land and rainfed farming. Iranian Research Organization for Science and Technology. Khorasan Reseach Center. Khorasan, Iran

Okut, N., 2001. Effects of different nitrogen doses and row spaces on the yield and quality components of Black Cumin (*Cuminum carvi* L.).PhD Thesis. Yüzüncü Yıl Univ. Van, Turkey

Rahimi, M. 1993. Study on possibility of chemical weed control of cumin. Iranian Research Organization for Science and Technology. Khorasan Reseach Center. Khorasan., Iran

Rahimian Mashhadi, H. 1991. Effect of sowing date and irrigation regime on growth and yield of Black Cumin. Iranian Research Organization for Science and Technology. Khorasan Reseach Center. Khorasan., Iran

Sharratt, B.S., and Gesch R. W.. 2004. Water Use and Root Length Density of *Cuphea* spp. Influenced by Row Spacing and Sowing Date. Agron. J. 96:1475-1480

Simon, J.E., Chadwick A.F. and Crack L.E., 1984. Herbs: An Indexed Bibliography. 1971- 1980. The scientific literature on selected herbs, and aromatic and medicinal plants of the temperate zone. Arcon Book press, Hamden CT, 770 PP

Tuncturk, R., and Tuncturk M.. 2006. Effects of Different Phosphorus Levels on the Yield and Quality Components of Cumin (*Cuminum cyminum* L.). Res. J. Agric. & Biol. Sci., 2(6): 336-340

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A study on flora of Çakmak Dam and its surroundings (Çarşamba, Samsun/Turkey)

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Abstract

This research was carried out from 2007 to 2009 in order to determine the flora of the Çakmak Dam (Çarşamba-Samsun) and its surroundings. In the area, 311 taxa belonging to 214 genera and 70 families were determined (214 species, 61 subspecies and 36 varieties). The families with the most taxa in the research area are Asteraceae with 31 taxa (9.96 %), Leguminosae with 29 taxa (9.32 %) and Gramineae with 28 taxa (9.00 %). Genera represented by the highest number of species are *Trifolium* L. (7 taxa), *Salvia* L. (6 taxa), *Vicia* L. (5 taxa) and *Geranium* L. (5 taxa). The distribution rates of taxa into phytogeographical regions are as follows: 25.72 % Euro-Siberian, 9.00 % Mediterranean, 1.28 % Irano-Turanien and 63.98 % pluriregional or of unknown phytogeographic origin. The number of endemic taxa within the study area is 3 (0.96 %).
Key Words*: Flora, Çakmak Dam, Samsun, Turkey*

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Çakmak barajı ve çevresinin florası üzerine bir araştırma (Çarşamba, Samsun/Türkiye)

Özet

Bu araştırma 2007-2009 yılları arasında, Çakmak Barajı (Çarşamba-Samsun) ve çevresinin florasını tespit etmek üzere yapılmıştır. Araştırma alanında, 70 familyaya ait 214 cins ve toplam 311 takson tespit edilmiştir (214 tür, 61 alttür ve 36 varyete). Araştırma alanında en fazla taksona sahip familyalar, 31 takson ile Asteraceae (9.96 %), 29 takson ile Leguminosae (9.32 %) ve 28 takson ile Gramineae (9.00 %)' dir. En çok tür ile temsil edilen cinsler *Trifolium* L. (7 takson), *Salvia* L. (6 takson), *Vicia* L. (5 takson) ve *Geranium* L. (5 takson)'dur. Taksonların fitocoğrafik bölgelere dağılım oranları şu şekildedir: Euro-Siberian 25.72 % , Akdeniz 9.00 % , Irano-Turanien 1.28 % ve coğrafik bölgesi bilinmeyenler veya birden fazla bölgede yayılış gösterenler 63.98 % ' dir. Çalışma alanındaki endemik takson sayısı 3 (0.96 %)' dür.

Anahtar Kelimeler: *Flora, Çakmak Barajı, Samsun, Türkiye*

1.Introduction

Dams have been constructed in order to prevent floods, to supply drinking and domestic water to generate energy and for irrigation purposes since the old times. They have a great deal of positive and negative effects on the environment besides their benefits like controlling stream regimes, consequently preventing floods obtaining domestic and irrigation water from the stored water and generating energy. Dams which contribute to the national economy from many aspects like irrigation, drinking water supply, flood control, electricity generation, fishing, tourism are also effective in increasing the living and culture level of the region that they were constructed. Meanwhile, the new environment created by the dam also supports the arrival of different species to the area (Tahmiscioğlu et al., 2007).

This research was carried out to determine the flora of Çakmak Dam and its surroundings in Samsun province. Our research area, the region Çakmak Dam, which have been constructed in 1985-1988, is the source of Samsun's

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drinking water (Anonymous, 1991). After the construction of dam, the vegetation of the area has been extensively destroyed by antropogenic effects and the research area will be flooded, therefore the biological diversity has been affected by this project. For this reason, the population of plants at the research area should be examined scientifically. Some floristic studies were also carried out in localities close to the research area by Kılınç and Özen (1988), Engin and Korkmaz (1991), Kutbay et al. (1995), Kılınç et al. (1998) and Özen and Kılınç (2002), but no regular floristic study has been performed in our research area, the region Çakmak Dam and its existing endemic plants in the region and to evaluate the effectiveness of dam construction on flora and finally to contribute to our knowledge of the flora of Samsun.

The research area is located on the Abdal river, in 30 km. south-eastern of the city of Samsun. According to the grid-square system adopted for the Flora of Turkey (Davis, 1965-1985), the study area is in the A6 square. The study area is bordered in the north by Yukarıağcagüney village, in the south by Gökçeçakmak village, in the west by Çakmak Dam and the east by Kırbıyıklar village (Figure 1). Therefore, the research area is approximately 4 km long. The altitude of the study area varies between 100 and 250 m.

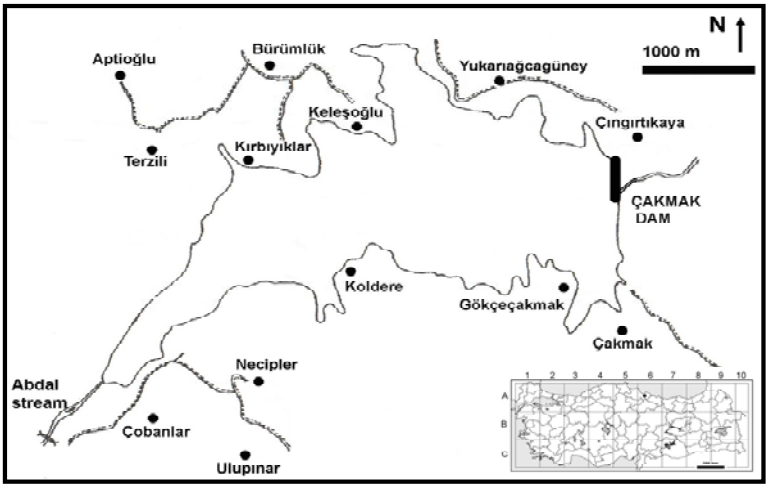

Figure 1. Map of the study area.

The geological structure of the research area mostly contains volcanic rocks belonging to the Neogen period. The most common soil type in the research area is the brown forest soil. Grayish-brown soils, alluvial and colluvial soil groups are also present locally in the riverside (Anonymous, 1991).

We used meteorological data obtained from the nearest meteorological stations Samsun and Çarşamba to determine the climate in the region (Anonymous, 2008). In Samsun and Çarşamba, the average annual temperature is 15.1˚C and 14.6 ˚C, respectively. The average annual precipitation is 702.4 mm in Samsun and 713.7 mm in Çarşamba. The most rainy months of the year are November and the lowest precipitation is found in July and June in Samsun and Çarşamba, respectively. The ombrothermic diagram was prepared using Walter's method (Figure 2 and 3). The rainfall regime of the study area is "autumn-winter-spring-summer" of West Mediterranean precipitation origin (Akman, 1999; Kılınç et al., 2006).

The main vegetation types observed to occur in the research area are forest vegetation, shrub vegetation, hydrophytic and rocky vegetation. Forest vegetation mostly includes *Pinus sylvestris* L., *Pinus nigra* Arn. subsp. *pallasiana* (Lamb.) Holmboe, *Acer campestre* L. subsp. *campestre*, *Fagus orientalis* Lipsky, *Quercus cerris* L. var. *cerris* , *Populus alba* L., *Coryllus avellana* L. var. *avellana*, *Carpinus betulus* L., *Carpinus orientalis* Miller subsp. *orientalis*, *Salix alba* L., *Salix babylonica* L., *Juglans regia* L., *Platanus orientalis* L., *Castanae sativa* Miller, *Robinia pseudoacacia* L., *Ulmus glabra* Hudson and *Morus alba* L. Furthermore, there exist also some plants in the shrub vegetation such as *Rubus canescens* DC var. *canescens*, *Juniperus oxycedrus* L. subsp. *oxycedrus*, *Rhododendron luteum* Sweet, *Spartium junceum* L., *Ilex aquifolium* L. and *Ligustrum vulgare* L. Hydrophytic vegetation is widespread along the riverside and Çakmak Dam. This vegetation includes *Equisetum ramosissimum* Desf., *Pteridium aquilinum* (L.) Kulm., *Asplenium adiantum-nigrum* L., *Cardamine bulbifera* (L.) Crantz, *Epilobium hirsutum* L., *Sonchus oleraceus* L., *Veronica anagallis-aquatica* L. subsp. *anagallis-aquatica*, *Mentha longifolia* (L.) Hudson subsp. *longifolia*, *Typha latifolia* L., *Typha angustifolia* L., *Juncus inflexus* L., *Cyperus longus* L. and *Carex divisa* Hudson. *Minuartia micrantha* Schischk., *Lotus corniculatus* L. var. *corniculatus*, *Sedum pallidum* Bieb. var. *bithynicum* (Boiss.) Chamberlain, *Crepis foetida* L. subsp. *rhoeadifolia* (Bieb.) Celak and *Origanum vulgare* L. subsp. *vulgare* are commonly occurred on the rocks in the research area.

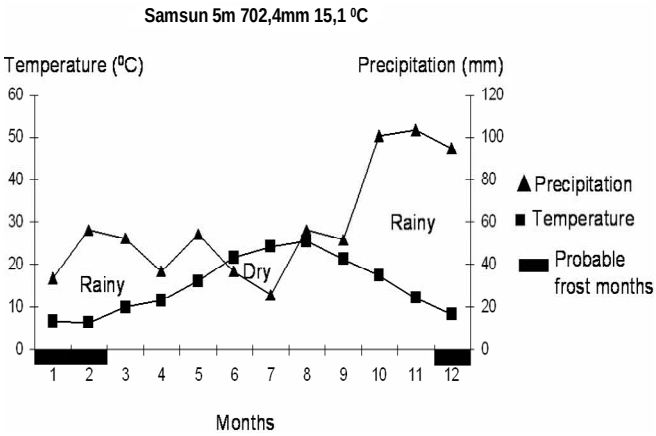

Figure 2. Ombrothermic diagram of Samsun.

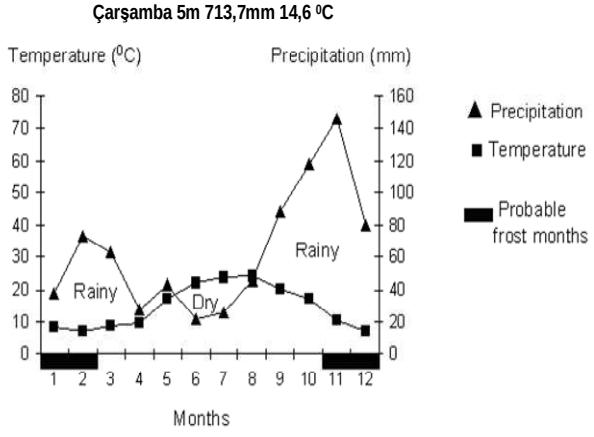

Figure 3. Ombrothermic diagram of Çarşamba.

2. Materials and methods

The materials of this study includes 684 plant specimens collected from the Çakmak Dam and its surrounding, in order to determine the floristic structure of the study area in 2007-2009. The research area is situated between 36° 39' 06.99" / 36° 34' 28.24" E longitude and between 41° 07'22.75" / 41° 05' 51.57" N latitude in Samsun province.

The specimens were dried using standard herbarium methods. The majority of the specimens were identified with the help of the *Flora of Turkey and The East Aegean Islands* (Davis 1965-1985; Davis et al., 1988) and the *Flora Europaea* (Tutin et al., 1964-1980). All of the plant specimens are kept in the herbarium of Ondokuz Mayıs University, Biology Department, Samsun (OMUB).

The plant taxa of the Çakmak Dam and its surroundings are listed in the appendix. All the taxa in the floristic list are given according to the order in *Flora of Turkey and The East Aegean Islands* (Davis 1965-1985; Davis et al., 1988). In the list, the following details are given: family and taxon name, authors of the species, locality, habitat, altitude, collection date, collector names, herbarium number. In addition, the phytogeographical region, IUCN (2001) threat categories and endemism rate also given.

The data of this study were compared with those of other studies (Kılınç and Özen; 1988, Engin and Korkmaz, 1991; Kutbay et al., 1995; Kılınç et al., 1998 and Özen and Kılınç, 2002).The authors of species names are given accordin g to Brummitt and Powell (2001).

Abbreviations

The abbrevations used in the text and the appendix are Euxine (Eux.), Euro-Siberian element (Euro-Sib.), Hyrcano-Euxine element (Hyr-Eux.), Mediterranean element (Medit.), Irano-Turanien element (Ir-Tur.), Cosmopolitan (Cosm.), East (E.), Endemic (End.), North (N.), North-east (N.E.), South (S.), South-east (S.E.), Adnan Akçin (A.A.), Tülay Aytaş Akçin (T.A.), Least concern (L.C.).

3. Results

THE FLORISTIC LIST

PTERIDOPHYTA
EQUISETACEAE

Equisetum ramosissimum Desf.
1 km E. of Çakmak Dam, roadsides and slopes, 100 m, 01.05.2007, T.A 056 & A.A., widespread.
E. telmateia Ehrh.
1 km S. of Çakmak Dam, roadsides, 120 m, 05.06.2007, T.A. 141 & A.A.

HYPOLEPIDACEAE
Pteridium aquilinum (L.) Kuhn
2 km N. of Çakmak Dam, slopes, 115 m, 01.05.2007, T.A. 050 & A.A., widespread.

ASPLENIACEAE
Asplenium adiantum-nigrum L.

1 km N.E. of Çakmak Dam, wet meadows, 115 m, 21.08.2008, T.A. 237 & A.A.

POLYPODIACEAE

Polypodium vulgare L. subsp. *vulgare*

2 km N.E. of Çakmak Dam, open places, 120 m, 11.08.2008, T.A. 303 & A.A.

SPERMATOPHYTA

GYMNOSPERMAE

PINACEAE

Pinus sylvestris L.

2 km N. of Çakmak Dam, open forest, 175 m, 11.09.2008, T.A. 304 & A.A.

P. nigra Arn. subsp. *pallasiana* (Lamb.) Holmboe

1 km N.E. of Çakmak Dam, forest, 250 m, 05.06.2007, T.A 065 & A.A.

P. brutia Ten.

2 km N.E. of Çakmak Dam, forest, 185 m, 07.10.2008, T.A. 305 & A.A.

CUPRESSACEAE

Juniperus oxycedrus L. subsp. *oxycedrus*

3 km N. of Çakmak Dam, open forest, 145 m, 05.06.2007, T.A. 157 & A.A.

ANGIOSPERMAE

DICOTYLEDONAE

RANUNCULACEAE

Helleborus orientalis Lam.

Yağbasan village, roadsides and fallow fields, 120 m, 13.04.2007, T.A. 016 & A.A.

Clematis vitalba L.

1 km S.E. of Çakmak Dam, meadows, 140 m, 05.06.2007, T.A. 140 & A.A.

Ranunculus neapolitanus Ten.

Güzelyurt village, 130 m, open hillsides, 13.04.2007, T.A. 029 & A.A.

R. muricatus L.

1 km E. of Çakmak Dam, Esençay side, open places, 120 m, 13.04.2007, T.A 010 & A.A.

R. arvensis L.

E. of Çakmak Dam, open places and fallow fields, 125 m, 10.07.2008, T.A. 157 & A.A., widespread.

PAPAVERACEAE

Papaver rhoeas L.

2 km S. of Çakmak Dam, 125 m, wet meadows, 21.05.2007, T.A. 113 & A.A.

Fumaria officinalis L.

3 km S.E. of Çakmak Dam, roadsides, 130 m, 21.05.2007, T.A. 093 & A.A.

BRASSICACEAE (CRUCIFERAE)

Raphanus raphanistrum L.

Yağbasan village, 120 m, fields and open places, 13.04.2007, T.A. 028 & A.A.

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

1 km S.E. of Çakmak Dam, fallow fields, 135 m, 21.05.2007, T.A. 127 & A.A., widespread.

Capsella bursa-pastoris (L.) Medik.

2 km E. of Çakmak Dam, Esençay near, 110 m, 13.04.2007, T.A. 007 & A.A., Cosm.

Alyssum alyssoides (L.) L.

N.E. of Çakmak Dam, rocky limostene slopes, 21.05.2007, T.A. 146 & A.A.

Nasturtium officinale R.Br.

1 km E. of Çakmak Dam, riverside, 130 m, 21.05.2007, T.A. 058 & A.A., widespread.

Cardamine bulbifera (L.) Crantz

3 km N.E. of Çakmak Dam, riverside, 120 m, 01.05.2007, T.A. 062 & A.A., Euro-Sib.

C. tenera Gmel. apud Meyer

Güzelyurt village, 120 m, fallow fields and open places, 13.04.2007, T.A. 031 & A.A.

Sisymbrium altissimum L.

2 km of E. of Çakmak Dam, roadsides, 120 m, 01.05.2007, T.A. 047 & A.A.

CISTACEAE

Cistus creticus L.

1 km N. of Çakmak Dam, open places and open hillsides, 210 m, 22.06.2007, T.A. 059 & A.A., Medit.

Helianthemum nummularium (L.) Miller subsp. *nummularium*

2 km N.E. of Çakmak Dam, rocky limostene slopes, 135 m, 11.08.2008, T.A. 306 & A.A.

VIOLACEAE

Viola odorata L.

1 km E. of Çakmak Dam, Esençay near, open places, 120 m, 13.04.2007, T.A. 011 & A.A.

V. sieheana Becker

N.E. of Çakmak Dam, Esençay near, 100 m, open places, 13.04.2007, T.A. 015 & A.A.

V. kitaibeliana Roem & Schult

1 km N.E. of Çakmak Dam, rocky place, 125 m, 05.06.2007, T.A. 064 & A.A.

CARYOPHYLLACEAE

Minuartia micrantha Schischk

2 km S. of Çakmak Dam, rocky limostone slopes, 130 m, 21.05.2007, T.A. 099 & A.A.
Stellaria media (L.) Vill. subsp. *media*
1 km E. of Çakmak Dam, Esençay near, open places, 140 m, 13.04.2007, T.A. 014 & A.A.
S. holostea L.
Güzelyurt village, roadside and open hillsides, 130 m, 13.04.2007, T.A. 033 & A.A., Euro-Sib.
Cerastium fontanum Baumg. subsp. *triviale* (Link.) Jalas
Esençay side, open places, 100 m, 13.04.2007, T.A. 005 & A.A.
Dianthus orientalis Adams
S.E. of Çakmak Dam, rocky slopes, 175 m, T.A. 186 & A.A.
Petrorhagia prolifera (L.) Ball & Heywood
2 km N.E. of Çakmak Dam, open hillsides, 135 m, 10.07.2008, T.A. 158 & A.A.
Silene otites (L.) Wibel
S. of Çakmak Dam, open places, 120 m, 05.06.2007, T.A. 143 & A.A.
S. vulgaris (Moench.) Garcke var. *vulgaris*
1 km S.E. of Çakmak Dam, meadows and fallow fields, 230 m, 11.09.2008, T.A. 289 & A.A.
S. dichotoma Ehrh. subsp. *euxina* (Rupr.) Coode & Culten
3 km S.E. of Çakmak Dam, roadsides, 155 m, 11.08.2008, T.A. 307 & A.A., Eux.

S. gallica L.
2 km E. of Çakmak Dam, fallow fields, 120 m, 11.08.2008, T.A. 308 & A.A., Cosm.

POLYGONACEAE

Polygonum persicaria L.
2 km S. of Çakmak Dam, open hillsides, 130 m, 21.08.2008, T.A. 232 & A.A.
P. convolvulus L.
1 km N. of Çakmak Dam, meadows, 130 m, 11.08.2008, T.A. 309 & A.A.
Rumex crispus L.
E. of Çakmak Dam, moist places, 180 m, 01.05.2007, T.A. 052 & A.A.
R. conglomeratus Murray
1 km E. of Çakmak Dam, meadows, 130 m, 10.07.2008, T.A. 171 & A.A.

CHENOPODIACEAE

Chenopodium murale L.
Yağbasan village, fallow fields, 130 m, 13.04.2007, T.A. 022 & A.A., Cosm.
C. album L. subsp. *album* var. *album*
1 km E. of Çakmak Dam, moist places and fallow fields, 120 m, T.A. 250 & A.A.

PHYTOLACCACEAE

Phytolacca americana L.
2 km E. of Çakmak Dam, open hillsides, 130 m, 10.07.2008, T.A. 176 & A.A.

HYPERICACEAE(GUTTIFERAE)

Hypericum androsaemum L.
3 km E. of Çakmak Dam, moist places, 165 m, 10.07.2008, T.A. 167 & A.A.
H. perfoliatum L.
3 km N.E. of Çakmak Dam, slopes, 185 m, 10.07.2008, T.A. 156 & A.A., Med.
H. perforatum L.
2 km S. of Çakmak Dam, rocky slopes, 140 m, 05.06.2007, T.A. 138 & A.A.

MALVACEAE

Malva sylvestris L.
N.E. of Çakmak Dam, open places, 130 m, 22.06.2007, T.A. 123 & A.A.
M. neglecta Wallr.
3 km S.E. of Çakmak Dam, roadsides, 165 m, 11.09.2008, T.A. 284 & A.A.
Lavatera punctata All.
E. of Çakmak Dam, fallow fields, 140 m, 10 07.2008, T.A. 169 & A.A.
Alcea setosa (Boiss.) Alef.
3 km N.E. of Çakmak Dam, meadows, 200 m, 11.09.2008, T.A. 310 & A.A., Med.

LINACEAE

Linum tenuifolium L.
1 km E. of Çakmak Dam, slopes, 130 m, 05.06.2007, T.A. 150 & A.A.

GERANIACEAE

Geranium purpureum Vill.
S.E. of Çakmak Dam, roadsides and open hillsides, 125 m, 01.05.2007, T.A. 055 & A.A.
G. rotundifolium L.
2 km N.E. of Çakmak Dam, rocky places, 150 m, 05.06.2007, T.A. 060 & A.A.
G. molle L. subsp. *molle*
1 km E. of Çakmak Dam, open places, 125 m, 05.06.2007, T.A. 059 & A.A.
G. columbinum L.
E. of Çakmak Dam, roadsides and open hillsides, 145 m, 01.05.2007, T.A. 057 & A.A.
G. asphodeloides Burm. fil. subsp. *asphodeloides*
3 km E. of Çakmak Dam, meadows and slopes, 185 m, 01.05.2007, T.A. 067 & A.A., Euro-Sib.

Erodium cicutarium (L.) L' Herit subsp. *cicutarium*
S.E. of Çakmak Dam, meadows, 130 m, 10.07.2008, T.A. 196 & A.A.
E. acaule (L.) Becherer & Thell.
3 km E. of Çakmak Dam, roadsides, 230 m, 21.08.2008, T.A. 311 & A.A., Med.

ACERACEAE

Acer campestre L. subsp. *campestre*
S. of Çakmak Dam, forest, 250 m, 21.05.2007, T.A. 116 & A.A.

VITACEAE

Vitis sylvestris Gmelin
1 km of N.E. of Çakmak Dam, forest, 120 m, 10.07.2008, T.A. 249 & A.A.

RHAMNACEAE

Frangula alnus Miller subsp. *alnus*
2 km N. of Çakmak Dam, meadows and forest, 185 m, 21.08.2008, T.A. 248 & A.A., Euro-Sib.

AQUIFOLIACEAE (ILICACEAE)

Ilex aquifolium L.
Yağbasan village, meadows, 175 m, 13.04.2007, T.A. 024 & A.A.

ANACARDIACEAE

Pistacia terebinthus L. subsp. *palaestina* (Boiss.) Engler
Northern slopes of Çakmak Dam, rocky places and slopes, 150 m, 11.09.2008, T.A. 312 & A.A., Med.

FABACEAE (LEGUMINOSAE)

Genista tinctoria L.
3 km S.E. of Çakmak Dam, rocky limostene slopes, 175 m, 10.07.2008, T.A. 191 & A.A., Euro-Sib.
Spartium junceum L.
E. of Çakmak Dam, slopes and open hillsides, 230 m, 21.08.2008, T.A. 292 & A.A., Med.
Robinia pseudoacacia L.
E. of çakmak Dam, roadsides, 120 m, 01.05.2007, T.A. 048 & A.A., Cosm.
Galega officinalis L.
1 km E. of Çakmak Dam, moist and open places, 140 m, T.A. 160 & A.A., Euro-Sib.
Psoralea bituminosa L.
1 km S. of Çakmak Dam, roadsides, 110 m, 21.05.2007, T.A. 087 & A.A.
Vicia cracca L. subsp. *cracca*
2 km S.E. of Çakmak Dam, open places, 130 m, 05.06.2007, T.A. 134 & A.A., Euro-Sib.
V. cracca L. subsp. *stenophylla* Vel.
Esençay side, open places, 110 m, 22.06.2007, T.A. 266 & A.A.
V. hybrida L.
N.E. of Çakmak Dam, slopes, 135 m, 10.07.2008, T.A. 343 & A.A.
V. sativa L. subsp. *nigra* (L.) Ehrh. var**.** *nigra*
1 km S.E. of Çakmak Dam, fields, 135 m, 22.06.2007, T.A. 063 & A.A.
V. narborensis L. var. *narborensis*
S.E. of Çakmak Dam, open hillsides, 120 m, 05.06.2007, T.A. 266 & A.A.
Lathyrus aureus (Stev.) Brandza
2 km N.E. of Çakmak Dam, meadows, 130 m, 05.06.2007, T.A. 074 & A.A., Eux.
L. laxiflorus (Desf.) O. Kunte subsp. *laxiflorus*
S. of Çakmak Dam, meadows, 125 m, 21.05.2007, T.A. 106 & A.A.
L. inconspicuus L.
2 km E. of Çakmak Dam, open hillsides, 185 m, 01.05.2007, T.A. 076 & A.A.
Trifolium repens L. var. *repens*
1 km S. of Çakmak Dam, moist places, 130 m, 21.05.2007, T.A. 096 & A.A.
T. fragiferum L. var. *fragiferum*
S. of Çakmak Dam, open places, 130 m, 21.05.2007, T.A. 097 & A.A.
T. resupinatum L. var. *microcephalum*
2 km N.E. of Çakmak Dam, roadsides, 150 m, 22.06.2007, T.A. 265 & A.A.
T. pratense L. var. *pratense*
1 km E. of Çakmak Dam, open places, 130 m, 21.08.2008, T.A. 313 & A.A.
T. canescens Willd.
1 km S. of Çakmak Dam, stream sides and wet places, 120 m, 10.07.2008, T.A. 344 & A.A., Eux.
T. stellatum L. var**.** *stellatum*
N.E. of Çakmak Dam, roadsides, 240 m, 10.07.2008, T.A. 345 & A.A.
T. arvense L. var. *arvense*
2 km N.E. of Çakmak Dam, roadsides, 125 m, 21.08.2008, T.A. 314 & A.A.
Melilotus alba Desr.
S.E. of Çakmak Dam, roadsides, 135 m, 11.09.2008, T.A. 295 & A.A.
Medicago minima (L.) Bart. var. *minima*
1 km S.E. of Çakmak Dam, open places and slopes, 05.06.2007, T.A. 136 & A.A.
M. polymorpha L. var. *polymorpha*
1 km E. of Çakmak Dam, open hillsides, 130 m, 01.05.2007, T.A. 082 & A.A.
Dorycnium pentaphyllum Scop. subsp. *herbaceum* (Vill.) Rouy

1 km S. of Çakmak Dam, roadsides, 135 m, 21.05.2007, T.A. 108 & A.A.
Lotus corniculatus L. var. *corniculatus*
2 km E. of Çakmak Dam, open hillsides and rocky places, 150 m, 01.05.2007, T.A. 081 & A.A., widespread.
Hymenocarpus circinnatus (L.) Savi
1 km E. of Çakmak Dam, open forest, 130 m, 05.06.2007, T.A. 103 & A.A., Med.
Coronilla scorpioides (L.) Koch
E. of Çakmak Dam, slopes and open hillsides, 130 m, T.A. 054 & A.A.
C. orientalis Miller var. *orientalis*
2 km S.E. of Çakmak Dam, roadsides, 130 m, 10.07.2008, T.A. 195 & A.A.
C. varia L. subsp. *varia*
3 km E. of Çakmak Dam, meadows, 200 m, 21.08.2008, T.A. 315 & A.A.

ROSACEAE

Laurocerasus officinalis Roemer
1 km S. of Çakmak Dam, open forest, 135 m, 21.05.2007, T.A. 131 & A.A.
Prunus spinosa L. subsp. *dasyphylla* (Schur) Domin
E. of Çakmak Dam, open places, 130 m, 01.05.2007, T.A. 064 & A.A., Euro-Sib.
Cerasus avium (L.) Moench
2 km S. of Çakmak Dam, open forest, 150 m, 21.05.2007, T.A. 128 & A.A.
Filipendula vulgaris Moench
2 km N.E. of Çakmak Dam, open places, 10.07.2008, T.A. 111 & A.A., Euro-Sib.
Rubus canescens D.C. var. *canescens*
1 km S.E. of Çakmak Dam, meadows, 130 m, 21.08.2008, T.A. 316 & A.A.
Potentilla recta L. (Group B)
1 km N. of Çakmak Dam, roadside, 130 m, 10.07.2008, T.A. 115 & A.A.
P. reptans L.
2 km S. of Çakmak Dam, roadsides, 185 m, 21.05.2007, T.A. 101 & A.A., widespread.
Fragaria vesca L.
1 km E. of Çakmak Dam, moist places and slopes, 125 m, 01.05.2007, T.A. 061 & A.A.
Agrimonia eupatoria L.
2 km of S.E. of Çakmak Dam, river banks, 170 m, 10.07.2008, T.A. 180 & A.A.
Sanguisorba minor Scop. subsp. *muricata* (Spach) Briq.
S. of Çakmak Dam, open places, 150 m, 05.06.2007, T.A. 135 & A.A.
Rosa canina L.
Esençay side, open places and stream sides, 105 m, 01.05.2007, T.A. 037 & A.A.
Mespilus germanica L.
1 km S.E. of Çakmak Dam, open places, 120 m, 10.07.2008, T.A. 170 & A.A., Hyr-Eux.
Crataegus monogyna Jacq. subsp. *monogyna*
Yağbasan village, roadsides, 120 m, 13.04.2007, T.A. 025 & A.A.
Malus sylvestris Miller subsp. *orientalis* (A. Uglitzkich) Browicz var. *orientalis*
2 km S. of Çakmak Dam, forest, 150 m, 21.05.2007, T.A. 130 & A.A.

LYTHRACEAE

Lythrum salicaria L.
2 km E. of Çakmak Dam, meadows, 175 m, 10.07.2008, T.A. 163 & A.A., Euro-Sib.

ONOGRACEAE

Epilobium hirsutum L.
E. of Çakmak Dam, wet places, 125 m, 10.07.2008, T.A. 199 & A.A.
E. montanum L.
1 km N.E. of Çakmak Dam, stream sides, 115 m, 11.09.2008, T.A. 317 & A.A., Euro-Sib.

CRASSULACEAE

Sedum pallidum Bieb. var. *bithynicum* (Boiss.) Chamberlain
1 km S.E. of Çakmak Dam, rocky places, 125 m, 10.07.2008, T.A. 183 & A.A., Eux.

SAXIFRAGACEAE

Saxifraga cymbalaria L. var**.** *cymbalaria*
2 km S.E. of Çakmak Dam, moist places, 135 m, 10.07.2008, T.A. 210 & A.A.

APIACEAE (UMBELLIFERAE)

Eryngium creticum Lam.
2 km N.E. of Çakmak Dam, fallow fields, 230 m, 21.08.2008, T.A. 308 & A.A., Med.
Chaerophyllum byzantinum Boiss.
1 km E. of Çakmak Dam, wet places, 135 m, 07.10.2008, T.A. 319 & A.A., Eux.
Bifora radians Bieb.
1 km S. of Çakmak Dam, roadsides and open places, 200 m, 21.05.2007, T.A. 100 & A.A.
Pimpinella corymbosa Boiss.
E. of Çakmak Dam, slopes and rocky places, 130 m, 21.08.2008, T.A. 229 & A.A., Ir-Tur.
Oenanthe silaifolia Bieb.
2 km E. of Çakmak Dam, wet places, 135 m, 10.07.2008, T.A. 154 & A.A.
Foeniculum vulgare Miller
Saraçlı village, wet places, 230 m, 10.07.2008, T.A. 216 & A.A.

Pastinaca sativa L. subsp. *urens* (Req. ex Godron) Celak
1 km N.E. of Çakmak Dam, meadows, 140 m, 11.09.2008, T.A. 320 & A.A.
Torilis leptophylla (L.) Reichb.
2 km S.E. of Çakmak Dam, wet places, 125 m, 10.07.2008, T.A. 165 & A.A.

ARALIACEAE

Hedera helix L.
Near Yağbasan village, 125 m, 13.04.2007, T.A. 026 & A.A.

CORNACEAE

Cornus mas L.
Esençay side, meadows, 110 m, 01.05.2007, T.A. 038 & A.A.

CAPRIFOLIACEAE

Sambucus ebulus L.
2 km N.E. of Çakmak Dam, roadsides, 250 m, 10.07.2008, T.A. 214 & A.A., Euro-Sib.

DIPSACACEAE

Dipsacus laciniatus L.
2 km S.E. of Çakmak Dam, roadsides, 135 m, 11.09.2008, T.A. 321 & A.A.
Knautia degenii Borbas ex Formanek
1 km E. of Çakmak Dam, roadsides, 125 m, 10.07.2008, T.A. 208 & A.A., End., L.C.
Scabiosa columbaria L. subsp. *columbaria* var. *columbaria*
2 km E. of Çakmak Dam, rocky limostene slopes, 145 m, 11.09.2008, T.A. 297 & A.A.

ASTERACEAE (COMPOSITAE)

Xanthium spinosum L.
2 km N.E. of Çakmak Dam, open hillsides, 150 m, 07.10.2008, T.A. 322 & A.A.
Inula vulgaris (Lam.) Trevisan
1 km E. of Çakmak Dam, rocky place, 120 m, 21.08.2008, T.A. 219 & A.A., Euro-Sib.
I. graveolens (L.) Desf.
N. of Çakmak Dam, stony slopes, 130 m, 21.08.2008, T.A. 220 & A.A., Med.
Filago eriocephala Guss.
3 km E. of Çakmak Dam, open places, 175 m, 21.08.2008, T.A. 251 & A.A., Med.
Solidago virgaurea L. subsp. *virgaurea*
2 km N.E. of Çakmak Dam, open places, 185 m, 21.08.2008, T.A. 208 & A.A., Euro-Sib.
Conyza canadensis (L.) Cronquist
N.E. of Çakmak Dam, river banks, 130 m, 07.10.2008, T.A. 323 & A.A. , Culture.
Bellis perennis L.
Esençay side, wet places, 100 m, 13.04.2007, T.A. 008 & A.A., Euro-Sib.
Senecio aquaticus Hill. subsp. *erraticus* (Bertol) Matthews
N.E. of Çakmak Dam, meadows, 130 m, 21.08.2008, T.A. 228 & A.A., Euro-Sib.
S. vulgaris L.
Near Esençay, open places, 105 m, 13.04.2007, T.A. 012 & A.A.
Tussilago farfara L.
Esençay side, roadsides, 110 m, 13.04.2007, T.A. 020 & A.A., Euro-Sib.
Eupatorium cannabinum L.
1 km N. of Çakmak Dam, stream sides and wet places, 115 m, 21.08.2008, T.A. 224 & A.A., Euro-Sib.
Anthemis tinctoria L. var. *tinctoria*
2 km S. of Çakmak Dam, open places and fields, 120 m, 21.05.2007, T.A. 110 & A.A.
Tanacetum poteriifolium (Ledeb.) Grierson
E. of Çakmak Dam, meadows, 130 m, 10.07.2008, T.A. 162 & A.A., Eux.
T. parthenium (L.) Schultz Bip.
1 km N. E. of Çakmak Dam, moist places, 140 m, 11.09.2008, T.A. 324 & A.A.
Onopordum acanthium L.
E. of Çakmak Dam, roadsides and rocky slopes, 135 m, 11.09.2008, T.A. 299 & A.A.
Cirsium polunii Davis & Parris
2 km N.E. of Çakmak Dam, roadsides, 130 m, 07.10.2008, T.A. 325 & A.A.
C. vulgare (Savi) Ten
S.E. of Çakmak Dam, roadsides, 135 m, 07.10.2008, T.A. 326 & A.A.
Carduus acicularis Bertol.
Esençay side, stony slopes, 110 m, 01.05.2007, T.A. 040 & A.A., Med.
Centaurea iberica Trev ex Sprengel
Near Esençay, open places, 100 m, 01.05.2007, T.A. 041 & A.A., widespread.
Carlina vulgaris L.
N.E. of Çakmak Dam, rocky slopes, 135 m, 21.08.2008, T.A. 235 & A.A.
Scolymus hispanicus L.
1 km N.E. of Çakmak Dam, roadsides, 115 m, 21.08.2008, T.A. 234 & A.A., Med.
Cichorium intybus L.
E. of Çakmak Dam, fallow fields, 175 m, 10.07.2008, T.A. 155 & A.A.
Picris hieracioides L.

N.E. of Çakmak Dam, roadsides, 125 m, 21.08.2008, T.A. 221 & A.A., Euro-Sib.
P. strigosa Bieb. subsp. *macrotricha* H.W. Lack
E. of Çakmak Dam, rocky limostene slopes, 235 m, 01.05.2007, T.A. 079 & A.A., Ir-Tur.
Sonchus asper (L.) Hill. subsp. *glaucescens* (Jordan) Ball.
S. of Çakmak Dam, open places, 135 m, 21.05.2007, T.A. 126 & A.A.
S. oleraceus L.
E. of Çakmak Dam, wet places, 145 m, 01.05.2007, T.A. 072 & A.A.
Lapsana communis L. subsp. *intermedia* (Bieb.) Hayek
1 km E. of Çakmak Dam, wet places, 120 m, 01.05.2007, T.A. 046 & A.A.
Taraxacum scaturiginosum G. Hagl.
1 km N.E. of Çakmak Dam, slopes, 110 m, 01.05.2007, T.A. 050 & A.A.
T. macrolepium Schischkin
Güzelyurt village, roadsides, 200 m, 13.04.2007, T.A. 032 & A.A.
Chondrilla juncea L. var. *juncea*
N. of Çakmak Dam, rocky places, 140 m, 07.10.2008, T.A. 301 & A.A.
Crepis foetida L. subsp. *rhoeadifolia* (Bieb.) Celak
1 km E. of Çakmak Dam, rocky places and slopes, 125 m, 10.07.2008, T.A. 185 & A.A.

CAMPANULACEAE

Campanula latifolia L.
E. of Çakmak Dam, wet places and open forest, 235 m, 21.08.2008, T.A. 281 & A.A., Euro-Sib.
C. rapunculoides L. subsp. *rapunculoides*
2 km E. of Çakmak Dam, moist places, 140 m, 10.07.2008, T.A. 212 & A.A., Euro-Sib.
C. latiloba A. DC. subsp. *latiloba*
E. of Çakmak Dam, open hillsides, 125 m, 10.07.2008, T.A. 175 & A.A., Eux., End., L.C.

ERICACEAE

Rhododendron luteum Sweet
Near Yağbasan village, open forest, 115 m, 13.04.2007, T.A. 023 & A.A., Eux.
Arbutus andrachne L.
1 km N.E. of Çakmak Dam, rocky places and slopes, 140 m, 11.09.2008, T.A. 327 & A.A.

PRIMULACEAE

Primula vulgaris Huds. subsp. *sibthorpii* (Hoffmanns) W.W. Sm & Forrest
Yağbasan village, open places, 120 m, 13.04.2007, T.A. 019 & A.A., Eux.
Cyclamen coum Miller var. *coum*
Near Yağbasan village, slopes, 110 m, 13.04.2007, T.A. 011 & A.A.
Lysimachia vulgaris L.
2 km E. of Çakmak Dam, wet places, 130 m, 10.07.2008, T.A. 174 & A.A.
Anagallis arvensis L. var. *arvensis*
E. of Çakmak Dam, open places and roadsides, 01.05.2007, T.A. 045 & A.A.

OLEACEAE

Fraxinus angustifolia Vahl. subsp. *oxycarpa (*Bieb. ex Willd) Franco & Rocha Afonso
S. of Çakmak Dam, open places and meadows, 13.04.2007, T.A. 129 & A.A., Euro-Sib.
Ligustrum vulgare L.
1 km N.E. of Çakmak Dam, meadows, 130 m, 21.08.2008, T.A. 241 & A.A., Euro-Sib.
Phillyrea latifolia L.
N. of Çakmak Dam, slopes and meadows, 230 m, 21.05.2007, T.A. 073 & A.A., Med.

APOCYNACEAE

Vinca major L. subsp**.** *hirsuta* (Boiss.) Stearn
Near Esençay, meadows, 120 m, 13.04.2007, T.A. 006 & A.A., Eux.

GENTIANACEAE

Blackstonia perfoliata (L.) Hudson subsp. *perfoliata*
1 km E. of Çakmak Dam, roadsides, 130 m, 10.07.2008, T.A. 194 & A.A.
Centaurium pulchellum (Swartz) Druce
E. of Çakmak Dam, slopes, 130 m, 10.07.2008, T.A. 187 & A.A.

CONVOLVULACEAE

Convolvulus arvensis L.
S. of Çakmak Dam, roadsides, 135 m, 05.06.2007, T.A. 137 & A.A.
Calystegia silvatica (Kit.) Griseb.
S. of Çakmak Dam, meadows, 125 m, 21.05.2007, T.A. 091 & A.A.

BORAGINACEAE

Myosotis ramosissima Rochel ex Schultes subsp. *ramosissima*
E. of Çakmak Dam, roadsides, 135 m, 01.05.2007, T.A. 103 & A.A.
M. arvensis (L.) Hill. subsp. *arvensis*
S.E. of Çakmak Dam, open places, 125 m, 10.07.2008, T.A. 136 & A.A., Euro-Sib.
Cynoglossum officinale L.
Near Esençay, open places, 115 m, 01.05.2007, T.A. 036 & A.A., Euro-Sib.
C. creticum Miller
E. of Çakmak Dam, roadsides, 150 m, 01.05.2007, T.A. 086 & A.A.

Echium italicum L.
N.E. of Çakmak Dam, fallow fields, 135 m, 10.07.2008, T.A. 161 & A.A., Med.
E. vulgare L.
N.E. of Çakmak Dam, roadsides, 230 m, 21.08.2008, T.A. 328 & A.A.
Trachystemon orientalis (L.) G.Don
Esençay side, open forest, 130 m, 13.04.2007, T.A. 018 & A.A., Eux.
Anchusa azurea Miller var. *azurea*
E. of Çakmak Dam, fallow fields, 125 m, 22.06.2007, T.A. 140 & A.A.

SOLANACEAE

Solanum nigrum L.
1 km E. of Çakmak Dam, roadsides and open places, 125 m, 21.08.2008, T.A. 230 & A.A., Cosm.
S. dulcamara L.
E. of Çakmak Dam, slopes and open hillsides, 125 m, 10.07.2008, T.A. 201 & A.A., Euro-Sib.
Physalis alkekengi L.
E. of Çakmak Dam, meadows and roadsides, 135 m, 21.08.2008, T.A. 227 & A.A.
Datura stramonium L.
Güzelyurt village, roadsides, 125 m, 11.09.2008, T.A. 258 & A.A., Cosm.
Hyoscyamus niger L.
E. of Çakmak Dam, open places and rocky slopes, 145 m, 11.09.2008, T.A. 274 & A.A., widespread.

SCROPHULARIACEAE

Verbascum spectabile Bieb. var. *spectabile*
E. of Çakmak Dam, wet places, 130 m, 05.06.2007, T.A. 188 & A.A.
V. speciosum Schrader
1 km N.E. of Çakmak Dam, slopes, 140 m, 21.08.2008, T.A. 346 & A.A.
Scrophularia scopolii [Hoppe ex] Pers var. *scopolii*
Yağbasan village, roadsides, 110 m, 13.04.2007, T.A. 030 & A.A., widespread.
Antirrhinum majus L. subsp. *majus*
N.E. of Çakmak Dam, roadsides, 130 m, 05.06.2008, T.A. 142 & A.A.
Veronica polita Fries
Near Esençay, open places, 115 m, 13.04.2007, T.A. 009 & A.A.
V. persica Poiret
1 km S. of Çakmak Dam, roadsides, 125 m, 13.04.2007, T.A. 116 & A.A.
V. anagallis-aquatica L. subsp. *anagallis-aquatica*
N. of Çakmak Dam, moist places, 170 m, 21.05.2007, T.A. 119 & A.A., Cosm.
V. chamaedrys L.
Near Esençay, open places, 110 m, 01.05.2007, T.A. 118 & A.A., Euro-Sib.
Parentucellia latifolia (L.) Caruel subsp. *latifolia*
S.E. of Çakmak Dam, wet places, 140 m, 01.05.2007, T.A. 053 & A.A., Med.

OROBANCHACEAE

Orobanche ramosa L.
S. of Çakmak Dam, roadsides, 125 m, 21.05.2007, T.A. 094 & A.A.
O. minor Sm.
2 km E. of Çakmak Dam, roadsides, 130 m, 01.05.2007, T.A. 083 & A.A.

VERBENACEAE

Verbena officinalis L.
N.E. of Çakmak Dam, meadows, 150 m, 11.09.2008, T.A. 329 & A.A., widespread.

LAMIACEAE (LABIATAE)

Teucrium chamaedrys L. subsp. *chamaedrys*
E. of Çakmak Dam, slopes and open hillsides, 130 m, 10.07.2008, T.A. 207 & A.A., Euro-Sib.
T. polium L.
N.E. of Çakmak Dam, open hillsides, 135 m, 11.09.2008, T.A. 330 & A.A.
Lamium purpureum L. var. *purpureum*
Yağbasan village, roadsides, 185 m, 13.04.2007, T.A. 027 & A.A., Euro-Sib.
L. album L.
Near Güzelyurt village, open places, 125 m, 21.05.2007, T.A. 119 & A.A., Euro-Sib.
Stachys balansae Boiss & Kotschy subsp. *balansae*
S. of Çakmak Dam, wet places, 160 m, 21.05.2007, T.A. 107 & A.A.
S. byzantina C. Koch
N.E. of Çakmak Dam, rocky places, 145 m, 11.09.2008, T.A. 277 & A.A., Euro-Sib.
S. sylvatica L.
S. of Çakmak Dam, wet places, 135 m, 21.05.2007, T.A. 095 & A.A., Euro-Sib.
S. annua (L.) L. subsp. *annua* var. *annua*
E. of Çakmak Dam, open places and moist places, 115 m, 01.05.2007, T.A. 051 & A.A., widespread.
Glechoma hederacea L.
Esençay side, open places, 100 m, 13.04.2007, T.A. 004 & A.A., Euro-Sib.
Prunella vulgaris L.
S. of Çakmak Dam, open places, 110 m, 21.05.2007, T.A. 092 & A.A., Euro-Sib.

P. laciniota (L.) L.
N.E. of Çakmak Dam, open places, 125 m, 10.07.2008, T.A. 132 & A.A., Euro-Sib.
Origanum vulgare L. subsp. *vulgare*
S.E. of Çakmak Dam, rocky slopes, 200 m, 10.07.2008, T.A. 208 & A.A., Euro-Sib.
Satureja hortensis L.
1 km S.E. of Çakmak Dam, roadsides, 125 m, 07.10.2008, T.A. 331 & A.A.
Calamintha nepeta (L.) Savi subsp. *glandulosa* (Req.) P.W. Ball
N. of Çakmak Dam, fallow fields, 230 m, 07.10.2008, T.A. 302 & A.A.
Clinopodium vulgare L. subsp. *vulgare*
N.E. of Çakmak Dam, rocky places, 125 m, 21.08.2008, T.A. 238 & A.A.
Thymus sipyleus Boiss. subsp. *rosulans*
2 km N. of Çakmak Dam, rocky slopes, 250 m, 21.08.2008, T.A. 215 & A.A.
Mentha pulegium L.
N.E. of Çakmak Dam, wet places, 120 m, 21.08.2008, T.A. 225 & A.A.
M. longifolia (L.) Hudson subsp**.** *longifolia*
S.E. of Çakmak Dam, stream sides, 130 m, 10.07.2008, T.A. 202 & A.A.
Salvia tomentosa Miller
1 km E. of Çakmak Dam, rocky limostene slopes, 135 m, 11.09.2008, T.A. 332 & A.A., Med.
S. viridis L.
Güzelyurt village, roadsides, 140 m, 10.07.2008, T.A. 282 & A.A., Med.
S. forskahlei L.
E. of Çakmak Dam, meadows, 125 m, 01.05.2007, T.A. 085 & A.A., Eux.
S. glutinosa L.
1 km E. of Çakmak Dam, slopes, 145 m, 10.07.2008, T.A. 173 & A.A., Hyr-Eux.
S. verbenaca L.
E. of Çakmak Dam, roadsides, 185 m, 10.07.2008, T.A. 287 & A.A., Med.
S. verticillata L. subsp. *verticillata*
2 km E. of Çakmak Dam, roadsides and open hillsides, 120 m, 10.07.2008, Euro-Sib.

PLANTAGINACEAE

Plantago major L. subsp. *major*
N. of Çakmak Dam, wet places, 120 m, 21.08.2008, T.A. 246 & A.A.
P. lanceolata L.
S. of Çakmak Dam, roadsides, 120 m, 21.05.2007, T.A. 088 & A.A.

THYMELAEACEAE

Daphne pontica L.
N. of Çakmak Dam, forest, 150 m, 10.07.2008, T.A. 174 & A.A., Eux.

EUPHORBIACEAE

Mercurialis annua L.
1 km N.E. of Çakmak Dam, open forest, 140 m, 13.04.2007, T.A. 073 & A.A.
Euphorbia orientalis L.
E. of Çakmak Dam, fallow fields and roadsides, 125 m, 10.07.2008, T.A. 168 & A.A., Ir-Tur.
E. stricta L.
Near Esençay, open places, 110 m, 13.04.2007, T.A. 002 & A.A., Euro-Sib.
E. helioscopia L.
Esençay side, open places, 120 m, 13.04.2007, T.A. 001 & A.A.
E. rigida Bieb.
Güzelyurt village, roadsides, 125 m, 13.04.2007, T.A. 034 & A.A., Med.

URTICACEAE

Urtica dioica L.
E. of Çakmak Dam, moist places, 115 m, 01.05.2007, T.A. 069 & A.A., Euro-Sib.

MORACEAE

Morus alba L.
1 km E. of Çakmak Dam, roadsides, 125 m, 05.06.2007, T.A. 145 & A.A., Culture.
Ficus carica L. subsp. *carica*
S. of Çakmak Dam, fields, 200 m, 21.05.2007, T.A. 127 & A.A., Widespread.

ULMACEAE

Ulmus glabra Hudson
N.E. of Çakmak Dam, forest, 145 m, 21.05.2007, T.A. 112 & A.A., Euro-Sib.

JUGLANDACEAE

Juglans regia L.
1 km S.E. of Çakmak Dam, open forest, 250 m, 10.07.2008, T.A. 196 & A.A.

PLATANACEAE

Platanus orientalis L.
S. of Çakmak Dam, forest, 185 m, 21.05.2007, T.A. 211 & A.A.

FAGACEAE

Fagus orientalis Lipsky.
S. of Çakmak Dam, forest, 150 m, 21.05.2007, T.A. 120 & A.A.

Castanea sativa Miller
S.E. of Çakmak Dam, forest, 230 m, 22.06.2007, T.A. 117 & A.A.
Quercus infectoria Olivier subsp**.** *infectoria*
N.E. of Çakmak Dam, forest, 185 m, 11.09.2008, T.A. 333 & A.A., Euro-Sib.
Q. cerris L. var. *cerris*
S. of Çakmak Dam, forest, 145 m, 21.05.2007, T.A. 124 & A.A., Med.

CORYLACEAE

Carpinus betulus L.
S. of Çakmak Dam, forest, 150 m, 21.05.2007, T.A. 114 & A.A., Euro-Sib.
C. orientalis Miller subsp. *orientalis*
N.E. of Çakmak Dam, forest, 140 m, 11.09.2008, T.A. 298 & A.A.
Corylus avellana L. var. *avellana*
N.E. of Çakmak Dam, roadsides, 135 m, 10.07.2008, T.A. 206 & A.A., Euro-Sib.
C. maxima Miller
S. of Çakmak Dam, fields, 150 m, 01.05.2007, T.A. 125 & A.A., Euro-Sib., Culture.

SALICACEAE

Salix alba L.
E. of Çakmak Dam, forest, 125 m, 22.06.2007, T.A. 148 & A.A., Euro-Sib.
S. babylonica L.
S. of Çakmak Dam, forest, 155 m, 01.05.2007, T.A. 121 & A.A., Culture.
Populus alba L.
S.E. of Çakmak Dam, forest, 140 m, 01.05.2007, T.A. 133 & A.A., Euro-Sib.
P. nigra L. subsp. *nigra*
N.E. of Çakmak Dam, stream sides, 185 m, 21.05.2007, T.A. 105 & A.A.

RUBIACEAE

Asperula involucrata Wahlenb.
S.E. of Çakmak Dam, open places, 135 m, 10.07.2008, T.A. 159 & A.A., Eux.
A. orientalis Boiss & Hohen.
S. of Çakmak Dam, roadsides and slopes, 120 m, 21.05.2007, T.A. 090 & A.A., Ir-Tur.
A. arvensis L.
E. of Çakmak Dam, open places, 115 m, 01.05.2007, T.A. 077 & A.A., Med.
Galium rotundifolium L.
Güzelyurt village, open forest, 135 m, 22.06.2007, T.A. 148 & A.A., Euro-Sib.
G. verum L. subsp. *verum*
S.E. of Çakmak Dam, rocky places, 130 m, 10.07.2008, T.A. 203 & A.A., Euro-Sib.
G. paschale Forsskal.
S.E. of Çakmak Dam, meadows, 145 m, 21.08.2008, T.A. 334 & A.A., Med.

GYMNOSPERMAE

MONOCOTYLEDONAE

ALISMATACEAE

Alisma plantago-aquatica L.
1 km E. of Çakmak Dam, river banks, 135 m, 11.09.2008, T.A. 335 & A.A., Euro-Sib.

ARACEAE

Arum euxinum R. Mill.
N.E. of Çakmak Dam, open forest, 140 m, 22.06.2007, T.A. 213 & A.A., Eux., End., L.C.

LILIACEAE

Smilax excelsa L.
N. of Çakmak Dam, meadows, 130 m, 21.05.2007, T.A. 085 & A.A., Eux.
Ruscus aculeatus L. var. *aculeatus*
E. of Çakmak Dam, meadows, 130 m, 11.09.2008, T.A. 264 & A.A..
Allium scorodoprasum L. subsp. *jajlae*
N.E. of Çakmak Dam, fallow fields, 150 m, 05.06.2007, T.A. 196 & A.A., Eux.
Ornithogalum sigmoideum Freyn & Sint.
Yağbasan village, roadsides, 125 m, 13.04.2007, T.A. 021 & A.A., Euro-Sib.
O. umbellatum L.
Near Yağbasan village, fallow fields, 120 m, 13.04.2007, T.A. 013 & A.A.
Muscari neglectum Guss.
Near Esençay, open places, 100 m, 13.04.2007, T.A. 003 & A.A.
Fritillaria pontica Wahlenb.
Yağbasan village, meadows, 110 m, 13.04.2007, T.A. 017 & A.A., Euro-Sib.

ORCHIDACEAE

Neottia nidus-avis (L.) LCM Richard
Near Ağcagüney village, open forest, 150 m, 10.07.2008, T.A. 217 & A.A., Euro-Sib.
Platanthera chlorontha (Custer) Reichb.
Near Yağbasan village, open forest, 145 m, 10.07.2008, T.A. 215 & A.A.
Ophrys holoserica (Burm. fil.) Greuter subsp. *holoserica*
S. of Çakmak Dam, open forest and wet places, 145 m, 21.05.2007, T.A. 109 & A.A., Med.

O. oestrifera Bieb. subsp. *oestrifera*
S.E. of Çakmak Dam, open forest, 140 m, 10.07.2008, T.A. 206 & A.A.
Serapias vomeracea (Burm. fil.) Briq. subsp. *laxiflora* (Soo) Gölz & Reinhard
Ağcagüney village, roadsides, 120 m, 01.05.2007, T.A. 043 & A.A., Med.
Anacamptis pyramidalis (L.) L.C.M. Richard
E. of Çakmak Dam, wet places, 10.07.2008, T.A. 153 & A.A.
Orchis spitzelii Sauter ex W. Koch
Ağcagüney village, moist places, 130 m, 01.05.2007, T.A. 042 & A.A., Med.

DIOSCOREACEAE

Tamus communis L. subsp. *communis*
Near Esençay, meadows, 100 m, 01.05.2007, T.A. 039 & A.A.

TYPHACEAE

Typha latifolia L.
E. of Çakmak Dam, stream sides, 120 m, 10.07.2008, T.A. 198 & A.A.
T. angustifolia L.
E. of Çakmak Dam, river banks, 120 m, 10.07.2008, T.A. 197 & A.A.

JUNCACEAE

Juncus inflexus L.
1 km E. of Çakmak Dam, stream sides, 125 m, 10.07.2008, T.A. 166 & A.A.
Luzula forsteri (Sm.) DC.
N.E. of Çakmak Dam, slopes, 135 m, 21.08.2008, T.A. 271 & A.A., Euro-Sib.

CYPERACEAE

Cyperus longus L.
E. of Çakmak Dam, stream sides, 130 m, 05.06.2007, T.A. 144 & A.A.
Schoenoplectus lacustris (L.) Palla subsp. *tabernaemontani* (C.C. Gmelin) A. & D. Löve
E. of Çakmak Dam, stream sides, 120 m, 10.07.2008, T.A. 172 & A.A.
Carex divulsa Stokes subsp. *divulsa*
E. of Çakmak Dam, roadsides and open places, 200 m, 01.05.2007, T.A. 074 & A.A., Euro-Sib.
C. divisa Hudson
Yağbasan village, stream sides, 125 m, 10.07.2008, T.A. 152 & A.A., Euro-Sib.
C. flacca Schreber subsp**.** *serrulata*
E. of Çakmak Dam, roadsides and slopes, 135 m, 01.05.2007, T.A. 070 & A.A., Med.

POACEAE(GRAMINEAE)

Brachypodium sylvaticum (Hudson) P. Beauv.
1 km S. of Çakmak Dam, rocky slopes, 185 m, 11.09.2008, T.A. 336 & A.A., Euro-Sib.
Aegilops geniculata Roth.
N.E. of Çakmak Dam, rocky limostene slopes, 230 m, 10.07.2008, T.A. 178 & A.A., Med.
Hordeum murinum L. subsp. *glaucum* (Steudel) Tzvelev
S. of Çakmak Dam, roadsides, 110 m, 21.05.2007, T.A. 098 & A.A.
Bromus hordeaceus L. subsp. *hordeaceus*
E. of Çakmak Dam, roadsides, 120 m, 05.06.2007, T.A. 149 & A.A.
B. intermedius Guss.
N.E. of Çakmak Dam, open places, 250 m, 01.05.2007, T.A. 084 & A.A.
B. squarrosus L.
1 km E. of Çakmak Dam, open places and slopes, 140 m, 10.07.2008, T.A. 293 & A.A.
B. madritensis L.
E. of Çakmak Dam, slopes, 135 m, 01.05.2007, T.A. 071 & A.A.
Avena fatua L. var. *fatua*
N.E. of Çakmak Dam, fallow fields, 135 m, 11.09.2008, T.A. 337 & A.A.
Rostraria cristata (L.) Tzvelev var. *cristata*
1 km E. of Çakmak Dam, rocky slopes, 140 m, 21.08.2008, T.A. 338 & A.A.
Holcus lanatus L.
E. of Çakmak Dam, wet places, 125 m, 10.07.2008, T.A. 164 & A.A., Euro-Sib.
Alopecurus myosuroides Hudson var. *myosuroides*
Güzelyurt village, roadsides, 125 m, 13.04.2007, T.A. 035 & A.A., Euro-Sib.,widespread.
Festuca arundinacea Schreber subsp. *arundinacea*
E. of Çakmak Dam, stream sides, 130 m, 11.09.2008, T.A. 300 & A.A.
F. heterophylla Lam.
N.E of Çakmak Dam, open places and slopes, 120 m, 10.07.2008, T.A. 182 & A.A., Euro-Sib.
Lolium perenne L.
S.E. of Çakmak Dam, roadsides, 125 m, 10.07.2008, T.A. 190 & A.A., Euro-Sib.
Vulpia myuros (L.) C.C. Gmelin
N.E. of Çakmak Dam, fallow fields, 130 m, 10.07.2008, T.A. 296 & A.A.
Poa annua L.
1 km E. of Çakmak Dam, roadsides, 140 m, 01.05.2007, T.A. 049 & A.A.
P. trivialis L.
N.E. of Çakmak Dam, meadows, 125 m, 10.07.2008, T.A. 294 & A.A.

P. pratensis L.
1 km N.E. of Çakmak Dam, open places, 135 m, 21.08.2008, T.A. 339 & A.A.
P. nemoralis L.
E. of Çakmak Dam, roadsides, 130 m, 10.07.2008, T.A. 184 & A.A.
Dactylis glomerata L. subsp. *hispanica* (Roth.) Nyman
Near Güzelyurt village, roadsides, 130 m, 21.05.2007, T.A. 104 & A.A.
Cynosurus cristatus L.
2 km E. of Çakmak Dam, slopes and rocky place, 175 m, 10.07.2008, T.A. 164 & A.A., Euro-Sib.
C. echinatus L.
N.E. of Çakmak Dam, roadsides, 125 m, 21.08.2008, T.A. 269 & A.A., Med.
Briza media L.
Güzelyurt village, rocky slopes, 135 m, 21.08.2008, T.A. 340 & A.A.
Stipa bromoides (L.) Dörfler
1 km N.E. of Çakmak Dam, open places, 140 m, 11.09.2008, T.A. 341 & A.A., Med.
Cynodon dactylon (L.) Pers var. *dactylon*
Yağbasan village, slopes, 130 m, 21.08.2008, T.A. 231 & A.A.
Setaria glauca (L.) P. Beauv.
E. of Çakmak Dam, fallow fields, 130 m, 11.09.2008, T.A. 342 & A.A.
Sorghum halepense (L.) Pers var. *halepense*
S.E. of Çakmak Dam, roadsides, 140 m, 10.07.2008, T.A. 209 & A.A.
Bothriochloa ischaemum (L.) Keng.
Saraçlı village, roadsides, 120 m, 21.08.2008, T.A. 347 & A.A.

4. Discussion

The present study examines the flora of Çakmak Dam and its surroundings. In the studies performed in the region over 2 years, 311 taxa were identified. Five of them belong to Pteridophyta and 306 belong to Spermatophyta divisions. Gymnosperms and Angiosperms comprised 4 and 302 taxa, respectively. Of these, 249 taxa belong to the Dicotyledones, while the other 53 taxa belong to Monocotyledonae. The dispersion of the plant taxa that were defined in the study area according to large taxonomical groups is shown in Table 1.

Table 1. The dispersion of taxa into large taxonomical groups.

	Number ofFamilies	Number of Genera	Number of Taxa
Pteridophyta	4	4	5
Spermatophyta	66	210	306
Gymnospermae	2	2	4
Angiospermae	64	208	302
Dicotyledonae	55	171	249
Monocotyledonae	9	41	53
Total	70	214	311

The region is a very important relictual refuge for plant species that are ancient Mediterranea flora such as *Phillyrea latifolia* L. (Oleaceae), *Arbutus andrachne* L. (Ericaceae) and *Cistus creticus* L.(Cistaceae) (Eminağaoğlu et al., 2006). The presence of these relict plant species in the region is largely due to the fact that the Caucasus was separated from the severe effects glacial retreats during the last Ice Age (Atalay 2006; Eminağaoğlu et al., 2008).

According to our observations, construction of Çakmak Dam led to clear differentiation of the vegetation at studied localities. The sites above the dam were occupied mainly by meadow vegetation which were infrequent below the dam. It could be explained by a lower moisture content above the dam. More favorable hydrological conditions above the dam led to distributed more abundant some plants such as *Equisetum ramosissimum*, *Pteridium aquilinum*, *Asplenium adiantum-nigrum*, *Veronica anagallis-aquatica*. subsp. *anagallis-aquatica*, *Mentha longifolia* subsp. *longifolia*, *Typha latifolia*, *Typha angustifolia*, *Juncus inflexus*, *Cyperus longus* and *Carex divisa*. The distribution of these species also depends on suitable environmental conditions for their establishment.

The species of the study area, categorised according to phytogeographical region can be listed as follows: Euro-Siberian elements 80 (13 Eux., 4 H. Eux.) (25.72 %), Mediterranean elements 28 (9.00 %) and Irano-Turanien elements 4 (1.28 %). The remaning 199 taxa (63.98 %) are pluri-regional or of unknown phytogeographic origin (Figure 4). The Euro-Siberian elements in the area are more common than the other phytogeographic region elements, because the area is located in the Euro-Siberian phytogeographic region. The presence of Mediterranean elements in the research area occupy the second place shows that the study area partly influenced by Mediterranean climate. The prevalence of Irano-Turanien elements in the study area was low (1.28 %), because of the Eastern Black Sea

Mountains, which act as a barrier along the sea shore and seperate the region into coastral and interior areas (Uzun and Terzioğlu, 2008). Additionally, the high altitude mountains in this region include a large number of elements belonging to the Irano-Turanien phytogeographical region (5.99 %) (Palabaş Uzun and Anşin, 2006).

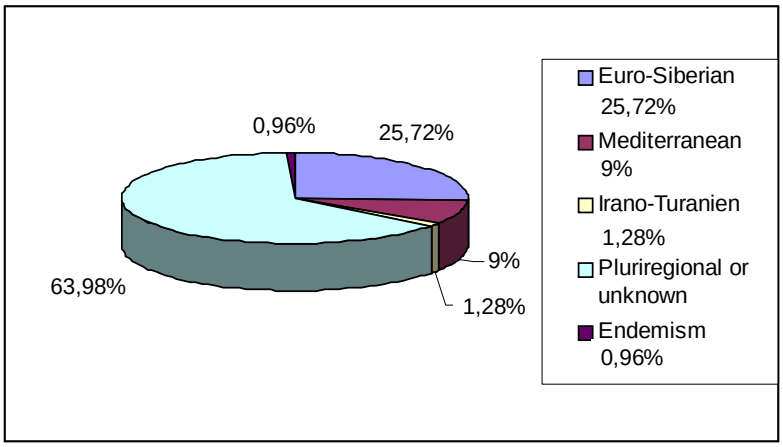

Figure 4. The spectrum of floristic elements in the research area.

The results of the studies conducted in close and similar areas, along with phytogeographical distribution are presented in Table 2. Euro-Siberian elements seems to be dominant in all areas studied. According to Table 2, the endemism rate is 0.96 % in the present study. Compared with studies conducted in close and similar regions, the rate of endemism is very low. However, the endemism rate of Black Sea Region is about 16 % (Anşin et al., 2002). The main reason for the low endemism ratio observed this study can be explained by the area is located at low altitude. Endemism rate is rather low near to the sea level regions due to low climatic and edaphic diversity. Additionally, low endemism rate can also be explained on the basis of the presence of more stable environmental factors when compared with the Central, Eastern and South Anatolian regions of Turkey. The similarity of the study area to the Black Sea region and the lack of extreme ecological factors may be one of the most important reasons for the low endemism ratio of the study area (Anşin, 1982; Kutbay and Kılınç, 1995). In addition, ecological diversity was decreased due to increasing antropogenic factors (i.e overgrazing, destruction etc.). As a result, the number of endemic species are comparatively low in our research area. Similar results were obtained from other floristic studies in the Eastern Black Sea Region of Turkey (Anşin 1979, 2002; Kikvidze and Ohsawa ,2001; Özen and Kılınç, 2002). Threat categories for three endemic taxa, which are *Knautia degenii* Borbas ex Formanek, *Campanula latiloba* A. DC. subsp. *latiloba* and *Arum euxinum* R. Mill, are Least Corcern (LC) (IUCN 2001) (Ekim et al., 2000).

Table 2. A comparison of the phytogeographical elements and endemism.

Research Area	1	2	3	4	5
Euro-Siberian	25.72	21.76	25.19	44.21	28.43
Mediterranean	9.00	13.06	9.65	6.53	11.44
Irano-Turanien	1.28	4.05	2.29	3.26	4.90
Pluriregional or unknown	63.98	—	—	54.22	55.23
Endemism	0.96	5.30	3.43	2.61	4.29

1. Flora of Çakmak Dam and its surroundings 2. Bafra-Altınkaya Baraj Gölü alanının Baraj Gövdesi Şahinkaya Boğazı Arasında Kalan Kesimi ve Yakın Civarının Florası 3. Flora of Nebyan Dağı (Samsun- Bafra) 4. Samsun Kocadağ ve Çevresinin Florası. 5.The flora and vegetation of Kunduz Forest (Vezirköprü/ Samsun).

The largest 10 families according to taxa number are shown in Figure 5. Asteraceae is first with 31 taxa followed by Leguminosae (29), Gramineae (28), Labiatae (26), Rosaceae (14), Caryophyllaceae (10), Umbelliferae (8), Boraginaceae (8), Scrophulariaceae (8) and Cruciferae (8). The total ratio of the 10 major families is 54.63 %, with the remaining families comprising 45.37 %. A comparison between our results and those reported by others from close and similar regions revealed that the sequence of the 3 largest families in the our study is the same for the flora of the area of Bafra-Altınkaya Dam lake (Engin and Korkmaz, 1991) and flora of Nebyan Dağı (Samsun-Bafra) (Kutbay et al., 1995) (Table 3). Differences in the rank of several families might be due to the results of dissimilarities in climates and habitats. Furthermore, the order of highly represented families in our study is generally compatible with the Flora of Turkey (Davis, 1965-1985). Asteraceae is not only the largest family in the Flora of Turkey (Güner et al., 2000), but also the largest and most widespread family of flowering plants in the world (Good, 1974; Uzun and Terzioğlu, 2008).

Additionally, the members of this family include many diaspores that are easily dispersed (Terzioğlu and Anşin, 2001). Leguminosae is the second largest family in the Flora of Turkey. These families have a wide ecological tolerance.

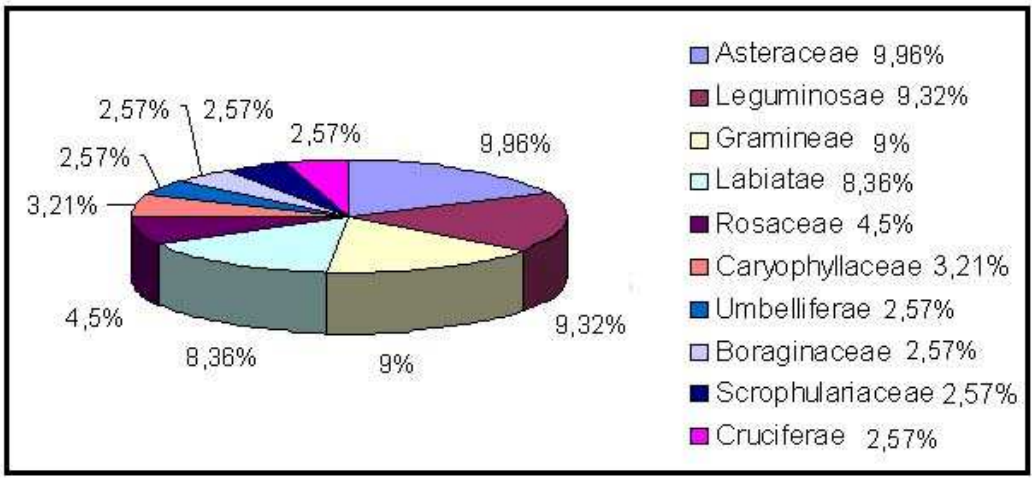

Figure 5. Distribution of the largest families in the research area.

Lamiaceae is the third largest family in the Flora of Turkey but in our study this family occurred in fourth rank. In our study, the third largest family is Gramineae. The possible reasons of the occurrence of this family at the study site, the species of this family are known as abundant in numbers around wetland environments.
The genera containing the highest number of species in this study are listed in Table 4. The genus *Trifolium* L. ranks first with 7 taxa (2.25 %). *Salvia* L. ranks second with 6 taxa (1.92 %) and *Vicia* L. and *Geranium* L. ranks third with 5 taxa (1.60 %).

Table 3. Comparison of the largest families in the Çakmak Dam and its environs and neighbouring areas (Numbering are below Table 2).

Families	Compared studies (taxa number and percentage)				
	1	2	3	4	5
Asteraceae	31 (9.96)	60 (13.51)	71 (11.62)	34 (11.11)	21 (6.53)
Leguminosae	29 (9.32)	39 (8.78)	62 (10.14)	33 (10.78)	34 (10.78)
Gramineae	28 (9.00)	28 (6.30)	43 (6.87)	13 (4.24)	15 (4.90)
Labiatae	26 (8.36)	22 (4.95)	41 (6.87)	26 (8.49)	18 (5.88)
Rosaceae	14 (4.50)	13 (2.47)	24 (4.09)	12 (3.92)	21 (6.86)
Caryophyllaceae	10 (3.21)	15 (3.37)	16 (2.61)	17 (5.55)	8 (2.61)
Umbelliferae	8 (2.57)	—	20 (3.27)	—	—
Boraginaceae	8 (2.57)	11 (2.47)	19 (3.10)	7 (2.28)	9 (2.94)
Scrophulariaceae	8 (2.57)	16 (3.60)	28 (4.41)	17 (5.55)	11 (3.59)
Cruciferae	8 (2.57)	24 (5.40)	22 (3.60)	15 (4.87)	12 (3.92)

Table 4. The genera containing the highest number of taxa.

Genera	Number of Taxa	Rate (%)
Trifolium	7	2.25
Salvia	6	1.92
Vicia	5	1.60
Geranium	5	1.60
Silene	4	1.28
Veronica	4	1.28
Stachys	4	1.28
Euphorbia	4	1.28
Bromus	4	1.28
Poa	4	1.28
Total	47	15.05

5. References

Akman, Y. 1990. İklim ve Biyoiklim,Palme Yayınları Mühendislik Serisi, 103, Ankara, 304 pp.

Anonymous, 1991. Samsun İçme Suyu Projesi. T.C. Bayındırlık ve İskan Bakanlığı, DSİ Genel Müdürlüğü, DSİ VII. Bölge Müd., Samsun.

Anonymous, 2008. Samsun Meteoroloji Müdürlüğü, Meteoroloji Kayıtları, Samsun.

Anşin, R. 1979. Trabzon-Meryemana Araştırma Ormanı Florası ve Saf Ladin Meşcerelerinde Floristik Araştırmalar (Flore de la foret de Rescerches de Meryemana-Trabzon et Les Recherches Floristiques Dans les Peuplements Purs D' Epicea). Trabzon: Karadeniz Gazetecilik ve Matbaacılık Press.

Anşin, R. 1982. Endemizm ve Doğu Karadeniz Bölgesinde Yetişen Endemik Bitki Taksonları. Karadeniz Teknik Üniversitesi Orman Fakültesi Dergisi, 5, 311-326.

Anşin, R., Özkan, Z.C., Eminağaoğlu, Ö. 2002. Doğu Karadeniz Bölgesi Endemik Taksonları (Endemic taxa of East Black Sea Region) . Artvin, II. Ulusal Karadeniz Ormancılık Kongresi Kitapçığı 2: 565-573.

Atalay, İ. 2006. The Effects of Mountainous Areas on Biodiversity: A Case Study from the Northern Anatolian Mountains and the Taurus Mountains. Grazer Schriften der Geographie und Raumforschung, 41, 17-26.

Brummitt, R.K., Powell , C.E. (eds) (2001). Authors of Plant Names. Kew Royal Botanic Gardens.

Davis, P.H., (ed.) (1965-1985). Flora of Turkey and the East Aegean Islands, Vol. 1-9, Edinburgh University Press, Edinburgh.

Davis, P.H., Mill, R.R., Tan, K. (ed.) 1988. Flora of Turkey and the East Aegean Islands (supplement), Vol. 10, Edinburgh University Press, Edinburgh.

Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z., Adıgüzel, N. 2000. Türkiye Bitkileri Kırmızı Kitabı, Eğrelti ve Tohumlu Bitkiler (Red Data Book of Turkish Plants, Pteridophyta and Spermatophyta), TTKD ve Van Yüzüncüyıl Üniversitesi Press, Ankara.

Eminağaoğlu, Ö., Kutbay, H.G., Bilgin, A., Yalçın, E. 2006. Contribution to the phytosociology and conservation of tertiary relict species in Northeastern Anatolia (Turkey). Belgian Journal of Botany, 139, 124-130.

Eminağaoğlu, Ö., Kutbay, H.G., Özkan, Z.C., Ergül, A. 2008. Flora of the Camili Biosphere Reserve Area (Borçka, Artvin, Turkey). Turkish Journal of Botany, 32, 43-90.

Engin, A., Korkmaz, H. 1991. Bafra-Altınkaya Baraj Gölü Alanının Baraj Gövdesi Şahinkaya Boğazı Arasında Kalan Kesiminin ve Yakın Çevresinin Florası. Ondokuz Mayıs Üniversitesi Fen Dergisi, 3(1), 278-309.

Good, R. 1974. The Geography of the Flowering Plants. Longman Group Limited, Fourth Edition, London.

Güner, A., Özhatay, N., Ekim, T., Başer, K.H.C. (ed.) 2000. Flora of Turkey and the East Aegean Islands. Vol. 11, Edinburgh University Press, Edinburgh.

IUCN 2001. IUCN Red List Categories. Version 3.1. IUCN Species Survival Commission, IUCN Gland, Switzerland and Cambridge, UK.

Kılınç, M., Özen, F. 1988. Ondokuz Mayıs Üniversitesi Kurupelit Kampüs Alanı ve Çevresinin Florası. Ondokuz Mayıs Üniversitesi Fen Dergisi, 1(2), 97-121.

Kılınç, M., Kutbay, H.G., Akçin, A. 1998. Samsun Kocadağ ve Çevresinin Florası. XIV. Ulusal Biyoloji Kongresi, Samsun.

Kılınç, M., Kutbay, H.G., Yalçın, E., Bilgin, A. 2006. Bitki Ekolojisi ve Bitki Sosyolojisi Uygulamaları. Palme Yayınları, Ankara.

Kikvidze, Z., Ohsawa, M. 2001. Richness of Colchic vegetation: comparison between refugia of South-western and East Asia. BMC Ecol, 116, 1-10.

Kutbay, H.G., Kılınç, M., Karaer, F. 1995. Nebyan Dağı (Samsun/ Bafra) Florası. Turkish Journal of Botany, 19, 345-371.

Özen, F., Kılınç, M. 2002. The Flora and vegetation of Kunduz Forests (Vezirköprü/ Samsun). Turkish Journal of Botany, 26, 371-393.

Palabaş Uzun, S., Anşin, R. 2006. Subalpine and alpine flora of Altındere Valley (Maçka/ Trabzon). Turkish Journal of Botany, 30, 381-398.

Tahmiscioğlu, M.S., Anul, N., Ekmekçi, F., Durmuş, N. 2007. Positive and negative impacts of dams on the environment. International Congress River Basin Management, 22-24 March, Antalya.

Terzioğlu, S., Anşin, R. 2001. A Chorological study on the taxa naturalized in the Eastern black Sea Region. Turk J Agric For, 25, 305-309.

Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., Walters, S., Webb, B.A.(ed.) (1964-1980). Flora Europaea. Vols. 1-5. Cambridge University Press, Cambridge.

Uzun, A., Terzioğlu, S. 2008. Vascular Flora of Forest Vegetation in Altındere Valley (Maçka-Trabzon). Turkish Journal of Botany, 32, 135-153.

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Contribution toward the description of a new *Caloglyphus* Berlese mite (Acarina: Acaridae) from collections in Pakistan

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Abstract

This paper relates to the recognition and description of one novel taxon *Caloglyphus verto* (Hypopus) within the genus *Caloglyphus* Berlese recorded from Pakistan. This species is characterized by possession of a typical gnathosoma in which distal fork is not separated from basal joint. The text comprises interpretations on description of diagnostic characters, morphometric measurements, collection site with ecological data, host material and differentiating remarks of new species from closely related species. Brief details lying on overview of literature of already identified *Caloglyphus* taxa and key covering all the known species in the country are given.

Key words: Acarina, Acaridae, *Caloglyphus,* New mite hypopus, Taxonomy, Pakistan

1. Introduction

Astigmatic mites family Acaridae are considered to be major pests of stored products. Mites feeding on different stored products cause direct injury; they also cause indirect damages by transmitting fungi and other microorganisms into the stored commodities. Previously the species of *Caloglyphus* were collected from potato tubers, onion bulbs, barley, rice, wheat, flour and chicken feeds (Ostovan and Kamali, 1995). Storage mites frequently cause injury and contamination of crop agro-products, and by allergens and toxins. The *Caloglyphus* often occurred in 4 kinds of "sensitive food ingredients" that include poppy, mustards, lettuce and wheat grain (Stejskal *et al*., 2002). This may have serious practical consequences since currently the food safety is one of the most important priorities. Taxonomy provides a framework that enables us to undertake studies on the relationships between living things, so that we are better able to understand and assess biodiversity and more efficiently manage it. Therefore, the goal of our study was to review and identify the occurrence of this biotic-hazard in various agricultural products for its integrated pest management development and its implementation.

Genus *Caloglyphus* at this moment has documentation from a lot of countries of the world, but Berlese first proposed and described the genus *Caloglyphus* in 1923 and he selected *Caloglyphus berlesei* Michael, 1903 as its type species for a single species (hypopus). Some species of genus *Caloglyphus* have been reported from several regions of world; Zakhvatkin (1941) prepared a comprehensive review of this genus and depicted 4 new species and re-described 6 species with improved descriptions. Nesbitt (1944 and 1949) and Samsinak (1966) raised 1, 3 and 1 new species to this genus, accordingly. Mahunka (1973, 1974, 1978 and 1979) described 2, 1, 2 and 1 new species, respectively from his area of study. Hughes (1976) prepared an excellent accumulation of knowledge to this genus. Tseng and Hsieh (1976) re-described 1 species with improved drawings. Samsinak (1980) revised the tribe *Caloglyphini*, re-established the genus *Caloglyphus* and illustrated 1 new species. Channabasavanna *et al*., (1981), Rao *et al*., (1982) and Ashfaq and Chaudhri (1983) included 1, 1 and 4 new species, correspondingly in this genus. Samsinak (1988) pointed out 1 new species of the tribe *Caloglyphini*. Zou and Wang (1989), Sevastyanov and Radi (1991), Sher *et al*., (1991), Klimov (1996) and Eraky (1999) supplemented 1, 3, 2, 1 and 1 new species, respectively to this genus. Klimov (2000) reviewed

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acarid mites of the tribe *Caloglyphini* with description of a new species. Oconnor (2003) listed two species of genus *Sancassania* (=*Caloglyphus*) phoretic on other species of arthropods. Klimov and Oconnor (2003) published phylogeny, historical ecology and systematic of some mites including full descriptions of each taxon, keys and biological information. Sarwar and Ashfaq (2004 and 2006), and Sarwar *et al*., (2005 and 2009) in their studies, recognized and expressed 7 new species reported from this global territory. Current investigations on the occurrence of *Caloglyphus* fauna in the urban environment, has encountered one species that showed sufficient dissimilarity with already existing taxa to be classified it as a separate species.

2. Materials and methods

For contributions to the knowledge of exploring and describing species of the genus *Caloglyphus,* samples for mites' collection were taken from places which were scarcely or not sampled properly earlier in the areas of Punjab province. Samples consisting of trees bark, leaf litter, stored fruits and grains were collected to allow a wide range of representations of the stored products and mites species found in these commodities. The *Caloglyphus* were extracted from substrates using a modified Berlese funnel apparatus and then individually removed with a brush under a stereomicroscope, in the laboratory. All specimens were slide-mounted for identification using Hoyer's medium. Drawings of different body parts were made with the help of an ocular grid. All measurements were given in micrometers (mµ).

A chronological analysis of the genus, description and illustration of main body characters and resemblance remarks for the new species are given by studying earlier literature. The terms of body parts and idiosomal chaetotaxy follow Griffiths *et al.*, (1990); and terms of leg chaetotaxy and solenidiotaxy follow Griffiths (1970).

Diagnosis of genus *Caloglyphus* Berlese

Dorsal shield smooth or scantly dotted. Gnathosoma considerably longer than wide at its base, two segmented segments clearly separated. Sternum 1 (*st1*) and apodeme 2 (*ap2*) not reaching posterior end and not united with each other. Coxal suckers 2 pairs, well developed/ completely reduced or replaced by fairly long seta. Coxal field III generally shut. Genital shield separated from/ not separated from ventral shield. Suctorial shield well developed, lateral suckers anterior to posterior suckers but at same level of anal suckers, shield separated from posterior body end by small distance, considerably smaller than shield length. Tarsi III and IV short, stout. Seta *e* not more than one-half of leg II, and I enlarged distally. Apex of genu I with 1 seta only. Seta *ba* of tarsi I and II tapering anteriorly. Claws normal, much smaller than tarsi.

3. Description of Hypopus

***Caloglyphus verto* sp. nov.**

DORSUM: Body 278 mµ long, 208 mµ wide, divided into propodosomal and hysterosomal shields. Propodosomal shield with rostral projection antero-medially, 90 mµ long, 190 mµ wide, dotted all around; setae *vi*, *ve*, *sci*, *sce* and *scs*, each 1 pair, simple, measuring 38 mµ, 6 mµ, 5 mµ, 9 mµ and 19 mµ in length, respectively; setae*sci*, *scs* and *sce* forming circular line; *sci-sci* 38 mµ, *sce-sce* 88 mµ and *sci-sce* 29 mµ apart. Hysterosomal shield 213 mµ long, 208 mµ wide, dotted, anterior and lateral margins with dots and broken striations, lateral margins turn toward the ventral side, 11 pairs setae, 2 pairs visible pores. Setae *d1* = *d2* = *d3* = *d4* = 6 mµ; *hi* 10 mµ, *he* 6 mµ; *la* 7 mµ, *lp1* = *lp2* = 8 mµ; *sai* 14 mµ, *sae* 8 mµ long; *d1* - *d1* 70 mµ, *d2* - *d2* 45 mµ, *d3* - *d3* 50 mµ, *d4* - *d4* 57 mµ; *d1* - *d2* 40 mµ, *d2* - *d3* 62 mµ, *d3* - *d4* 38 mµ and *la* - *la* 160 mµ apart. Hysterosomal shield anterior margin overlapping propodosomal shield posterior margin upto 25 mµ, overlapping area with dots and transverse, broken striations (Figure 1).

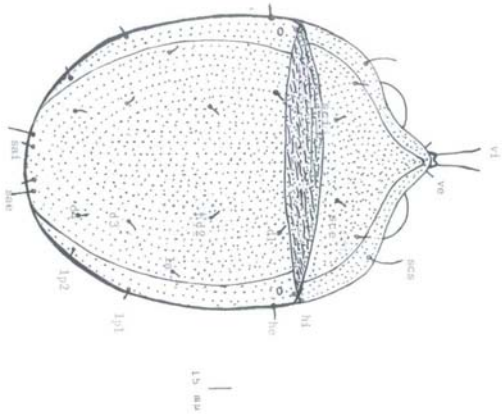

Figure 1. Dorsal side

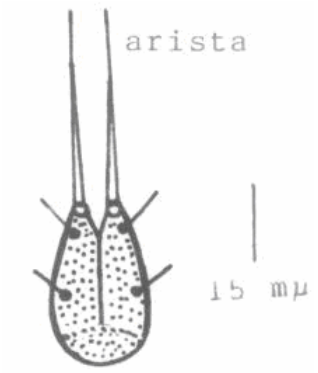

Figure 3 Gnathosoma

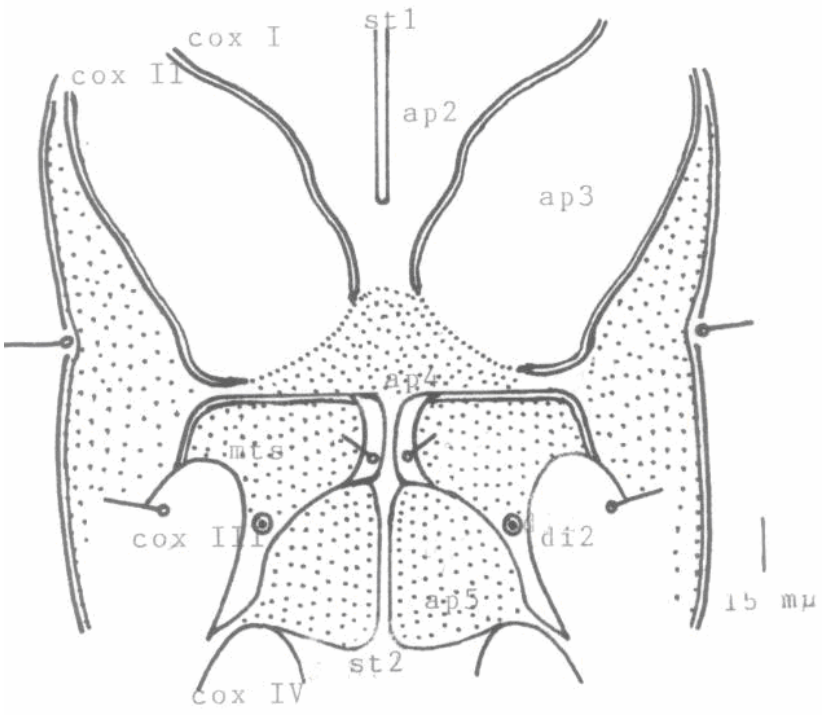

Figure 4. Coxal fields

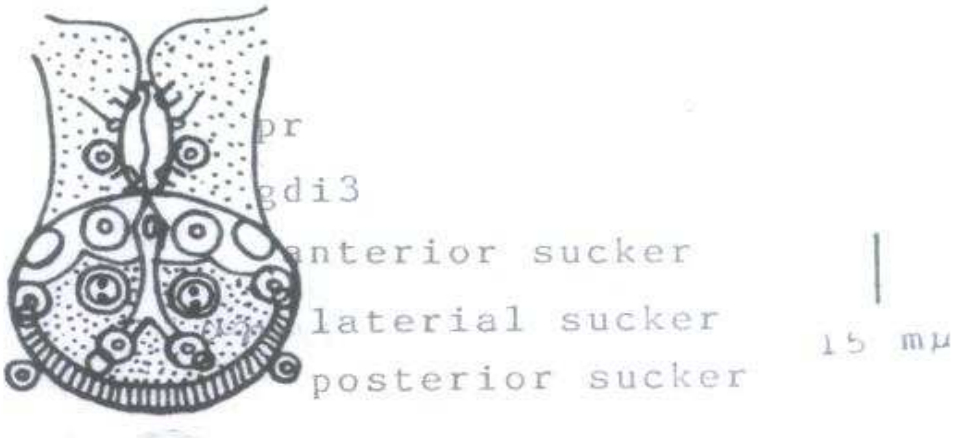

Figure 5. Suctorial shield

LEGS: Strong and stout, I-IV measuring 108 mμ, 95 mμ, 80 mμ and 70 mμ in length, respectively (trochanter base to tarsus tip). Setae and solenidia on legs I-IV segments: coxae 0-0-0-0, trochanters 1-1-1-0, femora 1-1-0-0, genua 3-3-1-1, tibiae 3-3-2-2, tarsi 12-9-8-7. Tarsi I and II 40 mμ and 34 mμ long, respectively. Seta *vF* on femora I and II 34 mμ and 36 mμ long, respectively, absent on femora III and IV. Seta *e* on tarsi I-IV measuring 40 mμ, 28 mμ, 25 mμ and 20 mμ in length, respectively. Seta *mG* on genua I and II spine-like; *hT* on tibiae I and II lancet-like, 14 mμ, 12 mμ, 23 mμ and 19 mμ long, respectively. Seta ó on genua I and II, a simple seta and a spine, 15 mμ and 6 mμ long, respectively. Tarsi III and IV short and stout. Seta ö on tibiae I and II 85 mμ and 32 mμ long, respectively. Seta *ba* on tarsus I 23 mμ long. Tarsi I-IV provided with 1 spoon-shaped + 2 leaf-like; 1 spoon-shaped + 2 leaf-like; 3 leaf-like + 1 lancet-like; 3 leaf-like + 1 lancet-like setae, respectively. Seta *d* on leg IV tarsus 33 mμ long (Figure 2).

TYPE: Holotype, hypopus, collected from Multan (latitude 30-12 N, longitude 71-28 E, altitude 221 m, and mean annual temperature and rainfall 26.50 ^{o}C and 168 mm, respectively) from leaf litter on 25.12.1994 (Sarwar) and deposited in Acarology Research Laboratory, Department of Agricultural Entomology, University of Agriculture, Faisalabad.

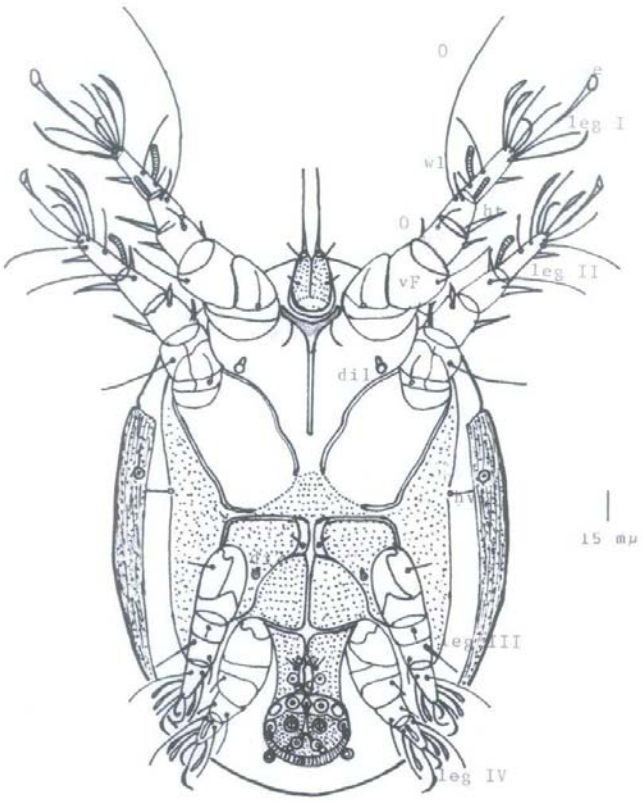

Figure 2. Ventral side

REMARKS: This new species closely resembles to that of *Caloglyphus trigonellum* Sher, Ashfaq and Parvez but differs from it due to the following characters:

1. Gnathosomal distal fork separated from basal joint in *C. trigonellum* but not separated in this new species.
2. Sternum 1 (*st1*) bifid posteriorly in *C. trigonellum* but not bifid in this new species.
3. Genital disc (*gdi3*) kidney-shaped in *C. trigonellum* but rounded in this new species.
4. Suctorial shield without radial striations in *C. trigonellum* but with striations posteriorly in this new species.
5. Tarsi I and II each with 5 leaf-like setae in *C. trigonellum* but each with 2 leaf-like setae in this new species.
6. Apodemes 4 (*ap4*) meeting medially in *C. trigonellum* but not meeting in this new species.

4. Conclusions

Most systematic work previously published on the mites of genus *Caloglyphus* associated with different stored commodities in Pakistan is represented by 13 species, at this instance; the present authors have collected and described 1 new species. With continuing studies and descriptions of additional new species, the fauna of the country will ultimately become completely known. As is common with other acaroids species that are generalist foragers, *Caloglyphus* is a genus of agricultural importance worldwide and they show a wide range of peculiar morphological characteristics. They might occur in much more pervasive localities to utilize many diverse hosts. However, host records of genus *Caloglyphus* are not yet sufficiently extensive to exhibit any clear phylogenetic signal.

The earlier described *C. agrios* and *C. hadros* species have been collected from adjoining sub-mountainous areas of similar ecological niche; their similarity could thus be attributed to their similar ecological habitats. The species *C. faisalabadiensis* and *C. trigonellum* are the commoners of the same habitat, having the identical hosts, thus it is revealed that resemblance of these species could be attributed to the same ecological zones they occupy. Whereas, the species *C. multaniensis, C. kenos,* new species *C. verto* and *C. opacatus* are the dwellers of arid plains, their affinity could thus be attributed to the similar ecological niche they inhibit. Species *C. cingentis, C. clemens, C. merisma, C. morosus, C. bradys* and *C. austerus* are the dwellers of varied ecological regions from hilly areas to coastal lands, as such, the affinities depicted by these species with one another could not be an attribute of ecology. Perhaps rather it is due to sharing of stable characters at generic level. It is noteworthy from the data that species of this genus have a wide range of distribution in four provinces of Pakistan and Azad Kashmir because they have been collected from discrete, diverse ecological habitats like hills, sub-mountainous areas, arid plains and coastal areas which indicates that species have an ability to adopt diverse ecological habitats; and hence can be presumed to have a wider genetic plasticity. The

ability of these species to adapt to diverse ecological habitats and yet sharing numerous characters reflects the occurrence of stable generic characters at this level and their adaptive amplitude to varying ecological zones. The characters used for the separation of species of this genus appear to be of consistent occurrence. It is hypothesized that in view of the discernable heterogeneity of the taxa, as the number of species described in this genus increase, it may be possible to split the genus into more sub-genera.

This information acquired on species identification and taxonomic sequence about *Caloglyphus* mites is desirable to properly assist in their management. Knowledge of the natural host associations is also supportive to provide baseline data prior to any operation put into practice to control a pest species; such baseline data will allow the recognition of precise host. Finally, knowledge of the natural geographic range of each species is also necessary in order to avoid introduction of potential pest mites into new areas. In order to complete the survey of different taxa, it is proposed to visit several of the collection sites to examine the fauna that were not previously surveyed. Finally, the accumulated taxonomic information could be used at a later date to conduct phylogenetic and evolution analyses of the taxa.

Key to Pakistan species of genus *Caloglyphus* Berlese (Hypopus)

1. Sternum 2 (*st2*) present ……2
- Sternum 2 (*st2*) absent ……12
2. Apodeme 2 (*ap2*) meeting apodem.e 3 (*ap3*) ……*C. austerus*, Sarwar *et al.* (2009)
- Apodeme 2 (*ap2*) not meeting apodeme 3 (*ap3*) ……3
3. Apodeme 3 (*ap3*) meeting apodeme 4 (*ap4*) …… 8
- Apodeme 3 (*ap3*) not meeting apodeme 4 (*ap4*)……4
4. Gnathosomal lateral margins parallel……5
- Gnathosomal lateral margins not parallel……6
5. Sternum 1 (*st1*) bifid posteriorly; paragenital seta (*pr*) bifid……*C. multaniensis*, Ashfaq and Chaudhri (1983)
- Sternum 1 (*st1*) not bifid posteriorly; paragenital seta (*pr*) not bifid……*C. agrios*, Sarwar *et al.* (2005)
6. Setae *sci* and *sce* forming straight line; coxal discs (*di1*, *di2*) not conoids……*C. opacatus*, Ashfaq and Chaudhri (1983)
- Setae *sci* and *sce* not forming straight line; coxal discs (*di1*, *di2*) conoids……7
7. Apodeme 4 (*ap4*) not meeting medially; paragenital seta (*pr*) antero-medial to genital disc (*gdi3*); gnathosomal distal fork not separated from basal joint……*C. verto*, n. sp.
- Apodeme 4 (*ap4*) meeting medially; paragenital seta (*pr*) messed to genital disc (*gdi3*); gnathosomal distal fork separated from basal joint……*trigonellum* Sher *et al.* (1991)
8. Gnathosoma notched posteriorly…… 9
- Gnathosoma not notched posteriorly…… 10
9. Setae *sci* and *sce* of equal size; apodemes 4 (*ap4*) meeting medially……*C. merisma*, Ashfaq and Chaudhri (1983)
- Setae *sci* and *sce* not of equal size; apodemes 4 (*ap4*) not meeting medially……*C. hadros*, Sarwar *et al.* (2005)
10. Gnathosomal distal fork separated from basal joint; genital disc (*gdi3*) kidney-shaped……11
- Gnathosomal distal fork not separated from basal joint; genital disc (*gdi3*) not kidney-shape……*C. kenos*, Sarwar and Ashfaq (2006)
11. Hysterosomal shield smooth; sternum 1 (*st1*) not bifid posteriorly; coxal discs (*di1*, *di2*) conoids ……*C. bradys*, Sarwar *et al.* (2009)
- Hysterosomal shield dotted; sternum 1 (*st1*) bifid posteriorly; coxal discs (*di1*, *di2*) not conoids ……*C. faisalabadiensis*, Sher *et al.* (1991)
12. Gnathosoma extended beyond the body; apodemes 4 (*ap4*) meeting medially……*C. morosus*, Ashfaq and Chaudhri (1983)
- Gnathosoma not extended beyond the body; apodemes 4 (*ap4*) not meeting medially……13
13. Coxal field III open; genital disc (*gdi3*) and suctorial shield with radial striations……*C. clemens*, Sarwar and Ashfaq (2004)
- Coxal field III closed; genital disc (*gdi3*) and suctorial shield without radial striation……*C. cingentis*, Sarwar and Ashfaq (2004).

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References

Ashfaq, M., Chaudhri, W. M. 1983. Four new (Hypopi) species of the genus *Caloglyphus* Berlese from Pakistan (Acarina: Acaridae). Pak. Entomol. 5 (1-2): 61-78.

Berlese, A. 1923. Centuria sesta di Acari Nuovi. Redia. 15: 237-262.

Channabasavanna, G. P., Krishna, N. S. Rao, Ranganath, H. R. 1981. A new *Caloglyphus* (Astigmata: Acaridae) from poultry litter in India with taxonomic comments on the genus. Ind. J. Acarol. 6 (1/2): 57-63.

Eraky, S. A. 1999. Five new hypopial nymphs (Acari: Acaridae and Histiostomatidae) described from different habitats. Folia Entomol. Hung. 60: 45-56.

Griffiths, D. A. 1970. A further systematic study of the genus *Acarus* L. 1758 (Acaridae: Acarina) with a key to species. Bull. British Mus. (Nat. Hist.) Zool. Ser. 19: 85-118.

Griffiths, D. A., Atyeo, W. T., Norton, R. A., Lynch, C. A. 1990. The idiosomal chaetotaxy of astigmatid mites. J. Zool. 220: 1-32.

Hughes, A. M. 1976. The Mites of Stored Food and Houses. Tech. Bull. No. 9, Ministry of Agriculture Food and Fisheries, London. 400 pp.

Klimov, P. B., Oconnor, B. M. 2003. Phylogeny historical ecology and systematics of some mushroom associated mites of the genus *Sancassania* (Acari: Acaridae) with new generic synonymies. Invertebrate Systematics. 17: 469-514.

Klimov, P. B. 2000. A review of acarid mites of the tribe *Caloglyphini* (Acaridae: Acariformes) with description of a new genus and species from Siberia and Russian Far East. -Vestink Zoologii Ukraine. 34 (4-5): 27-35.

Klimov, P. V. 1996. A new species of acarid mite from the genus *Caloglyphus* (Acari: Acaridae) from the Russian Far East. Zool. Zhur. 75 (4): 613-619.

Mahunka, S. 1973. Auf insekten lebende Milben (Acari: Acarida, Tarsonemida) aus Afrika II. Acta Zool. Hung. 19 (3-4): 289-337.

Mahunka, S. 1974. Auf insekten lebende Milben (Acari: Acarida, Tarsonemida) aus Afrika III. Acta Zool. Hung. 20 (1-2): 137-154.

Mahunka, S. 1978. Schizoglyphidae fam. n. and new taxa of Acaridae and Anoetidae (Acari: Acarida). Acta Zool. Hung. 24 (1-2): 107-131.

Mahunka, S. 1979. The examination of myrmecophilous Acaroidea mites based on the investigations of Dr. C. W. Rettenmeyer (Acari: Acaroidea) II. Acta. Zool. Hung. 25: 311-356.

Michael, A. D. 1903. British Tyroglyphidae. Ray Soc. London. Vol II, 183 pp.

Nesbitt, H. H. J. 1944. Three new mites of the subfamily Rhizoglyphinae. Canad. Entomol. 76 (2): 21-27.

Nesbitt, H. H. J. 1949. Six new Mexican mites of the sub family Rhizoglyphinae, Acarina. Pan. Pacific Entomol. 25 (2): 57-70.

Oconnor, B. M. 2003. Systematics and ecology of North American bee-associated mites: potential threats to native and introduced pollinators. Ann. Arbor. Michigan. USA. 1079-1098.

Ostovan, H., Kamali, K. 1995. New records of six species of astigmatic mites (Acari: Astigmata) infesting stored products in Iran. Journal of Agricultural Sciences. 1 (2): 53-66.

Rao, N. S. K., Ranganath, H. R., Channabasavanna, G. P., Krishna, N. S. Rao, Rao, N. S. K. 1982. *Caloglyphus karnatakaensis* sp. Nov. (Acari: Acaridae) from India with taxonomic comments on the genus C*aloglyphus*. Ind. J. Acarol. 7 (1): 37-43.

Samsinak, K .1980. *Caloglyphus rodriguezi* new species with taxonomic remarks on the tribe C*aloglyphini* (Acari: Acaridae). Mitt. Zool. Mus. Berlin. 56 (2): 201-206.

Samsinak, K. 1966. Die Neuerrichtung der Gattung *Cosmoglyphus* Oudmans 1932 gleichzeitig ein Beitrag zum Problem der "Copra itch". Zool. Anz. 176 (1): 27-42.

Samsinak, K. 1988. *Sancassania ultima* a new mite of the tribe *Caloglyphini* (Acari: Acaridae). Entomol. Mitt. Zool. Mus. Hambg. 9 (133): 159-164.

Sarwar, M., Ashfaq, M. 2004. Two new *Caloglyphus* Berlese mites (Astigmata: Acaridae) recorded in Pakistan. Pak. J. Sci. Ind. Res. 47 (6): 455-461.

Sarwar, M., Ashfaq, M. 2005 [2006]. A new mite pest (Acarina: Acaridae) detected from stored commodity in the Punjab province of Pakistan. Acarologia. XLVI, 1-2: 115-120.

Sarwar, M., Ashfaq, M., Akbar, S. 2005. Numerical taxonomy of two new mites species of the genus *Caloglyphus* Berlese (Acaridae) from Pakistan. Pak. J. Sci. Ind. Res. 48 (5): 345-353.

Sarwar, M., Ashfaq, M., Nadeem, S. 2009. On the identity of new acarid mites in genus *Caloglyphus* Berlese occurring in Asian expanse (Pakistan) (Acarina: Acaridae). Journal of Agriculture and Biological Sciences. 1 (1): 38-47.

Sevastyanov, V. D., Radi, G. K. K. K. 1991. New species of the mite family Acaridae (Sarcoptiformes) from Lower Egypt. Entomol. Rev. 8: 139-146.

Sher, F., Ashfaq, M., Parvez, A.1991. Two new (hypopi) species of genus *Caloglyphus* Berlese (Acarina: Acaridae) from Pakistan. Pak. Entomol. 13 (1-2): 27-34.

Stejskal, V., Hubert, J., Kubatova, A. 2002. Associated-food-hazards: storage fungi and mites in poppy, mustard, lettuce and wheat. Plant Protection Science. 38 (2): 673-680.

Tseng, Y.H., Hsieh, S.A. 1976. A new record of acarid mite *Caloglyphus mycophagus* (Megnin) from Taiwan (Acarina: Astigmata). Taiwan Sugar Res. Inst. No. 74: 47-52.

Zakhvatkin, A. A. 1941. *Fauna of USSR Arachnoidea VI (1) Tyroglyphoidea (Acari).* Zool. Inst. Acad. Sci. U.S.S.R. New Ser. No. 28. English Translation 1959, Rateliffe, A., and Hughes, A. M., Amer. Inst. Biol. Sci. 573 pp.

Zou, P., Wang, X. Z. 1989. A new species and two new records of Acaridae associated with edible fungi from China (Acarina: Acaroidea). Acta Agric. Shanghai. 5 (3): 21-24.

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DNA extraction protocol from Brown Algae

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Abstract

There are various methods published about DNA extraction from marine algae. These methods are the modifications of several DNA extraction methods from other organisms. Extraction of DNA from seaweeds are difficult processes because of the polysaccharide and polyphenole compounds of their thallus. In this study, DNA is extracted from a brown alga (*Scytosiphon lomentaria* and *Cystoseira sp.*, *Ectocarpus sp*.) collected from the Bay of Izmir by using modified CTAB (cetiltrimethylamonium bromide) protocol and used in PCR analysis. This modified method was also found efficient and applicaple for other molecular purposes.

Key words: DNA extraction, CTAB, Brown Algae

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Özet

Denizel alglerden DNA izolasyonu için çeşitli yöntemler bulunmaktadır. Ancak bu yöntemler diğer canlılar için kullanılan DNA izolasyon yöntemlerinin modifikasyonlarıdır. Alglerden DNA izolasyonu talluslarında bulunan polisakkaritler ve fenolik bileşiklerden dolayı zor bir işlemdir. Bu çalışmada, Izmir Körfezi'nde toplanan kahverengi alglerden (*Scytosiphon lomentaria* ve *Cystoseira sp.*, *Ectocarpus sp*.) CTAB (cetiltrimethylamonium bromide) yöntemiyle DNA izolasyonu gerçekleştirilmiş ve elde edilen DNA PCR yöntemi ile çoğaltılmıştır. Bu modifiye yöntem ile moleküler amaçlı çalışmalar için uygun DNA eldesi sağlanmıştır.

Anahtar Kelimeler: DNA izolasyonu, CTAB, kahverengi algler

1. Introduction

The application of molecular tools in studies of marine algae has often been hindered by difficulties in acquiring suitable DNA from them. In particular, polysaccharides and secondary metabolites represent an obstacle to DNA isolation, since DNA often copurifies with them, thus inhibiting downstream enzymatic reactions such as PCR (Shioda et al., 1987; Vidal et. Al., 2002).

Phaeophyceae is an important algae class which contains economicly important organisms. Also they have antimicrobial activity, usage in cosmetics, medicine, textile industry and paper production. Generally the identification methods based on observing morphological charasteristics. But this method has problems because of the morphological changes according to habitats, climate and growth level in the same species. Also some different species may share same morphological characteristics. Because of these reasons, certain and sensitive methods were needed for identification of the algae species. In recent years molecular techniques used in so many studies such as identification of the species, phylogenetics, understanding relationships within the species, monitoring costal waters, genotoxicity etc. The first step for molecular analysis is extraction of the DNA of the organism. The quality and quantity of extracted

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DNA effects the the result of the molecular analysis. All organisms even species have different kinds of DNA extraction methods. Monitoring costal waters for searching harmful algae involves microscobic examination of the plankton. But this method is time consuming and requires taxonomic experience because identification based on morphological characters (Godhe et al., 2001). Methods on Polymerase Chain Reaction (PCR) are popular for detection toxic dinoflagellates. Detection of *Gymnodinium mikimotoi* Miyake & Komimami ex Oda and *Alexandrium minitum* Halim by PCR based methods in field samples were described (Godhe et al., 2001).

The main problems in DNA extraction from macroalgae are the large amount of polysaccharides (Sosa and Oliveira, 1992) such as sulfated polysaccharides and carboxylic polysaccharides (Bold & Wynne, 1978) in their thallus and high nuclease activity (Wee et al., 1992). DNA extraction from brown algae has problems because of their large amount of phenolic components and polysaccharides. Also the procedure requires large amount of material.

The multinucleate cells of green algae in the orders Caulerpales, Charales, Dasycladales and Siphonocladales are valuable experimental organisms for investigating fundamental cellular and developmental phenomena (Coleman et al., 1989). The giant cells possessed by these algae have several advantages for cellular, molecular and biochemical work. Their coenocytic nature permits extraction of thousands of nuclei after disturbing a single cell (Staves & LaClaire, 1985). Also they typically lack significant quantities of the polyphenolic compounds that interfere with nucleic acid purification from Brown algae and many higher plants (John, 1992).

There are so many DNA prufication methods to enhance the DNA quality. These are CsCl ultracentrifuge method (Sosa and Oliveira, 1992), agarose gel-electrophoresis purification (Saunders, 1993) and hydroxyapatite column purification (Dutcher et al., 1930). Although these methods improved the DNA quality, they are complex, time consuming and expensive methods. None of them are compatible with large number of sample associated with population based studies (Wattier et al., 2000).

In this study, we use four different methods to extract DNA from one of the brown algae, *Scytosiphon lomentaria* (Lyngbye) Link, *Cystoseira sp.* and *Ectocarpus sp*.

2. Materials and Methods

Plant Material:
S. lomentaria Cystoseira sp. and *Ectocarpus sp*. samples colleced from Bay of Izmir. The samples identified based on their morphological characteristics. Then they rinsed with distle water. The epifites cleaned under steroscobe and air-dried on fitler paper.

Chemicals:
CTAB buffer: 1 M Tris, pH 8, 100 ml
5 M NaCl, 280 ml
0.5 M EDTA, 40 ml
CTAB, 20 g
dH_2O, 680 ml
TE buffer: 10 mM Tris, pH 8
1 mM EDTA

CTAB buffer and β-ME incubated in 65˚C water bath. The dried material ground in liquid nitrogen into 1.5 ml eppendorf tube containing 600 µl CTAB buffer and β-ME. The samples were mixed and incubated for 45 minutes at 65˚C. This step lyses the cells. After incubation 500 µl chloroform: isoamylalchol (C:IA) was added. The samples mixed for 10 minutes and centrifuged for 5 minutes for precipitate the proteins. The supernatant was transferred to a new tube and the CIA extraction was repeated. The supernatant transferred to a new tube again and approximately 125 µl ice-cold isopropanol used to precipitate the DNA. After this step the supernatant was discard and 300 µl. TE buffer was added and the tube incubated at 37˚C for 1 hour. DNA was washed with 20µl 3 M NaAc and ethanol, centrifuged for 10 minutes at 1.844 x g. and the supernatant was discard again. The pellet was washed with ethanol again and centrifuged for 2 minutes at 1.844 x g. Supernatant was discard after centrigufetion. After that the pellet dried on the air and solved in 100 µl TE buffer. DNA could kept for 18 months at +4˚C (Steen, 1999).

In the other DNA extraction method used for *S. Lomentaria, Cystoseira sp.* and *Ectocarpus sp*., PVP was used addition to these chemicals. According to this protocol 100 mg. dried thallus ground in CTAB buffer with 4 g PVP without pre-heating. Then the tubes left incubation overnight. After incubation C:IA added and centrifuged for 8 minutes at 14462 x g. The first layer of the sample pipetted in to new eppendorf tube. Then 8 µl ice-cold 7.5 M ammonium acetate and 80 µl ice-cold isopropanol added into the tube. After shaking by hand the tubes were left overnight incubation at - 20˚C. After incubation the samples centrifuged at max. speed for 3 minutes. The supernatant

discard and ice-cold absolute ethanol was added into the tubes. The pellet dried after centrifuge for 1 minute. Finally, the pellet dissolved in 100 µl TE (Steen, 1999).

In the third protocol that we experimented for *S. Lomentaria, Cystoseira sp.* and *Ectocarpus sp.*, the CTAB buffer pre-heated before starting to extraction. 2 µl β-ME used per 1 ml CTAB buffer. Following extraction steps applied as in the previous methods. The samples centrifuged at low speed in centrifuge steps (approximately 1.844 x g. for each steps) (Colosi & Schall 1993).

In the fourth method liquid nitrogen was not used before CTAB tretament. This is the only different point among others. Fresh plant tissue directly extracted in CTAB buffer with β-ME (1 ml CTAB/2 µl β-ME). The other steps including CIA, isopropanol and ethanol treatment applied as usual. Finally the pellet resuspanded in 20-30 µl TE.

In the fifth method we tried three different modifications of the protocol that Coyer et al. published in 1995. In our first experiment we extracted the cleaned samples with extraction buffer as described as the second group of second experiment in Coyer et al., 1995. This extraction buffer includes %2 CTAB, %0.1 PVP, 100mM Tris-HCl, 20mM EDTA, %0.1 SDS. In our second experiment we add NaCl to the extraction buffer. In the last experiment we used another extraction buffer that consist of 20 g CTAB, NaCl (5 M), Tris-HCl (1 M), EDTA (0.5 M) and β-ME. All the tubes incubated at room temperature for a week. After incubation the protocol continued by addition of 500 µl C:IA. Samples mixed vigorously and centrifuged for 10 minutes at 14462 x g. Three layers are formed after centrifugation. DNA is excised in the upper layer. The upper layer transfered to a new eppendorf. 24 µl ice-cold 7.5 M ammonium acetate and 175 µl 2-propanol added to the tubes then incubated at -20^{o}C overnight. The tubes centrifuged for 3 minutes after incubation. The aquaous part discarded and the pellet was washed 2 times with absolute ethanol and centrifuged for 2 minutes. The supernatant discarded and the pellet left for an hour fora air drying. The pellet resuspanded in 100 µl TE buffer. DNA can stored at -20^{o}C for years or 18 months at +4^{o}C.

3. Results

After extraction protocols the DNA samples run in %0.8 agarose gel at 80V for two hours (Figure 1). Also we examined the DNA samples in spectrofotometer at 260 and 280 nm. The DNA samples used in PCR with RAPD (Random Amplified Polymorphic DNA) primers for checking the quality of the DNAs' for molecular analysis (Figure 2).

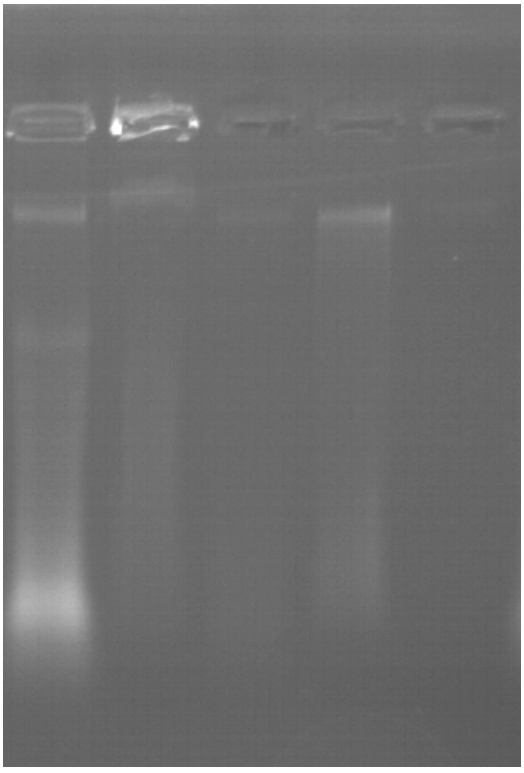

Figure 1. Agarose gel electrophoresis results of the *Cystoseira sp.* DNAs by different extraction methods.

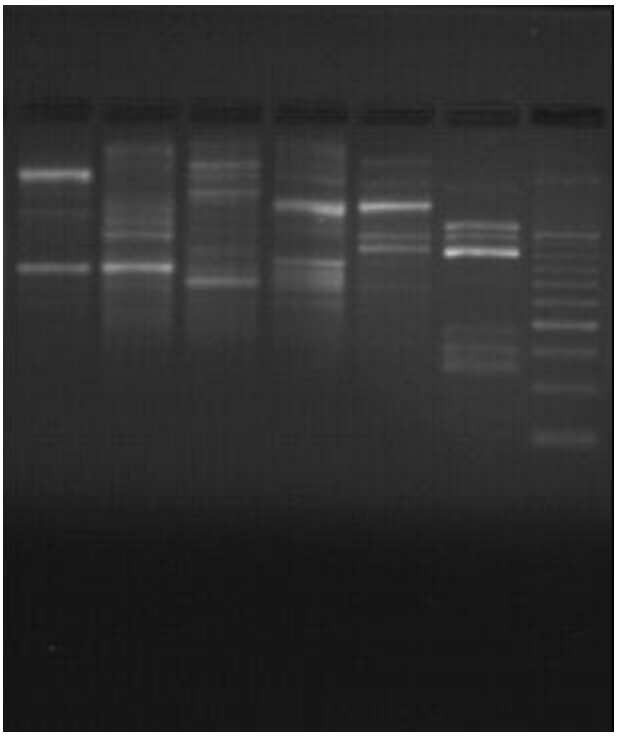

Figure 2. Agarose gel electrophoresis results after RAPD-PCR analysis. Line 1-6: *Cystoseira barbata, C. compressa, C. mediterranea, C. crinita, Ectocarpus sp*. and *Scytosiphon lomentaria* respectively, Line 7: DNA ladder 100 bp.

4. Conclusions

The efficient DNA extraction protocol from brown algae for molecular analysis described in this study. The main differences of the DNA extraction protocols from algae and other organisms is the chemicals that used for elemination of the polysaccharides. These chemicals are β-ME, PVP (Polivinilpirrolidon) and SDS (Sodiumdodecil sulfate). Increased consantrations of this chemicals used for brown algae because of the high contents of polysaccharides and phenolic compounds of the thallus. We used only β-ME and PVP among these chemicals. According to the results the efficient DNA extraction methods are first and the second protocols. The only method that has PVP step is the second one. One of the reason that second protocol yielded efficient DNA for the PCR analysis could be this feature. If we compare the third method with the first one which include same chemicals we could see the concantration differences about β-ME between them. The first method has brighter bands than third one in the agarose gel electrophoresis. This could be the consequence of the high concantration of β-ME that first protocol has. The fourth method which does not include liquid nitrogen grinding step gave the lowest DNA yield.

After the spectrophotometry and agarose gel electrophoresis analysis we could say that the most efficient methods are the first and second protocols.

These two DNA isolation protocols tested again by changing their incubation extentions in different steps. The target was to find the efficient incubation time with low contamination and high DNA quantity. Incubation with CTAB buffer for a short period and isopropanol, for a long period gave good DNA yield for molecular analysis. Coyer et al. (1995) searched the efficiency of grinding with liquid nitrogen step in DNA extraction protocols. In their study 12 algae samples tested in two different experiment. In the first experiment the first group of samples incubated in extraction buffer with SDS for 45 minutes after grinding in liquid nitrogen. The second group incubated by same way without liquid nitrogen step. In first group of second experiment the samples incubated in extraction buffer for a week after grinding in liquid nitrogen. In the second group this proccess done without liquid nitrogen step. In the first experiment they found differences between the two groups. The first group yielded 64% much DNA than second group. In the second experiment they couldn't find noticeable differences between the two groups. According to that study, the time and labour consuming liquid nitrogen step of DNA extraction protocol gave the same result with 1 week incubation step. By that study a field-competible DNA extraction method was constituted.

In our study the extraction method with liquid nitrogen step was preferred instead of one week incubation period. Although one week incubation seems long period for incubation, it is competible for laboratory away field studies. Because of the chemicals and the equipments are eassly available in all labororatory, makes this extraction method

suitable for the molecular studies with marine algae. Also this protocol requires less amount of algae sample for DNA extraction.

PCR analysis with RAPD primers has shown that the first DNA extraction method is appropriate for molecular analysis. In this RAPD-PCR analysis four *Cystoseira* species, *Ectocarpus sp*. and *Scytosiphon lomentaria* used by four RADP primers.

The aim of this study is to describe the efficient DNA extraction protocol from macro marine algae for the purpose of molecular analysis. Different DNA extraction protocols have been tested by modifying them. After getting results the best protocols have been tested again by chancing their incubation times. After all these analysis, the liquid nitrogen application found necessary for DNA isolation. The most effective protocol tested in this study is the first one which includes liquid nitrogen grinding step. The effectiveness of this protocol probably depends on the β- ME content of the extraction buffer. This metodology should prove to be applicable to an even wider variety of algae especially the sample material is limited.

References

Bold, H.C, Wynne M. J. 1978. Introduction to the algae: structure and reproduction. New Jersey: Prentice-Hall Inc.

Coleman, A. W., L. J. Goff, J. R. Stein-Taylor. 1989. Algae as Experimental Systes. A. R. Liss, Inc., New York.

Colosi, Schall 1993. CTAB miniprep DNA extraction protocol. Laboratuary Book.

Coyer, J.A., Steller, D.L., Alberte, R.S. 1995. A field-competible method for extraction of fingerprint-quality DNA from *Macrocystis pyrifera* (Phaeophyceae). J. Phycol. 31: 177-180.

Dutcher, S. K., J. Power, R. E. Galloway and M. E. Porter, 1991 Reappraisal of the genetic map of Chlamydomonas reinhardtii. J. Hered. 82: 295–301.

Anna Godhe, Donald M. Anderson, Ann-Sofi Rehnstam-Holm. PCR amplification of microalgal DNA for sequencing and species identification: studies on fixatives and algal growth stages. Harmful Algae 4 (1): 375-382.

John M. E. 1992. An efficient method for isolation of RNA and DNA from plantscontaining polyphenolics. Nucleic Acids Res. 20: 2381.

Saunders, G.W. 1993. Gel purification of red aldal genomic DNA: an inexpensive and rapid method for the isolation of polymerase chain reaction- friendly DNA. J. Phycol. 29, 251-254.

Shioda M., Murakmi-Murofusi K. 1987. Selective inhibition of DNA polymerase by polysaccharide purified from slime of Physarum polycephalum. Biochem. Biophys. Re. Commun. 146: 5279-5280.

Sosa & Olivera, 1992. Nucleic acid extraction from seaweed tissues for polymerase chain reaction. Journal of Marine Biotechnology 5: 95-99.

Staves M. P., J. W. LaClaire. 1985. Nuclear synchrony in Valonia macrophysa (Chlorophyta) light microscopy and flow cytometry. J. Phycol. 21: 68-81.

Steen, S.W. 1999. Handbook for DNA isolation, RAPD-PCR and PCR-RFLP. Botanical Garden and Museum, University of Oslo.

Vidal et al., B. Vidal, C. Pasqualini, N. Le Belle, M.C. Holland, M. Sbaihi, P. Vernier, Y. Zohar and S. Dufour, 2004. Dopamine inhibits luteinizing hormone synthesis and release in the juvenile European eel: a neuroendocrine lock for the onset of puberty, *Biol. Reprod.* 7: 1491–1500.

Wattier, R.A., Prodolh, P.A., Maggs, C.A. 2000. DNA isolation protocol for red seaweed (Rhodophyta). Plant Molecular Biology Reporter 18: 275-281.

James L. Wee, Joby Chesnick, Rose Ann Cattolico. 1992. Partıal Characterızatıon Of The Chloroplast Genome From The Chromophytıc Alga *Synura Petersenıı* (Synurophyceae). Journal of Phycology 29-1: 96-99.

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Biodiversity study of SIS (Small Indigenous Species) of fish in Northwest part of Bangladesh and detection of threatened species

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Abstract

This study provides the current status of small indigenous fish species especially the threatened species. Regular data were collected from some important urban and peri-urban fish markets and from natural waters of the Northwest part of Bangladesh. The availability of SIS of fish declined to a great extent over the years and many of them are rare or endangered. Due to high population growth there is an ever-increasing gap between supply and demand of SIS of fish. Some rivers of the Northwest part of Bangladesh are well connected with Indian rivers and that causes the SIS of fish diversity in the natural waters comparatively rich. The most significant message of this study is that, some vulnerable and endangered SIS of fish are locally abundant in the natural waters of the Northwest part of Bangladesh. So they should be conserved for their common availability and sustenance throughout the country that would be a most important step in favor of global ichthyo-biodiversity conservation.

Key words: Ichthyo-biodiversity, small indigenous species, endangered fish, Bangladesh.

1. Introduction

Bangladesh is blessed with numerous inland water bodies which are very rich in diversity of aquatic species. In the past, various SIS of fish were abundant in the rivers, beels, canals, streams and ponds. These are usually caught by the subsistence fishermen that provided a large portion of the animal protein intake of them. Since 1970s the abundance of small indigenous fish species has been declining due to despite their ability to reproduce quickly and withstand poor environmental conditions. Both natural and manmade catastrophes degradation of aquatic environment and the reduction of many wetlands and water areas of Bangladesh have resulted in the disappearance of many suitable habitats of floodplain riverine and brackish water small indigenous fish species (Wahab *et al*., 2003). Many of these valuable indigenous fish species have been threatened or endangered. Indeed some are already on the verge of extinction. Small indigenous species (SIS) of fish are important source of nutrition and livelihood for the rural people of Bangladesh. SIS of fish in our country is considered to those which grow to a maximum length of about 25 cm or 9 inch at maturity (Khanam *et al*. 2003; Felts *et al.* 1996; Hossain *et al.*, 1997 and 1999). From the 260 freshwater fish species of Bangladesh, over 150 species have been classified as small indigenous species (SIS). These small indigenous fish species are the main, indeed the only source of the protein and most of the fat soluble vitamins for the rural people who represent more than 80% of the total population (Hossain *et al.* 2002).

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Besides, Due to high population growth there is an ever-increasing gap between supply and demand of fish (including SIS) in Bangladesh. Narrowing the gap not only requires increasing production but also improvements at all aspects of marketing and distribution systems (ICLARM 1991, SAARC, 1994).

However, as SIS of fish have been considered as an important source of essential macro and micro nutrients, they can play a vital role in the elimination of malnutrition. SIS of fish can play a significant role to prevent night blindness as a rich source of vitamin-A. Analysis SIS of fish showed that they contain large amount of calcium and most likely also iron and zinc. Some species of fish like mola, dhela, darkina and kaski etc. also contain high amount of vitamin-A (Thilsted *et al.*, 1997). Anyway, although some researchers have been conducted research on SIS of fish in Northern part of Bangladesh (Hossain *et al.*, 1997; Afroze *et al.*, 1997), sufficient data on biodiversity of SIS of fish in the Northwest part of Bangladesh especially in Dinajpur district has not yet been available . So, the present study has been classified on the following objectives**:**

- To know the biodiversity of SIS of fish in Dinajpur district
- To identify status of threatened SIS of fish in Dinajpur district

2. Materials and methods

Bangladesh lies between the longitude of 88E and 92.30 E and the latitudes of 20 N and 26.30 N. The country is an extensive plain land except its eastern and southeastern margin where low ranges of Lusai and the Garo Hills are found. This flat plain is built by the enormous load of alluvium laid down by the great rivers and their tributaries (Rahman, A. K. A., 2005). This country is called country of hundred rivers and it has 290 rivers from which 94 are international along with numerous ponds, beels, haors, lakes, flood plains, brackish water and marine waterbodies. However, Northwest part of Bangladesh is mainly important for the availability of various freshwater ecosystems.

The research work has been performed from January – December/2008. Two types of fish markets were used for this study- urban and peri-urban fish markets. On the other hand, required data about SIS of fish were collected from important rivers and beels of the Northwest part of Bangladesh.

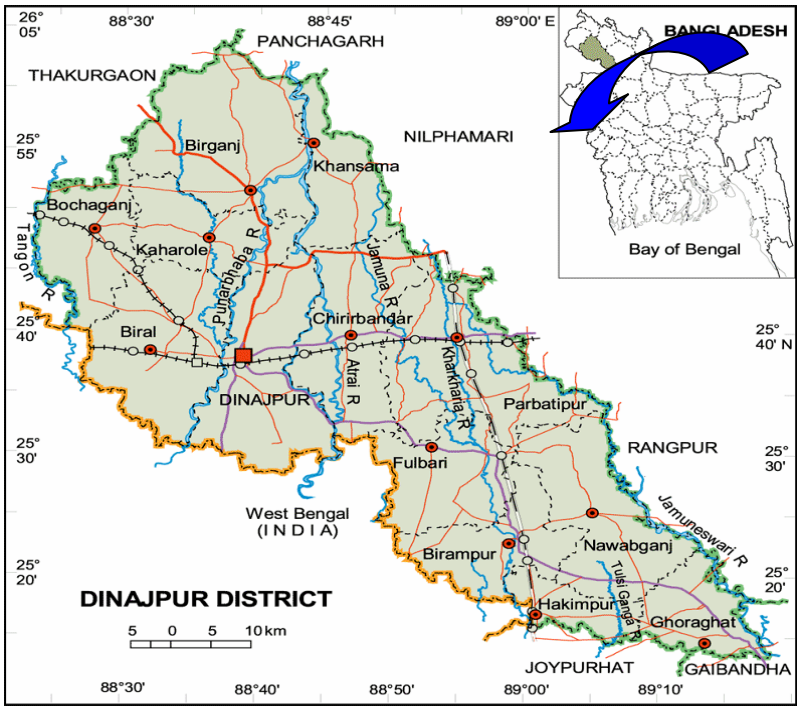


Figure-1. Map of Dinajpur district showing data collection areas

The urban and peri-urban fish markets from where data were collected are-

i) Urban fish markets: Bhahadur bazar, Railway bazar, Fulbari bazaar and Parbotipur bazar.

ii) Peri-urban fish markets: Basherhat fish market, Jamtoli bazaar, Doshmail bazar, Bushirbandar bazar and Chirirbandar bazar.

2.1 Experimental fish markets

a) Urban fish markets: Among the studied urban fish markets, Bahadurbazar if a larger fish market of the Northwest part of Bangladesh and is situated in the main town of Dinajpur district. Fish from various natural waters and ponds of different sites of Dinajpur district have been supplied here for selling. Fishes have also been distributed to various local small fish markets of this district from here. The main consumer group of this fish market is businessman and service holders. Besides, Railway bazar, Fulbari bazar and Parbotipur bazar are also the largest fish markets of the Northwest part of Bangladesh which are located in various upazilas of Dinajpur district.

b) Peri-urban fish markets: The data collecting peri-urban fish markets of this study were- Basherhat fish market, Jamtoli bazaar, Doshmail bazar, Bushirbandar bazar and Chirirbandar bazaar which are located near to important natural waters of the Northwest part of Bangladesh. The main consumer groups of these peri-urban fish marketsS are the villagers, businessmen and service holders of the respective localities.

2.2 Experimental natural waterbodies

Required data about small indigenous species of fish (SIS) were collected from important natural waterbodies of the Northwest part of Bangladesh. The list of survey conducted natural waterbodies is given below:

Table 1. The list of survey conducted natural water bodies

Type of the water body	**Name**	**Location**
River	Kankra river	Chirirbandar
	Atrai river	Chirirbandar
	Choto jamuna	Parbatipur
	Gorveshori river	Parbatipur
	Kanchan river	Dinajpur sadar
	Dhepa river	Dinajpur sadar
Beel	Koroi beel	Birol
	Asholia beel	Nowabganj
	Small local beels	Dinajpur Sadar

2.3 Data collection

Field works were undertaken in each of the 6 Upazillas over which important rivers and beels spread in Northwest part of Bangladesh: Dinajpur sadar, Parbatipur, Fulpur, Chirir bondar, Birol and Nawabgonj. Data were collected from: interviews and focus group discussions with fishermen, retailers, middlemen and consumers of fish; secondary literature, semi structured and structured questionnaires were developed, pretested and adapted prior to the survey proper. Weekly sampling was performed through the whole year from the major natural water bodies and fish markets of the Northwest part of Bangladesh both in morning (7 am to 9 am) and evening (4 pm to 6 pm).

2.4. Data analysis

The analysis of the data mainly involved tabular and descriptive technique. The data were summarized and a number of tables and graphs were prepared in accordance to the objectives of the study. The technique of analysis included the classification of tables and graphs into meaningful result by arithmetic mean and Percentage.

2.5 Species identification

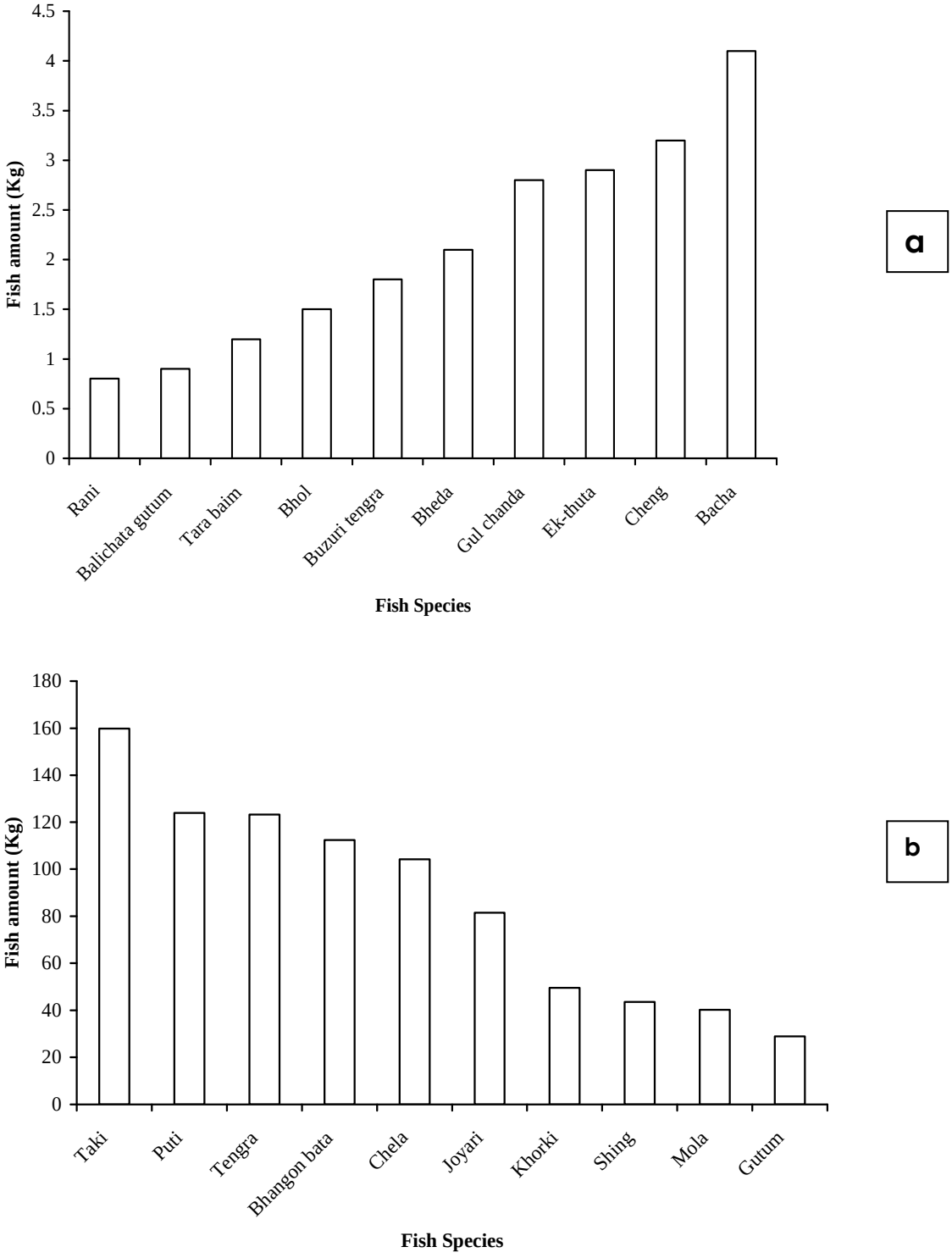
The collected fish were identified on the basis of the descriptions of Rahman (2005), Jhingran and Talwar (1991) and Froese and Pauly (2007).

3. Results

3.1. Supply of SIS of fish in the studied fish markets of the Northwest part of Bangladesh:

The supply of SIS of fish in the urban fish markets during the study period found to average range normally 0.8-160 kg per month. Besides, a few number of SIS of fish were also irregularly supplied in this fish market. The minimum average 10 lowest and highest SIS of fish were shown in the figure-2 (a, b). It is found that most abundant SIS of fish are Taki, Punti, Tengra, Chela, Khoki, Jouary etc. and least supplied SIS are Rani, Tara bain, Ek-thuta, Bhol etc. On the other hand, in Basherhat fish market (periurban fish market) the height supplied SIS of fish were Tila

koksha (khorki), Joya (Jouary), Tengra, Chela, Gutum, Punti, Bhangan bata, kolisha etc and least supplied SIS of fish were Koi, Magur, Balichata gutum, Rani, Tara baim, Golsha etc. The monthly average 10 height dominant and least supplied SIS of fish are presented in the figure – 3 (a, b). All the highest available fish species were found every day in both fish markets in the study period. But the least available SIS of fish were not regularly found. Such as, Rani (*Botia dario*) was found only for three days; Putul rani (*Botia lohachata*) was found in five days; Tara baim was found for seven days; Bhol was seen only for ten days; Buzuri tengra was found for twelve days and Bheda was found for thirteen days only.



Fgure-2(a, b). The monthly average (kg) 10 least supplied (a) and highest supplied (b) SIS of fish in the Urban fish markets

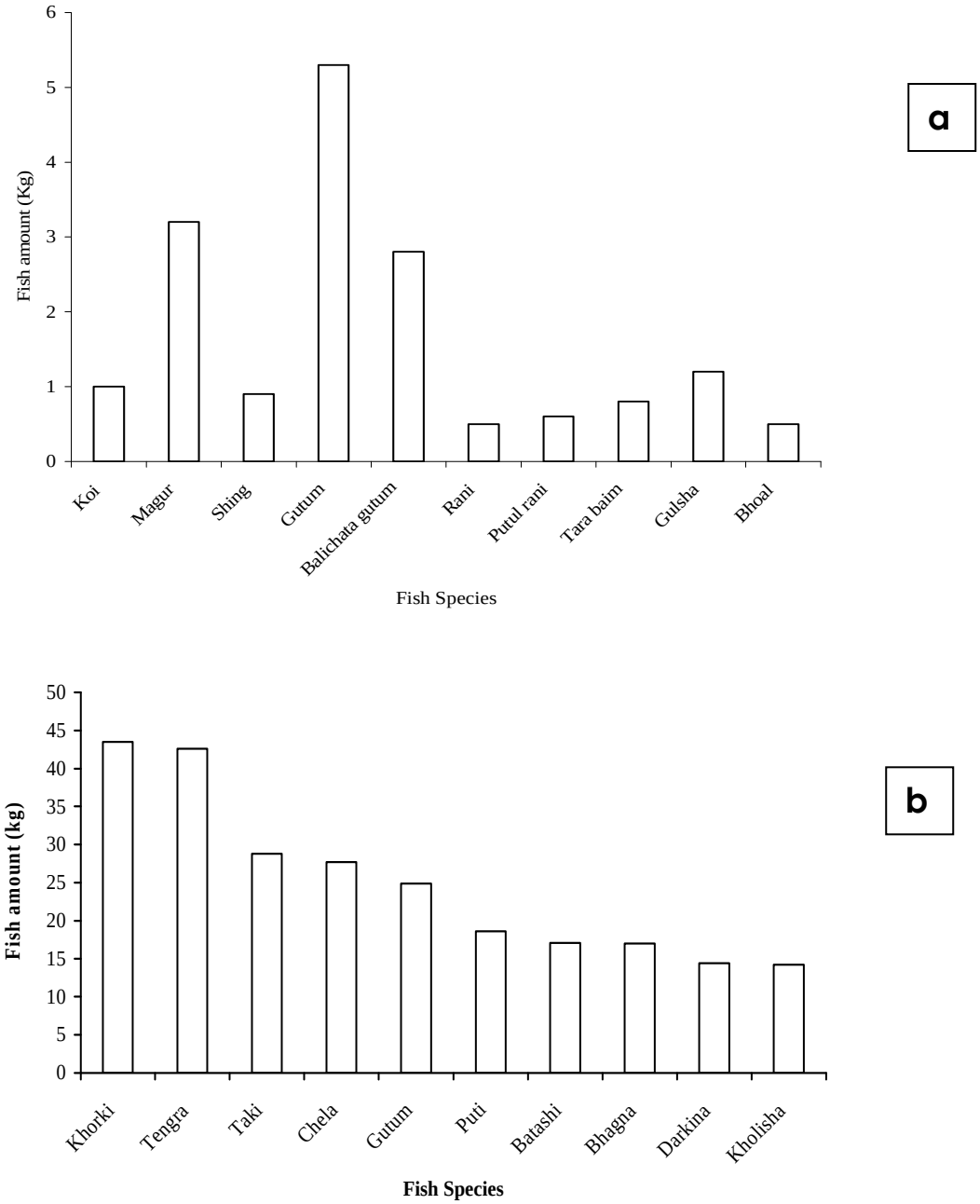


Figure-3 (a, b). The monthly average (kg) 10 least supplied (a) and highest supplied (b) SIS of fish in peri-urban fish markets

Apart from this, during the study period it was observed that some species were found as mixture with the above cited SIS of fish and these were rarely available such as-, Bagir, Potka, Kanpona, Cheka, Sissor, Chebli, Shilong, Kajoli, Napitkoi, Nephtani etc. The total found SIS of fish in the studied fish markets of the Northwest part of Bangladesh is shown in the table-2. It was found that a total of 45 SIS of fish were supplied in the studied urban and peri-urban fish markets of the Northwest part of Bangladesh. There sources were both the natural waters and culture ponds.

Table 2. List of the supplied SIS of fish in the studied fish markets of the Northwest part of Bangladesh

Sl. no.	**Local name**	**Scientific name**
1.	Juary/Joya	*Aspidoparia jaya*
2.	Khorki/Tila Koksa	*Barilius tileo*
3.	Bhangon bata	*Labeo bata*
4.	Bhagna/Tatkini	*Cirrhinus reba*
5.	Jat puti	*Puntius sophore*
6.	Tit punti	*P. ticto*
7.	Pahari gutum	*Somileptes gongota*
8.	Gutum/Puiya	*Lapidocephalus guntea*
9.	Rani	*Botia dario*
10.	Putul rani	*B. lohachata*
11.	Magur	*Clarias batrachus*
12.	Shingi	*Heteropneustes fossilis*
13.	Batasi	*Pseudeutropius atherinodes*
14.	Golsha	*Mystus cavasius*
15.	Bujuri tengra	*Mystus vitatus*
16.	Foli	*Notopterus notopterus*
17.	Tara baim	*Macrognothus aculeatus*
18.	Guchi baim	*Mastacembelus pancalus*
19.	Kolisha/chopra	*Colisa fasciatus*
20.	Boicha	*C. lalia*
21.	Koi	*Anabus testudineus*
22.	Nama chanda	*Chanda nama*
23.	Gul chanda	*Pseudanbasis ranga*
24.	Kakila	*Xenentodon cancila*
25.	Taki/lata	*Channa punctatus*
26.	Cheng	*C. orientalis*
27.	Ghora chela	*Securicula gora*
28.	Narkali chela	*Salmostoma bacaila*
29.	Mola	*Amblypharyngodor mola*
30.	Kaski	*Corica soborna*
31.	Mola punti	*Puntuius guganio*
32.	Modho pabda	*Ompok pabda*
33.	Balichata gutum	*Acanthocobitis botia*
34.	Shilong	*Silonia silonia*
35.	Kajuli/Baspata	*Ailia coila*
36.	Chapila	*Gudusia chapra*
37.	Napit	*Badis badis*
38.	Dhela	*Ostiobrama cotio*
39.	Chep chela	*Chela cachinus*
40.	Chebli	*Danio devario*
41.	Bani koksha	*Barillius barna*
42.	Chuna kolisha	*Colisa sota*
43.	Kani pubda	*O. bimaculatus*
44.	Phutani punti	*P. phutunio*
45.	Hora gutum	*Nemacheilus sikmaaiensis*

3.2. Demand of SIS of fish in the studied fish markets

SIS of fish were not well demanded in past due to their abundance in rivers, hours, beels and other natural waterbodies. But presently SIS of fish are not commonly abundant in natural waterbodies. Another important thing is that as the SIS of fish are highly nutritional and tasty they are highly demanded to health aware people. The low supply and high demand make some SIS of fish like Mola, Dhela , Pabda, Chela, Shing, magur etc. very expensive. In a word, it can be said that the supply of SIS of fish is declining where the demand is increasing gradually. Khanam *et al*., (2003) was also found similar result in a study conducted in peri-urban fish markets.

3.3. Market chain of SIS in the Northwest part of Bangladesh

The marketing channel of SIS of fish varied from one place to another. Anybody can purchases SIS of fish from anybody and anyone can sell SIS to anybody. The general marketing pattern of SIS of fish including a number of middlemen. Incase of urban fish markets, the market chain from fisherman to consumers passes through a number of intermediaries: after buying fish from fisherman/farmer, middleman (locally known as foria) bring them to the wholesale market and sale to the wholesaler (Arotdar). The retailers buy SIS of fish from wholesaler through auction with a highest bid. The retailers then bring the SIS of fish to particular market where they usually sale the fish to the consumers. There is no licensing system of fish retailer and middlemen. Fisherman or fish farmer also sale SIS of fish directly to the wholesaler or even to the consumers (figure-4) mainly in peri-urban fish markets. It is a very common scenario almost in all the sites of Bangladesh that fishermen and fish farmers do not get expected price from their harvested fishes although consumers have to pay high price to buy from the retailers where ultimately middlemen become benefited. This statement is also supported by Hossain *et al*., (2002). Hannan (1994) described that fishermen lived from hand to mouth and highly highly neglated class in both Muslim and Hindu society. Baily (1994) also noted fishermen and their families is South and Southeast Asia often are considered to be among the poorest of the poor.

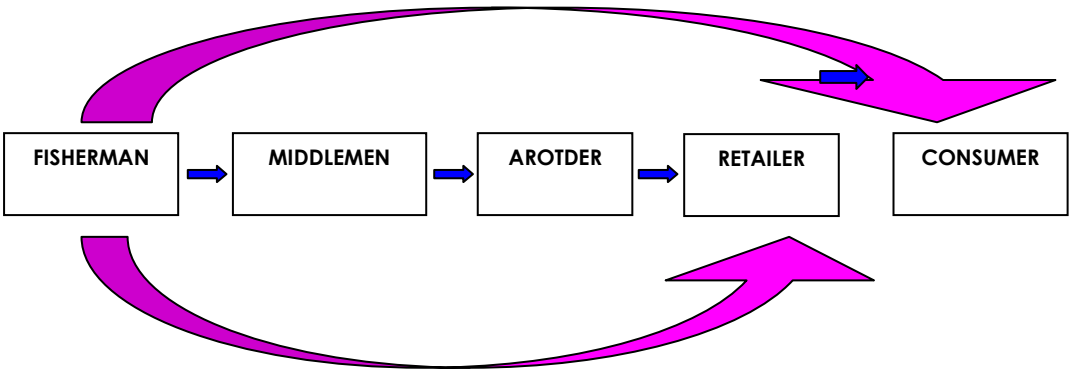


Figure 4. Marketing chain of SIS of fish in the Northwest part of Bangladesh

3.4. Present status of SIS of fish biodiversity in the Northwest part of Bangladesh

Due to warm temperature, good rainfall and nutrient rich fertile soils and waters make the aquatic environment of Bangladesh rich in varieties of aquatic flora and fauna. The vast wetlands, wide river-bed systems, rainfall and warm temperature play a significant role in the rich ichthyo-diversity of this country. There are a total of 260 species of indigenous freshwater fish belonging to 55 families are available in Bangladesh. Out of them 143 freshwater fishes are categorized as small indigenous species (SIS) of fish. Most of the SIS of fish were available in the natural waterbodies of the Northwest part of Bangladess. Since 1970s, the production of SIS of fish has been declining despite their ability to reproduce of short intervals and withstand poor environmental conditions. However, the list of identified SIS of fish of the Northwest part of Bangladesh is mentioned in the table-3.

A total of 61 small indigenous species of fish was identified collected from various natural waters. Because of various environmental modification and man made interventions, some SIS of fish are in endangered or critically endangered in Bangladesh (IUCN, 2001). Similarly, in the natural water bodies of the Northwest part of Bangladesh, some SIS of fish are reducing alarmly and found very rare. More or less same statement is described by Hossain *et al*., 2003. According to them, the habitat degradation recently has become a great concern in most aquatic ecosystems in Bangladesh. Marked changes have been observed in natural fish populations of many fish species because of unplanned environmental modifications and man made interventions affecting the spawning and feeding grounds of fishes. In this situation, it is crucial that appropriate measures to be taken to reduce habitat loss to conserve aquatic ecosystem and to protect the biodiversity of the SIS of fish. It is clear that availability of SIS of fish is gradually declining through out the country.

Table3. Presently identified SIS of fish biodiversity in the Northwest part of Bangladesh

Sl. No.	**Local Name**	**Common Name**	**Scientific Name**
1.	Kakila	Indian needdle fish	*Xenentodon Cancila*
2.	Ek-thota	Congaturi halfbeak	*Hyporhamphus limbatus*
3.	Taki	Spotted snakehead	*Channa punctatus*
4.	Cheng	Walking shakehead	*Channa orientalis*
5.	Rani	Bengal Loach	*Botia dario*
6.	Putul rani	Reticulata loach	*Botia lohachata*
7.	Chep chela	Minnow	*Chela cachius*
8.	Narkeli chela	Large razorbelly minnow	*Salmostoma bacaila*
9.	Mola	Mola carplet	*Amblypharyngodon mola*
10.	Dhela	Cotio	*Osteobrama cotio cotio*
11.	Kaski	Ganges river spral	*Corica soborna*
12.	Chapila	Sardine	*Gudusia chapra*
13.	Modo pabda	Pabdah catfish	*Ompok pabda*
14.	Bheda bhol	Trout barb	*Raiamas bola*
15.	Bhangan bata	Boga labeo	*Labeo bata*
16.	Bacha	Garu bacha	*Clupisoma garua*
17.	Korki	Tila koksha	*Barilius tileo*
18.	Juary/ Joya	Jaya	*Aspidoparia jaya*
19.	Bele	Tank goby	*Glossogobius giuris*
20.	Bagair	Dwarf goonch	*Bagarius bagarius*
21.	Gang magur	Grey eel-catfish	*Plotosus canius*
22.	Potka	Ocellated puffer fish	*Tetraodon cutcutia*
23.	Khanpona	Blue panchax	*Aplocheilus panchax*
24.	Darkina	Flying barb	*Esomus danricus*
25.	Panga	Panga	*Pangio pangia*
26.	Cheka	Squarehead catfish	*Chaca chaca*
27.	Sisor	Sissor catfish	*Sisor rhabdophorus*
28.	Bhagna	Reba carp	*Cinhinus reba*
29.	Chebli	Sind danio	*Danio devario*
30.	Shilong	Sliond catfish	*Silonia silonia*
31.	Kajoli	Gangetic ailia	*Ailia coila*
32.	Mola punti	Glass barb	*Puntius guganio*
33.	Phutuni Punti	Spotted barb	*Puntius phutunio*
34.	Jat punti	Pool barb	*Puntius Sophore*
35.	Tit punti	Ticto barb	*Puntius ticto*
36.	Sarputi/Punta	Olive barb	*Barbodes sarana*
37.	Puiya/ Gutum	Guntea loach	*Lepidocephalus guntea*
38.	Hora gutum	Anandale loach	*Lepidocephalus annandalei*
39.	Pahari gutum	Gongota loach	*Somileptes gongota*
40.	Belichata gutum	Mottled loach	*Acanthocobitis botia*
41.	Shing	Stinging catfish	*Heteropneustes fossilis*
42.	Magur	Walking catfish	*Clarias batrachus*
43.	Tengra	Day's mystus	*Mystus bleekeri*
44.	Buzuri tengra	Ghuitta tengra	*Mystus tengra*
45.	Batashi	Indian potasi	*Pseudeutropius atherinoides*
46.	Gulsha	Gangetic mystus	*Mystus cavasius*
47.	Foli	Bronge feather back	*Notopterus notopterus*
48.	Tara baim	Lesser spiny eel	*Macrognathus aculeatus*
49.	Guchi	Barred spiny eel	*Mastacembelus pancalus*
50.	Kolisha	Banded gourami	*Colisa fasciatus*
51.	Choto Kolisha	Dwarf gourami	*Colisa chuna*
52.	Boisa / Chuna kolisa	Dwarf gourami	*Colisa lalia*
53.	Napit koi / Napit	Spiketail paradise fish	*Badis badis*
54.	Bheda	Mottled nandus	*Nandus nandus*
55.	Koi	Climbing perch	*Anabus testudineus*
56.	Nama chanda	Glassy perchlet	*Chanda nama*
57.	Gul chanda / Ranga chanda	High fin glassy perchlet	*Pseudambassis lala*
58.	Lal chanda	Indian glassy fish	*Pseudomonas ranga*
59.	Nephtani	Frail gourami	*Ctenops nobilis*
60.	Kani pabda	Butter catfish	*Ompok bimaculatus*
61.	Bhangan bata	Boga labeo	*Labeo bata*

Out of one hundred forty three (143) SIS of freshwater fish species of Bangladesh, fifty four (54) are considered as threatened species by IUCN (2001). A authentic study (FAP6, 1994) has also found that the number of the number of fresh water fish species have been gradually declining and some species have been locally extinct. Full flood control and control flooding had an adverse impact on fish biodiversity and resulted in a reduction of 33% of the total number of fish species recorded annually in Bangladesh. Although it is the common scenario for natural waters of Bangladesh some exceptional information is true for the natural waters of the Northwest part of Bangladesh. After completion of this experiment, it has been observed that a few critically endangered and endangered SIS of fish are abundantly found in the natural waterbodies of the Northwest part of Bangladesh especially in Dinajpur district. The list of commonly abundant threatened SIS of fish is presented in the table-4. It was observed that more or less 16 important SIS of threatened fish are commonly available in the North-west part of Bangladesh. Although fifty four (54) are considered as threatened species by IUCN (2001) through out the Bangladesh, 16 endangered SIS of fish are locally common available in the Northwest part of Bangladesh due to the well connection of some Indian rivers with the natural waters of Dinajpur.

Table 4. Commonly available threatened SIS of fish in the natural waters of the Northwest part of Bangladesh

Sl. Number	**Local name**	**Scientific name**	**National status**
1.	Juary/Joya	*Barilus bengalensis*	Endangered
2.	Khorki/Tila koksha	*Barilius tileo*	Endangered
3.	Bhagna	*Cirrhinus reba*	Vulnerable
4.	Bhangan bata	*Labeo bata*	Endangered
5.	Foli	*Notopterus notopterus*	Vulnerable
6.	Chela	*Chela laubuca*	Endangered
7.	Tit punti	*Puntius ticto*	Vulnerable
8.	Sarpunti/Puta	*Barbodes sarana*	Endangered
9.	Tara baim	*Macrognathus aculiatus*	Endangered
10.	Balichata gutum	*Acanthocobitis botia*	Endangered
11.	Phari gutum	*Somileptes gongota*	Endangered
12.	Rani	*Botia dario*	Endangered
13.	Putul rani	*Botia lohachata*	Endangered
14.	Golsha tengra	*Mustus cavasius*	Vulnerable
15.	Ghaura	*Clupisoma garua*	Critically endangered
16.	Bhol	*Raiamas bola*	Endangered

Therefore, it is a very important message for our nation because if we immediately take protective measures to conserve these commonly available rare SIS of fish in natural waters of the Northwest part of Bangladesh, then our country would be able to save them from their extinction. Educationalists, journalists, social workers, nutritional researchers, NGOs are interested in managing the sustainable aquatic habitats for all these smaller fishes. But the improvement of farming system particularly for the HYV, setting up of industries, encroachments of wet lands for agro cropping, populations explosion, over-fishing and dewatering with mechanized pumps etc. damage the environments in some cases at beyond recovery level. All these activities declining the aquatic biodiversity including ichthyo-biodiversity and the biota that are now threatened due to environmental destruction (Hossain 1992 & 1997 a,b).

4. Conclusions

Recently we can see more slogans such as Globalization, Green house effects, Poverty alleviation, Sustainable management resources, Livelihood approach and Organic farming etc. Incorporation on small indigenous fish species (SIS) in the carp polyculture system away from all these slogans. It is the duty of the scientists, social workers, donor agencies and Government organizations to aware the people and communities about the potential role in ensuring nutritional security and poverty alleviation of the rural poor in Bangladesh through protecting and conserving of small fishes. The availability of SIS of fish is in decline, partly due to fishing pressure from the ever increasing population and partly due to loss of natural habitats.

Apart from this, the presently practiced carp and large fish always encourage fish farmer to eliminate indiscriminately all the SIS from their waterbodies before large fish stocking. It causes the supply of SIS of fish is highly fluctuating and far less than the market demand. So, the price is increasing alarmingly. Therefore, once mostly abundant and easily available SIS of fish is quickly getting out of the reach of poor people and ultimately become gradually rare available. So, it is significant and urgent to take all the necessary steps to protect and conserve all the most and least available SIS of fish through out the world including Bangladesh.

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References

Afrose, S., Sultana, S., and Hossain, M. A. 1997. Small fish as a source of nutrition for our people. Proc.National Workshop on Small Indigenous Fish Culture in Bangladesh, Rajshahi University, PP. 57- 64.

Bailey, C. 1994. Employment, labour productivity and income in small-scale fisheries of South and Southeast Asia. In: Socio-economic issues in Coastal Fisheries Management. Proceedings of the IPFC Symposium, Bankok, Thailand, 23-26 November, 1993; FAO Indo pacific Fishery Commission (IPFC), no. 8 pp. 24-45.

Felts, R. A., Rajts, F., and Akteruzzaman, M. 1996. Small indigenous fish species culture in Bangladesh. IFADEP Sub-Project - 2. Development of Indian Fisheries. 41 PP.

Hannan, M. 1994. Fisherfolk organization in Bangladesh. In: Socio-economic issues in Coastal Fisheries Management. Proceedings of the IPFC Symposium, Bankok, Thailand, 23-26 November, 1993; FAO Indo pacific Fishery Commission (IPFC), no. 8 pp. 216-222.

Hossain, M.A., Ahsan, M.K., and Hussain, M. A. 2003. Small fish resources in the rivers, flood plains and unplanned areas of Bangladesh. Technical Proc. of BAU-EENRECA/DANIDA Workshop on Potentials of SIS in Aquaculture and rice-field stocking for improved food of nutrition security in Bangladesh. 30-31October 2002, BAU, Mymensingh, Bangladesh. pp. 166.

Hossain, M.A. and Afoze, S. 1991. Small fish as resource in rural Bangladesh. Fish byte, 9(2). 16-18.

Hossain, M.A., Afsana, K., and Azad Shah, A.K.M. 1999. Nutritional value of some. Small indigenous fish species (SIS) of fish in Bangladesh, Bangladesh Journal of Fisheries Research 3(1). 77-85.

Hossain, M.A. 1997a. Conservation of animals for a balanced environment. Presidential address, Silver Jubilee (1972-1997), Zoological Society of Bangladesh (ZSB), Department of Zoology, Dhaka University, July 2-3, pp. 24-30.

Hossain, M.A. 1997b. Various aspects of small indigenous species (SIS) of fish in Bangladesh. Proc. Nat. Workshop on SIS culture in Bangladesh, December 12, 1996, key note speech, IFADEP SP–2, PP. 16-30.

Hossain, M. A., 1992. Role of biologists in sustainable development and biological resource management. Souvenir, 8th National Conference of Zoological Society of Bangladesh, Rajshahi University, January 29-31, pp. 22-32.

Hossain, M.A.R., M. Z. Ali., M.N.A. Khanam., S. Devnath, and A.K.M. R. Amin. 2002. Participatory rural appraisal with small indigenous species of fish (SIS) retailers in two fish markets. Progress. Agric. 13(1 and 2): 133-138.

Jhingran A. G., and Talwar, P. K. 1991. Inland Fishes of India and Adjacent Countries, Vol. I.&2. 1158 p. Oxford and HIB Publishing Co., Pvt. Ltd., New Delhi, India.

Rahman, A. K. A., 2005. Fresh water fishes of Bangladesh. 2 nd edn. Zoological Society of Bangladesh, Dhaka, Bangladesh, 71-310 p.

Thilsted, S.H., N. Roos, and N. Hasan, 1997. The role of small indigenous fish species in food and nutrition security in Bangladesh. NAGA- The ICLARM Quartery, July-Dec . 13-15.

ICLARM, 1991. Socioeconomic impact of fish culture extension programme. Annual progress report, ICLARM, Dhaka.

IUCN, 2001. Red book of threatened fishes of Bangladesh. IUCN- The world Conservation Union. 116 pp.

Khanam, M.N.A., Ali. M.B., Ali, M. M., and Hossain, M. A. R. 2003. Supply and marketing channel of small indigenous species of fish and livelihood strategy of the retailers in a peri- urban fish market. Technical proc. of BAU-DANIDA. Workshop on potentials of SIS in Aquaculture and Rice- field stocking for improved food nutrition security in Bangladesh. PP. 135-142.

Froese R. and Pauly. 2007. Fish Base. Available from URL:http://www.fishbase.org/Country/Country Checklist. php.

SAARC, 1994. Proc. SAARC Workshop on fisheries socioeconomics and marketing. Bangladesh Agricultural Research council (BARC), Dhaka.

Wahab, M. A. 2003. Small indigenous fish species of Bangladesh: Potentials for culture and conservation. Technical Proc. of BAU-EENRECA/DANIDA Workshop on Potentials of SIS in Aquaculture and rice-field stocking for improved food of nutrition security in Bangladesh. 30-31 October 2002, BAU, Mymensingh, 1-12.

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A new record for Turkish Mycota: *Serpula lacrymans* (Wulfen) J.Schröt

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Abstract

This fungi specimen is founded in Dolmabahçe Palace at the time of restoration – conservation processes; it has been identified as *Serpula lacrymans* (Wulfen) Schröt and registered for the first time in Turkey. This fungus is defined and photographed. The photo of the spores seen under the light microscope is given in this study.

Key Words: Basidiomycetes, Serpulaceae, *Serpula lacrymans*, dry rot, Turkey

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Türkiye mikoflorası için yeni bir kayıt: *Serpula lacrymans* (Wulfen) J.Schröt

Özet

Bu mantar türü 2001 yılında Dolmabahçe Sarayında yürütülen restorasyon-konservasyon çalışmaları sırasında bulunmuş, *Serpula lacrymans* (Wulfen) J. Schröt olarak teşhis edilmiştir. Türkiye'de ilk defa kaydedilmiştir. Bu tür tanımlanmış ve resmedilmiştir. Sporların ışık mikroskobu altındaki görüntüleri verilmiştir.

Anahtar Kelimeler: Basidiomycetes, Serpulaceae, *Serpula lacrymans*, kuru çürüklük, Türkiye

1. Introduction

The Dolmabahçe Palace is located in Istanbul at the district of Beşiktaş and on the European Coastline of Bosphorus. Because of the building is located at the coastline with a heavily air polluted metropolitan area, high relative humidity, salts from the sea leaves; it is vulnerable to natural detrimental factors. The building is based on timber posts embedded into the infill, overlaid with a timber grid in filled with a layer of rough cement Horasan Harcı, 1.00 m–1.20 m deep. There are three rows of timbers throughout the grid over which the buildings were constructed. The outer walls are made of stone, the interior walls of brick, and the floors of wood. They support a roof of timber surfaced with lead. The structural timbers are mainly pine and oak, together with some African and Indian woods originally (Anonymous, 2005).

Although there is a lack of information on the presence of *S. lacrymans* in Turkey, it is clear that certain building materials such as lath and plaster used in many historic constructions are particularly susceptible to the fungus. Microbial biodeterioration of building materials and their contents in both modern and historic buildings are attributed to changes in the building environment. The main environmental parameters favouring the decay of materials and contents are water, humidity, temperature and lack of ventilation (Palfreyman and Low, 2002). These environmental factors cause biodeterioration of building materials for these reasons, a *Serpula lacrymans* specimen is observed on door and its cornice made from the coniferous timber wood located at the basement of the Dolmabahçe Palace where the air-conditioning is inadequate and the humidity is high (75-90 %)

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Reports of *S.lacrymans* in the wild were, until recently, limited to sightings of basidiocarps, with no isolates available for analysis. Two reports are generally considered to be reliable, one from Bagchee (1954) which describes *S.lacrymans* at two sites in Himachal Pradesh in the Himalayan foothills of India (specifically at Narkanda and Pulga), the second from Cooke (1957) identified *S. lacrymans* on the slopes of Mount Shasta in Northern California in the USA. A third unconfirmed report suggests that *S. lacrymans* is found in the Sumava Mountains in the Czech Republic (Bagchee, 1954; Kotlaba, 1992; Cooke, 1957). However there is no published report until today regarding to the presence of this fungus specie in Turkish flora.

S. lacrymans preferentially attacks softwoods but also hardwoods as well as other cellulosic materials such as paper, cardboard and textiles (Palfreyman, Low, 2002).

2. Materials and Methods

The specimens of *S. lacrymans* were obtained from pine wood used at the Dolmabahce Palace in Istanbul; June, 2001. The fungal specimens were photographed in original place where it was first founded; the macroscopic features were noted and transported to the Plant Diseases and Microbiology Laboratory of Science and Letters Faculty, Marmara University for microscopic evaluation.

In the microscopic examination of the fungus the below findings were noted. The fungi were treated with 20 % KOH solution for softening and preparation for microscopic examination. Olympus Cx41 Light microscope was used for microscopic examination. Then the microscopic photos were taken with Image-Pro Express (Micropublisher 5.0 RVT) imaging device which is compatible with this microscope. The fungi were identified according to Jordan (1995) and Breitenbach, Kranzlin (1986).

3. Results

In the light of the literature, this fungus is reported as a new macrofungus record for the mycoflora of Turkey (Solak et al., 2007; Sesli, Denchev, 2009). The specimen is preserved in the Herbarium of the Faculty of Science and Letters, Marmara University, Istanbul (MUFE). Its description, locality, date of collection and herbarium number are given below (Istanbul, Dolmabahce Palace, on pine wood, 19.06.2001, H.T., 1). The systematics of the species was made according to Index fungorum.

Serpulaceae

Serpula lacrymans (Wulfen) P.Karst.
Syn. Boletus lacrymans Wulfen, *Boletus obliquus* Bolton, *Gyrophana lacrymans* (Wulfen) Pat., *Merulius destruens* Pers., *Merulius domesticus* H.G. Falk, *Merulius giganteus* Saut., *Merulius guillemotii* Boud., *Merulius lacrymans* (Wulfen) Schumach., *Merulius lacrymans var. guillemotii* (Boud.) Boud., *Merulius lacrymans* var.terrestris Peck., *Merulius terrestris* (Peck) Burt., *Merulius vastator* Tode, *Serpula destruens* (Pers.) Gray., *Serpula domestica* (Falck) Bondartsev, *Serpula terrestris* (Burt) S.Ahmad, *Sesia gigantea* (Saut.) Kuntze., *Sistotrema cellare* Pers.

The fruit body of *Serpula lacrymans* (Wulfen) P.Karst. is embedded in a surface of 36 cm in length and 13 cm by height. The horizontal surface is round shaped like a disk and the vertical surface is in the shape of small brackets. The vertical surface has favourable diameters of 4-18 cm in diameter and 0,4- 0,8 cm in thickness. The fungus is spongiform and pulpy in texture so that can be easily separated from the substrate. The fruiting body is at first yellowish, scarlet in colour and as the fungus decays and gets elder changes into a morello brownish colour. The himenium surface is wrinkle and corrugated, also moist and the edges has marginal zones of white and well bordered. (Figure 1). The young fruiting body of the fungus has a pleasant fungous odour, as it gets older becomes foul and unpleasant. The spores are massive and rusty red in colour. The spores are ellipse in shape, smooth and yellowish brown in colour. The spores are 11-13 µm x 5.5-8 µm in dimension (Figure 2). Some of them have droplets. Basidia slendery clavate has 4 sterigmata and shows basal clamped pattern. The hyphae are colourless and the septa with clamps. Rhizomorphs are brownish and has thick- walled and with crystals.

Figure 1**.** Fruiting body of *Serpula lacrymans*

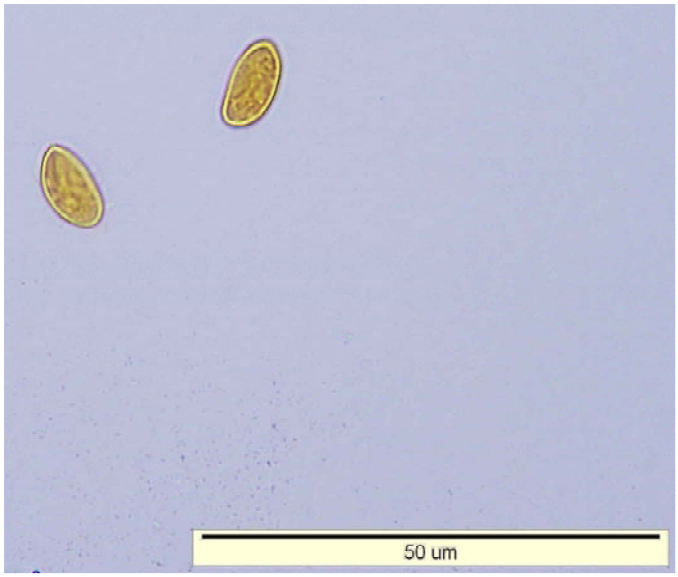

Figure 2**.** Spores of *Serpula lacrymans* in LM

4. Discussion

The struggle for the eradication of *Serpula lacrymans* in historic and cultural constructions is a great ordeal. The dry rot fungi different than the others humidify the region where they are located and they transfer the water to dry timber meters away from where they are located via their mycelia. This is the only and most important fungus which can do rots in low temperatures in the buildings.

In the restoration and conservation processes done in the Dolmabahçe Palace, solutions and aerosols and in the places where needed, injection techniques are used for fungi eradication process. The infected timber material which is replaced with the new one is impregnate to with the pressure-vacuum technique thus, successful results has been acquired in the struggle against fungi.

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References

Anonymus, Dolmabahçe Sarayı, 2005. Milli Saraylar Daire Başkanlığı Yayın No:28 TBMM Basımevi, Ankara
Bagchee, K. 1954. *Merulius lacrymans* (Wulf) Fr. in India. Sydowia 8, pp 191-202.
Breitenbach J, Kranzlin F. 1986. Fungi of Switzerland. (Volume 2), Luzerne: Verlag Mykologia., pp 210-211
Cooke, W.B. 1957. The genera *Serpula* and *Merulipora*. Mycologia 49, pp 197-225.
Jordan, M.1995. The Encyclopedia of Fungi of Britain and Europe, UK, pp 129.
Kotlaba, F.1992. Finds of *Serpula lacrymans* in nature. Ceska Mykology 46, 99-104,160.
Palfreyman J. W., Low G. 2002. Studies of the domestic dry rot fungus *Serpula lacrymans* with relevance to the management of decay in buildings, pp 5-11, Historic Scotland, Technical Conservation, Research and Education Division.
Sesli, E., Denchev C.M. 2009. Checklists of the myxomycetes, larger ascomycetes, and larger basidiomycetes in Turkey. Mycotaxon 106 [2008]: 65-67 + on-line version: 1-102 (http://www.mycotaxon.com/resources/checklists/sesli-v106-checlkist.pdf).
Solak MH, Işıloğlu M, Kalmış E, Allı H. 2007. Macrofungi of Turkey Checklist, İzmir, Üniversiteliler Ofset.
URL: www.indexfungorum.org/Names/NamesRecord.asp?RecordID=102458.

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The first record of genus *Lipocrea* Thorell, 1878 in Turkey (Araneae, Araneidae)

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Abstract

Lipocrea epeiroides (O. P. Cambridge, 1872) is recorded for the first time for araneofauna of Turkey. This represents a new record of both the species and genus *Lipocrea* Thorell, 1878 from Turkey. Its description, morphological characteristics, and photographs are presented.

Key words: *Lipocrea epeiroides*, Araneidae, Turkey, new record

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Türkiye için *Lipocrea* Thorell, 1878 cinsinin ilk kaydı (Araneae, Araneidae)

Özet

Lipocrea epeiroides (O. P. Cambridge, 1872) Türkiye araneofaunası için ilk kez kaydedildi. Türün deskripsiyonu, morfolojik özellikleri ve fotoğrafları verildi.

Anahtar kelimeler: *Lipocrea epeiroides*, Araneidae, Türkiye, yeni kayıt

1. Introduction

Araneidae is one of the largest spider families which contains 2992 species in 168 genera with worldwide distribution (Platnick, 2010). The generic concepts of *Larinia* Simon, 1874 and its related groups were revised by Grasshoff (1970a, b, c, 1971) and the author split the "*Larinia* group" into eight genera: *Larinia*, *Drexelia* McCook, 1892, *Lipocrea* Thorell, 1878, *Siwa* Grasshoff, 1970, *Paralarinia* Grasshoff, 1970, *Faradja* Grasshoff, 1970, *Mahembea* Grasshoff, 1970 and *Lariniaria* Grasshoff, 1970. Some authors (Levi, 1975; Marusik, 1986) rejected the conclusions of Grasshoff, but some authors such as Levy (1986) have supported some of Grasshoff's results. The genus *Lipocrea* was originally described by Thorell (1878) and includes 4 species: *L. diluta* Thorell, 1887 known from Myanmar to Australia; *L. fusiformis* (Thorell, 1877) known from Philippines, Sulawesi, India to Japan, *L. longissima*

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(Simon, 1881) known from Afrotropical region and *L. epeiroides* (O. P. Cambridge, 1872) so far known only from Israel and Yemen (Platnick, 2010).

The aim of this paper is to present the first record of the spider *L. epeiroides* for the araneofauna of Turkey. The detailed morphological illustrations of *L. epeiroides* are also provided.

2. Material and methods

Only one male specimen was collected by sweeping from Hatay province, Turkey. The identification was made using the descriptions of Levy (1986). Digital images were taken by SMZ10A Nikon stereomicroscope. For SEM photographies, the male palp were dried at 30 ºC temperature and coated with a thin layer of gold by Polaron SC 502 sputter coater. The material was examined at an accelerating voltage of 15 kV under Jeol JSM 6060 LV Scanning Electron Microscope. The specimen is preserved in 70 % ethanol and deposited in the personal collection of Jörg Wunderlich (Heidelberg, Germany) with collection number: R20/AR/CJW. All measurements in the text are in millimeters (mm). Measurements are taken from the dorsal side of legs.

The taxonomy follows Platnick (2010) and the terminology follows Levy (1986).

3. Results

Family Araneidae Simon, 1895

Lipocrea epeiroides (O. P. Cambridge, 1872)

Material examined: Hatay province, Hassa district, Aktepe town, collected on annual plants (36°40'21.10"N; 36°30'48.16"E), 1 male, 05. V. 2008, leg. E.A. Yağmur & E. Tezcan.

Description of male: Carapace smooth surfaced, yellowish with a dark brown deep fovea (Figure 1). Anterior and posterior lateral eyes touching each other. Anterior median eyes separated one from another about 1 diameter. (Figure 2). Sternum yellowish, spear-shaped (Figure 3). Tips of chelicerae brownish. Chelicerae with two big, one medium, and one small teeth promarginally and one big and two small teeth retromarginally (Figure 4). Abdomen long and narrow, pointed at each end, ending with a small tip, two pale brown bands with black spots extend along dorsum (Figure 5a, b). Abdomen dorsally with some long, thin transparent hairs. (Figure 5b). Venter with white, longitudinal patch surrounded by a brownish large border, and two whitish spots close to spinnerets (Figure 6). No coxal tuber on walking legs (Figure 3). Femora I-II with a ventral-retrolateral row of dark color bristles (Figure 7a), and femora IV, on basal-ventral part, with 2 short spines emerged from small tubercles (Figure 7b).

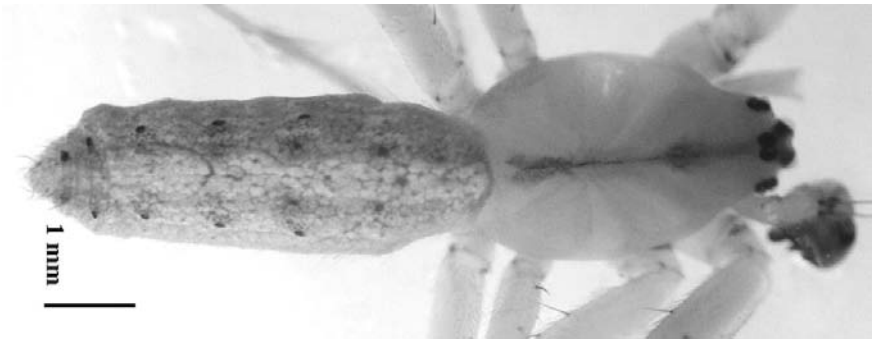


Figure 1. General appearance of *L. epeiroides* (O.P. Cambridge, 1872) (Dorsal view).

Palp: Two patellar bristles are very distinct (Figure 2). Median apophysis large and spoon-shaped, median apophysis bears finger-shaped pointed process on mesal side; dark coloured large conductor forms a cap mesally; large terminal apophysis ending with pointed tip bending downwards; subterminal apophysis large and bears pointed tip; embolus thick (Figures 8-10).

Figure 2. Eyes and patellar bristles of palp, left palp was removed by authors (Dorsal view).

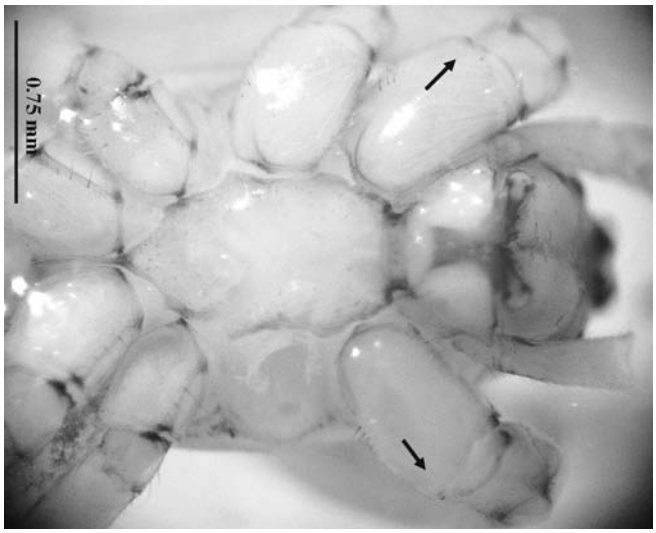


Figure 3. Sternum and no coxal tuber on walking legs (arrows)

Measurements: Body length 6.7; carapace 2.85; abdomen length 3.85; length of legs: I 14.53, II 14.35, III 11.60, IV 13.5; leg I: coxa 0.08; trochanter 0.29; femur 3.30; patella 1.45; tibia 4.10; metatarsus 5.20; tarsus 0.11.

Remarks

L. epeiroides was originally described with the specimens collected from vicinity of Jericho, Israel by O.P. Cambridge (1872), and then, there have been only few additional data on this species. The species is not common in the collections, so we have limited information on the zoogeographical pattern and habitat of this species. Our sample was collected by sweeping from heaths in rocky area. The recording of this species from Turkey widens its range of distribution.

The morphometric measurements and other characteristic features of our sample conforms to holotype charactersitics of this species given by Levy (1986) and no significant differences have been determined in palpal structures.

Acknowledgements

We are extremely grateful to Dr. Yuri M. Marusik (Magadan; Russia) and Jörg Wunderlich (Heilderberg; Germany) for their advice and valuable comments.

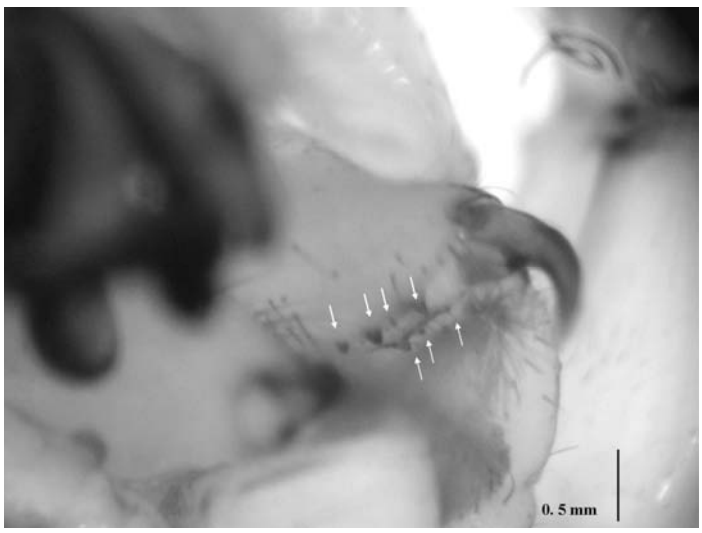


Figure 4. Cheliceral teeth

References

Cambridge, O. P. 1872. General list of the spiders of Palestine and Syria. Proceedings of the Zoological Society of London. 1872: 212-354.

Grasshoff, M. 1970a. Die Gattung *Kilima* n. gen. (Arachnida: Araneae: Araneidae). Senckenbergiana biologica. 51: 119-128.

Grasshoff, M.1970b. Die Tribus Mangorini. I. Die Gattungen *Eustala*, *Larinia* s. str., *Larinopa* n. gen. (Arachnida: Araneae: Araneidae-Araneinae). Senckenbergiana biologica. 51: 209-234.

Grasshoff, M. 1970c. Die Tribus Mangorini. II. Die neuen Gattungen *Siwa*, *Paralarinia*, *Faradja*, *Mahembea* und *Lariniaria* (Arachnida: Araneae: Araneidae-Araneinae). Senckenbergiana biologica. 51: 409-423.

Grasshoff, M. 1971. Die Tribus Mangorini, III. Die Gattung *Drexelia* MacCook (Arachnida: Araneae: Araneidae-Araneinae). Senckenbergiana biologica. 52: 81-95.

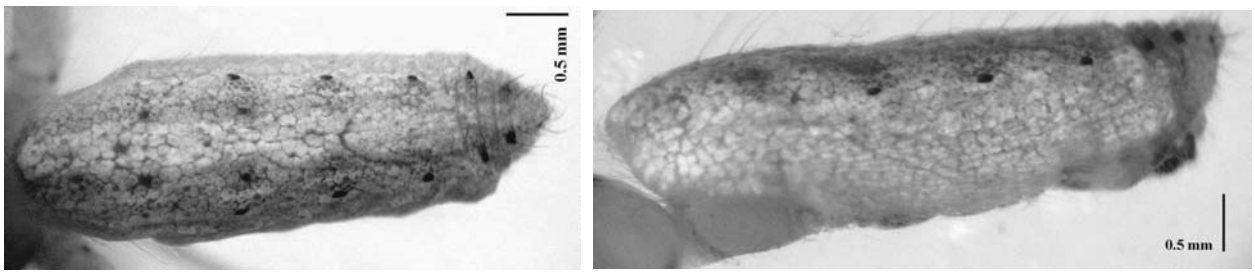
Levi, H.W. 1975. The American orb-weaver genera *Larinia*, *Cercidia* and *Mangora* north of Mexico (Araneae, Araneidae). Bulletin of the Museum of Comparative Zoology. 147: 101-135.

Levy, G. 1986. Spiders of the genera *Siwa*, *Larinia*, *Lipocrea* and *Drexelia* (Araneae: Araneidae) from Israel. Bulletin of the British Arachnological Society. 7/1: 1-10.

Marusik, Y. M. 1986. The orb-weaver genus *Larinia* Simon in the USSR. Spixiana. 9: 245-254.

Platnick, N.I. 2010. The world spider catalog, version 10.5. American Museum of Natural History, online at http://research.amnh.org/entomology/spiders/catalog/index.html

Thorell, T. 1878. Studi sui ragni Malesi e Papuani. II. Ragni di Amboina raccolti dal Prof. O. Beccari. Annali Mus. civ. Stor. nat. Genova. 13: 1-317.



A **B**

Figure 5. Dorsal (A), and lateral view of abdomen (B).

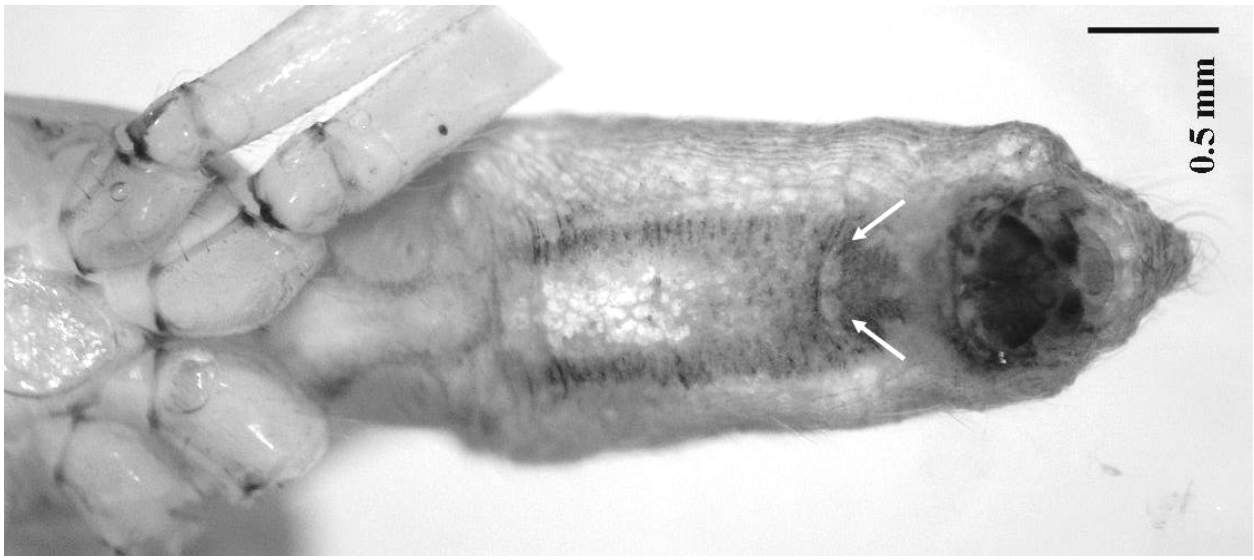
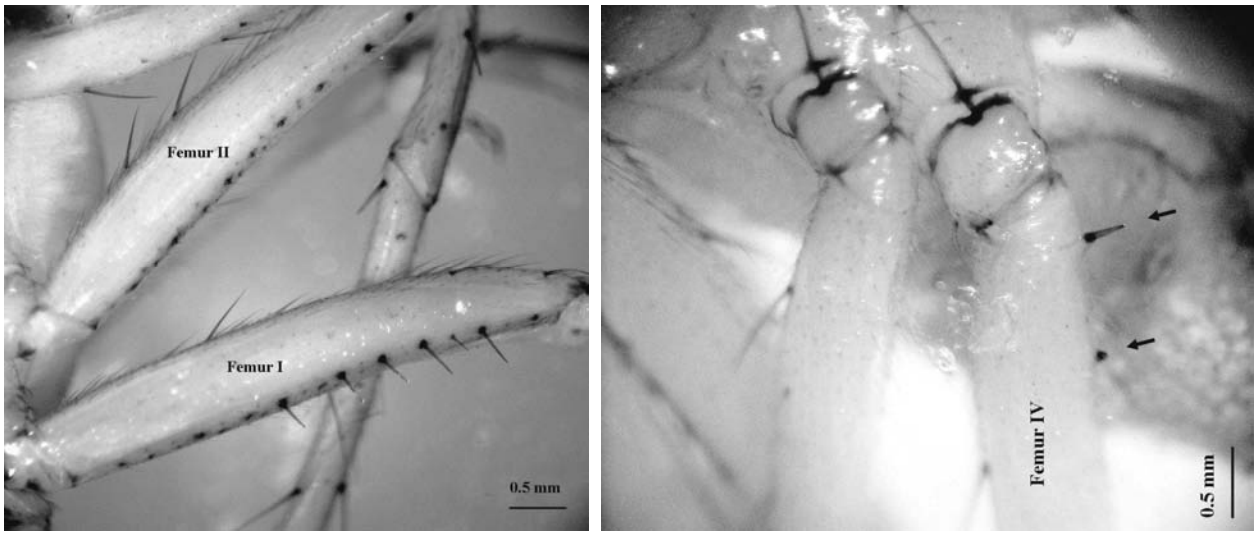


Figure 6. Abdomen, ventral view, with two whitish spots (arrows).



A **B**

Figure 7. Bristles on femora I and II (A), spines on basal-ventral part of femur IV (B).

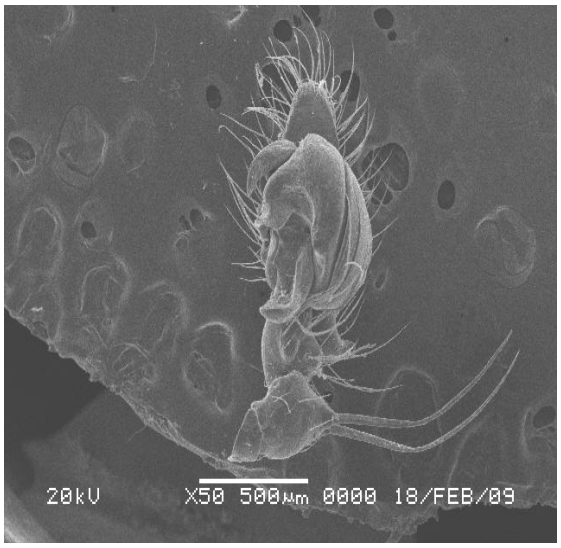


Figure 8. Ventral view of left palp

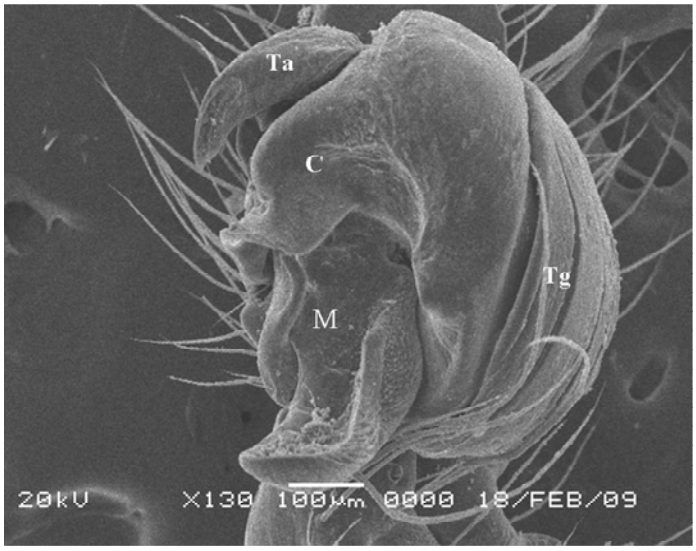


Figure 9. Ventral view of left palp, enlarged. Ta: Terminal Apophysis, C: Conductor, Tg: Tegulum, M: Median Apophysis.

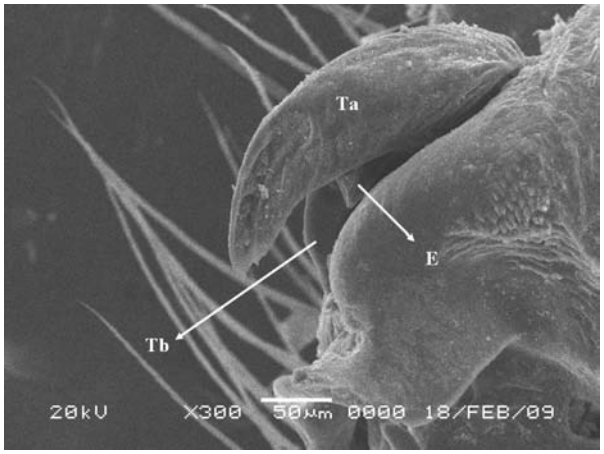


Figure 10. Ventral view of left palp. Ta: Terminal Apophysis, Tb: Subterminal Apophysis, E: Embolus

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Estimation of genetic divergence among elite mungbean (*Vigna radiata*) genotypes by RAPD analysis

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Abstract

Genetic diversity among 15 mungbean genotypes of Pakistan was assessed through Random Amplified Polymorphic DNA (RAPD) analysis, with 30 random decamer primers using polymerase chain reaction (PCR). A total of 370 bands were observed, with 12.3 bands per primer, of which 91.6% were polymorphic. OPG-08 produced maximum number of fragments while minimum numbers of fragments were produced with primer OPH-05. Cluster analysis by the Unweighted Paired Group Method of Arithmetic means (UPGMA) showed that these 15 genotypes could be classified in five groups with a similarity ranging from 0.48-0.86. Maximum similarity was observed between NM-51, NM-54 and NM-98 (0.86). Interestingly, these mungbean genotypes have been developed at one breeding center, while ML-5 was found the least similar line due to its exotic nature. The analysis revealed that the inter-varietal genetic relationship of several genotypes is related to their center of origin. Most of the mungbean genotypes have a narrow genetic base. These results correspond well with previous reported results on mungbean from other countries. The RAPD analysis indicated that it may be a more efficient marker than morphological marker, isozyme and RFLP technology. Based on present results, these genotypes could be successfully utilized in selecting divergent parents for breeding and mapping purposes in future.

Key words: Cluster Analysis, Mungbean genotypes, Diversity, RAPD, Genetic similarities

1. Introduction

Mungbean (*Vigna radiata* L. Wilczek) 2n=2x=22 is one of the most important pulse crop of Pakistan with an average yield of 546 kg ha^{-1} and is grown over an area of 0.21 million hectares annually (MINFAL, 2007). On the basis of area and production it is the second largest pulse crop after chickpea. It is bi-annually cultivated crop because of its high degree of heat tolerance up to 40°C. India, the central Asian region, is known as the centre of diversity and domestication (Vavilov, 1951; Smartt, 1985).

To identify the useful and effective germplasm for the development of line of an exhaustive characteristic with maximum diversity should be selected. The crosses between parents with maximum genetic divergence are generally the most responsive for bringing up the genetic improvement (Arunachalam, 1981) but this practice resulted in a narrow genetic base for the new mungbean varieties.

Previously morphological markers, with their complex and undeciphered genetic control, were used for individual identification. Morphological features are indicative of genotypes but are represented by only a few loci because there are not a large enough number of characters available. Moreover, they can also be affected by environmental factors and growth pattern. The RAPD technique generates molecular markers for comparative analysis that are quick, effective, easy to use, free from environmental influences, unlimited in number, random but have wide coverage of genome and have a relatively higher level of polymorphism (Newbury and Ford-Lloyd, 1993).

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The RAPD technique provides an unlimited number of markers which can be used for various purposes like cultivar analysis and species identification in most crop plants (Williams *et al*., 1990). (Multani and Lyopreegn, 1995) reported that RAPD markers could be used to distinguish closely related varieties of same species. A few studies have been carried out using RAPD alone or in combinations with Inter-simple sequence repeat (ISSR) for finding out the diversity in mungbean (Roopa *et al*., 2008; Afzal *et al*., 2004; Saini *et al*., 2004; Lakhanpaul *et al*., 2000; Bisht *et al*., 1998; Santalla *et al*., 1998;). Muthusamy *et al*., (2008) studied RAPD and ISSR markers in rice bean and got 719 amplification products from RAPD and 479 from ISSR. Comparing the results of diversity obtained from RAPD with ISSR in the common bean, Galvan *et al.*, (2003) identified that the ISSR is more effective to separate the genotypes on the basis of gene pool. Keeping in view these findings of the earlier researchers, the present research work was, therefore, planned to elucidate the genetic divergence of popular cultivated varieties of *Vigna. radiata* in Pakistan.

2. Materials and Methods

2.1. Plant material

A total of 15 commercial varieties of mungbean, one from India and 14 from Pakistan, (Table 1) were investigated in the present study. Plants were raised in growth chamber under control conditions using vermiculate as growth media for good plant stand and soft leaf tissues.

Table 1. Name, pedigree and centre of origin of 15 mungbean (*Vigna radiata*) genotypes

Genotypes	Pedigree	Center of origin
Ramzan	VC 1482C × NM 92	NIFA, Peshawar, Pakistan
NM-92	VC 2768B × NM 36	NIAB, Faisalabad, Pakistan
NM-98	NM 20-21 × VC 1482E	NIAB, Faisalabad, Pakistan
NM-51	VC1973A x 6601	NIAB, Faisalabad, Pakistan
NM-28	Local Selection	NIAB, Faisalabad, Pakistan
ML-5	No.54 × Hyb.45	PAU, Ludhiana, India
AEM-96	Irradiating 6601	NIA, Hayderabad, Pakistan
NM54	VC1973A × 6601	NIAB, Faisalabad, Pakistan
Pak 22	Local Selection	NIAB, Faisalabad, Pakistan
NM89	NM 20-21 × VC1482E	NIAB, Faisalabad, Pakistan
6601	Local Selection	NIAB, Faisalabad, Pakistan
NM 20-21	Irradiated Pak-22	NIAB, Faisalabad, Pakistan
NM 19-19	Irradiated Pak-22	NIAB, Faisalabad, Pakistan
Chakwal Mung-97 (CM-97)	Local Selection	BARI, Chakwal, Pakistan
AZRI Mung-06	CI/94-4-19	AZRI, Bhakkar, Pakistan

2.2. DNA isolation

Total genomic DNA was isolated with the modified CTAB method (Saghai-Maroof *et al*., 1984) and the DNA quantification was carried out using NanoDrop 1000 Spectrophotometer V3.7.1 Thermo Fisher® Scientific, Inc (Figure 1; Table 2). Approximately 250 mg leaf material was grinded to a fine powder using liquid nitrogen and quickly transferred into 25 ml of pre-warmed (60^0C) isolation buffer in a capped polypropylene tube, incubated for 1 hour at 65^0C in a water bath and mixed by swirling gently with an interval of every 10 minutes. Equal volume of Chloroform: Isoamyl alcohol (CI) was added to these tubes and the contents were hand shaken for 10 minutes.

Figure 1. Thermo Scientific NanoDrop^{TM} 1000 Spectrophotometer used for quantification of genomic DNA

Table 2.Quantification of genomic DNA using NanoDrop 1000 Spectrophotometer software 3.7.1

Sample ID	ng/ul	A260	A280	260/280	260/230	Cursor abs.	340 raw
Ramzan	4521.25	90.425	45.585	1.98	1.93	46.878	4.097
NM-92	3510.52	70.21	35.512	1.98	1.56	44.93	10.33
NM-98	2284.29	45.686	22.297	2.05	1.80	25.349	4.49
NM-51	4272.21	85.444	45.742	1.87	1.35	63.33	13.264
NM-28	2010.67	40.213	20.973	1.92	1.47	27.425	6.066
ML-5	3466.86	69.337	36.458	1.90	1.33	52.02	12.789
AEM-96	3054.09	61.082	31.029	1.97	1.75	34.941	3.678
NM54	2864.69	57.294	29.338	1.95	1.63	35.193	4.884
Pak 22	2024.15	40.483	21.752	1.86	1.46	27.657	6.912
NM89	2449.08	48.982	25.027	1.96	1.63	29.987	7.259
6601	3299.11	65.982	32.777	2.01	1.94	33.966	3.213
NM 20-21	3036.71	60.734	30.326	2.00	1.87	32.51	4.843
NM 19-19	1980.42	39.608	19.884	1.99	1.83	21.594	1.923
CM-97	2174.65	43.493	21.427	2.03	1.92	22.613	2.058
AZRI Mung-06	3042.46	60.849	30.376	2.00	1.88	32.362	3.429

The tubes were centrifuged for 10 minutes at 8000 rpm; the upper aqueous layer was extracted twice with fresh CI and the final aqueous layer was transferred to a centrifuge tube. To these tubes, 0.6 volume of ice-cold isopropanol was added and shaken for several times. By using a glass hook, DNA was spooled out in the form of whitish fibers and transferred to washing solution after drying. DNA was dissolved in an appropriate volume of 1X TE buffer.

For purification, RNase-A was added to the tube (50 μgml^{-1}) and the mixture was incubated for 1 hour at 37^0C. DNA was extracted with CI by centrifuging the tubes at 10,000 rpm for 5 minutes at room temperature. DNA was precipitated with 2 volume of ice cold absolute ethanol and was recovered by centrifuging the tubes at 5000 rpm for 10 minutes. The pellet was washed with 70% ethanol and dissolved in appropriate volume of IX TE.

2.3. RAPD analysis

Thirty random primers (Table 3) of 10-base oligonucleotide of Operon Technologies for the PCR provided by the automated genome facility Southern Illinois University Carbondale (SIUC), USA were used for divergence study in mungbean. PCRs were carried out in 0.05 cm^3 reaction volumes each containing 50 ng of genomic template DNA diluted from master genomic solution (Table 2), 0.2 µM of the particular primer, 100 µM of each dNTP, 2 µl of Taq DNA polymerase 10X buffer, 1 unit Taq polymerase (Perkin Elmer) and 2.5 mM $MgCl_2$. PCR amplification was performed on a Gene AMP PCR System 9700 from PE Applied Biosystems® under the following conditions: Initial denaturation at 95^0C for 5 minutes, followed by 45 cycles of denaturing at 94^0C for 3 minutes, annealing at 32^0C for 1 minute, extension at 72^0C for 1 minute and final extension at 72^0C for 5 minutes. The amplification products obtained from PCR along with 1kb DNA ladder of NEB® were checked on 0.8% agarose gel tray from Maxicell® EC 360M electrophoretic gel system E-C apparatus corporation with electric supplier EC 154 and visualized under UV light using Quantity One® software, following staining with ethidium bromide.

2.4. Data analysis

The frequency of RAPD polymorphism was calculated based on presence (taken as 1) or absence (taken as 0) of common bands (Ghosh *et al*., (1997). The binary data were used to compute pair-wise Jaccard Similarities Coefficient on NTSYS-PC. A dendrogram based on similarity coefficient was generated by using the unweighted pair group of arithmetic means (UPGMA).

Table 3. Primers, their sequences and basic temperature used for mungbean *V. radiata* L. Wilczek) genotypes amplification.

Primer	Sequence	Basic Temperature ^{0}C
OPG-02	GGCACTGAGG	34
OPG-03	GAGCCCTCCA	34
OPG-04	AGCGTGTCTG	32
OPG-06	GTGCCTAACC	32
OPG-07	GAACCTGCGG	34
OPG-08	TCACGTCCAC	32
OPG-09	CTGACGTCAC	32
OPG-10	AGGGCCGTCT	34
OPG-11	TGCCCGTCGT	34
OPG-14	GGATGAGACC	32
OPG-15	ACTGGGACTC	32
OPH-01	GGTCGGAGAA	32
OPH-02	TCGGACGTGA	32
OPH-03	AGACGTCCAC	32
OPH-04	GGAAGTCGCC	34
OPH-05	AGTCGTCCCC	34
OPH-06	ACGCATCGCA	32
OPH-07	CTGCATCGTG	32
OPH-09	TGTAGCTGGG	32
OPH-10	CCTACGTCAG	32
OPH-11	CTTCCGCAGT	32
OPH-12	ACGCGCATGT	32
OPH-13	GACGCCACAC	34
OPH-14	ACCAGGTTGG	32
OPH-15	AATGGCGCAG	32
OPH-16	TCTCAGCTGG	32
OPH-20	GGGAGACATC	32
OPZ-01	TCTGTGCCAC	32
OPZ-05	TCCCATGCTG	32
OPZ-09	CACCCCAGTC	34

3. Results and Discussion

Genomic DNA of 15 mungbean genotypes were amplified with 30 different random primers of Operon Technologies, USA. All 15 genotypes with 30 primers revealed a unique banding pattern. This might be indicative of a wide genetic base of mungbean genotypes studied. Different primers produced a different level of polymorphism among the different varieties (Figure. 2A, 2B, 2C, 2D).

A total of 370 DNA fragments were amplified, with an average of 12.3 RAPD amplification products per primer. Out of 370 amplified fragments, 31 (8.4%) were found to be monomorphic. The remaining 339 (91.6%) were polymorphic in single or multiple bands of the 15 mungbean genotypes. The amplitude of polymorphisms was high even when there was not a single primer (out of 30 studied) which could differentiate clearly between all the mungbean genotypes. The size of the amplified fragments also varied with different primers. The approximate size of the largest fragment produced was 3.0 kb and the smallest fragment produced was approximately 0.25 kb. Out of the 15 genotypes studied, NM-28 (released by NIAB, Faisalabad, Pakistan) produced the maximum number of DNA amplified fragment (248), while ML-5 (released by Punjab Agricultural University, Ludhiana, India) produced 153 bands, which is the minimum number. Other mungbean genotypes produced between 189 and 236 bands in common. The variety NM-54 and NM 19-19 (both released by NIAB, Faisalabad, Pakistan) produced 223 bands, which were maximum common bands for tested genotype. A maximum of 14 fragments were amplified with primer OPG-08 and a minimum of 8 bands with primer OPH-05.

To estimate the genetic similarities of the mungbean genotypes, a similarity matrix obtained using Jaccard coefficients shown in Table 4. These similarity coefficients were used to generate a dendrogram (Figure. 3) by UPGMA analysis in order to determine the grouping of different varieties. Maximum similarity was observed between NM-51, NM-54 and NM-98 (0.86). Interestingly, these varieties have been developed at one breeding center. On the basis of the RAPD data their genetic bases looked very narrow. From the similarity matrix, the least similar genotype was ML-5 as it has been an exotic line of India. Its similarity ranges from 0.48 to 0.69. The coefficient of similarity of most of the

other varieties ranges between 0.48 to 0.83. Using 21 decamer RAPD markers Lakhanpaul *et al*., (2000) got a total of 267 amplification products with an average of 12.71 per primer with an overall polymorphism of 64% using 32 Indian mungbean genotypes. The extent of polymorphism was moderate to low and the Jaccard similarity coefficient values ranged 0.65 to 0.92. Muthusamy *et al*., (2008) assessed genetic diversity among 10 land races of rice bean genotypes and compared the RAPD and ISSR data. In their studies, the RAPD generated more polymorphic loci (70.30%) than the ISSR which were only (61.79%). The pairwise similarity index ranged from 0.530 to 0.782, while Galvan *et al*., (2003) concluded that ISSR is a better tool than RAPDs to identify beans by gene pool of origin though they did not reveal as many differences between individuals as RAPDs.

Cluster analysis using RAPD resulted in five main cluster groups. The dendrogram (Figure. 3) assigned the mungbean genotypes into groups which correspond well with their centers or sub centers of release and or pedigree relationship. In cluster 'B' three genotypes NM-51, NM-54 and NM-98 are more closely related as compared to any other variety. They have high estimates of genetic identity (0.86). In cluster 'A' out of three mungbean varieties Ramzan and NM-92 clustered together indicating that they are more closely related as compared to ML-5 since Ramzan and NM-92 are indigenous while the ML-5 is an exotic line. The cluster 'C' and 'D' comprises three varieties each namely NM 20-21, NM-89, NM 19-19 and NM-28, Pak-22, 6601, with similarities ranges between 0.70- 0.77 and 0.70-0.82, respectively. The variety ML-5 showed a similarity 0.74 with the rest of the varieties of cluster B, C and D. The cluster 'E' comprised of two varieties Chakwal Mung-97 (CM-97) and AZRI Mung-06. The clustering of the varieties might be due to selection of the elite lines from a single population. High level of polymorphism has been observed with RAPD marker, revealing a wide and diverse genetic basis of the germplasm accessions analysed (Roopa *et al*., 2008) and its correlation with agronomic and morphological parameters. Earlier, low to moderate polymorphism was observed while analysing 32 Indian mungbean cultivars using 21 RAPD primers (Lakhanpaul *et al*., 2000). Moreover, breeders mostly crossing the elite lines of other breeding countries in mungbean improvement programs, making the breeding material identical which ultimately result in close kinship of the varieties. The genetic similarity obtained from the analysis will be useful in selecting divergent parents for breeding and mapping purposes.

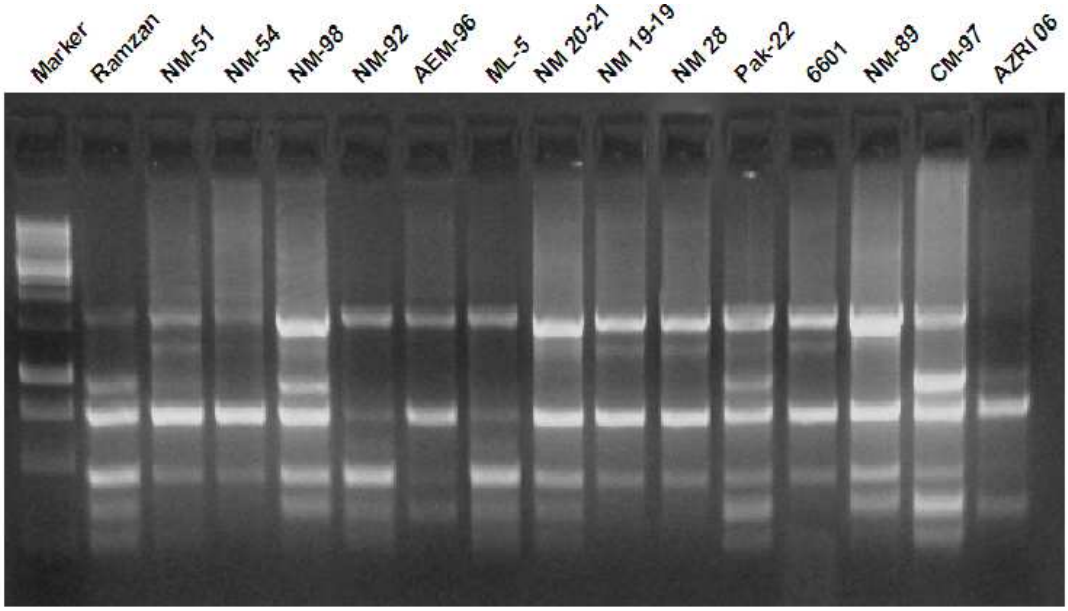

Figure 2A. Amplification products obtained using RAPD Primer OPG-08

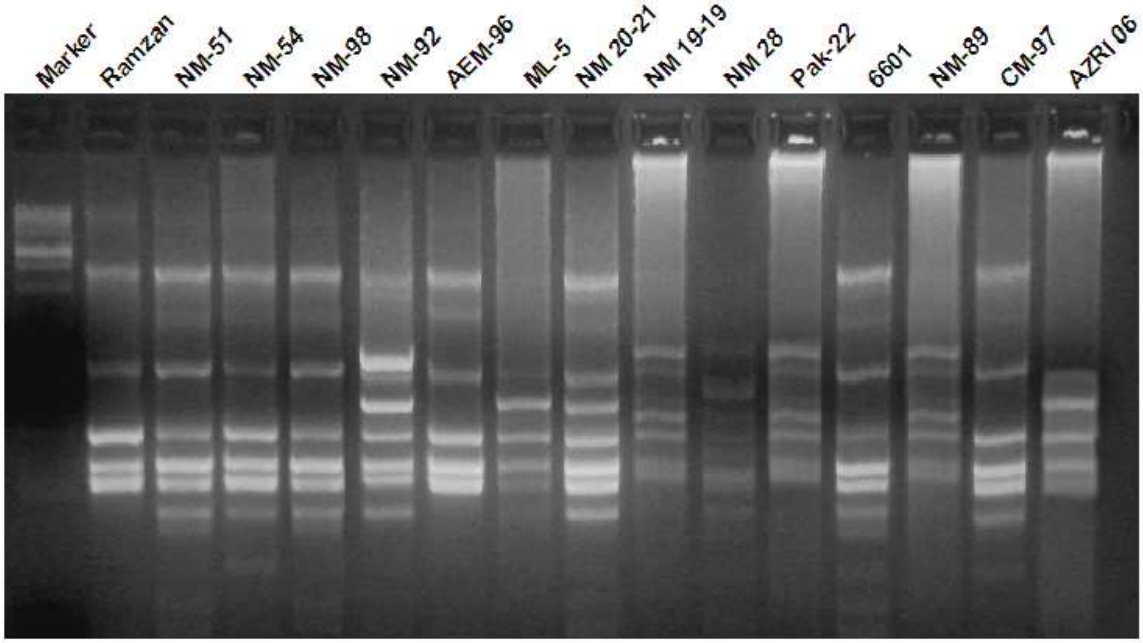

Figure 2B. Amplification products obtained using RAPD Primer OPG-09

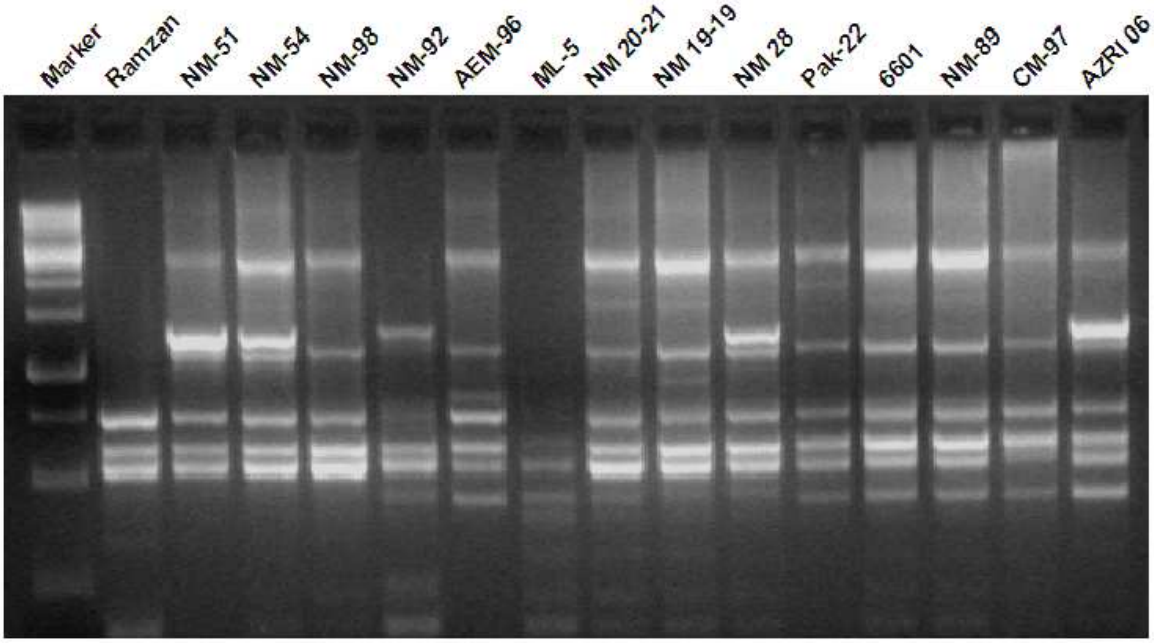

Figure 2C. Amplification products obtained using RAPD Primer OPH-03

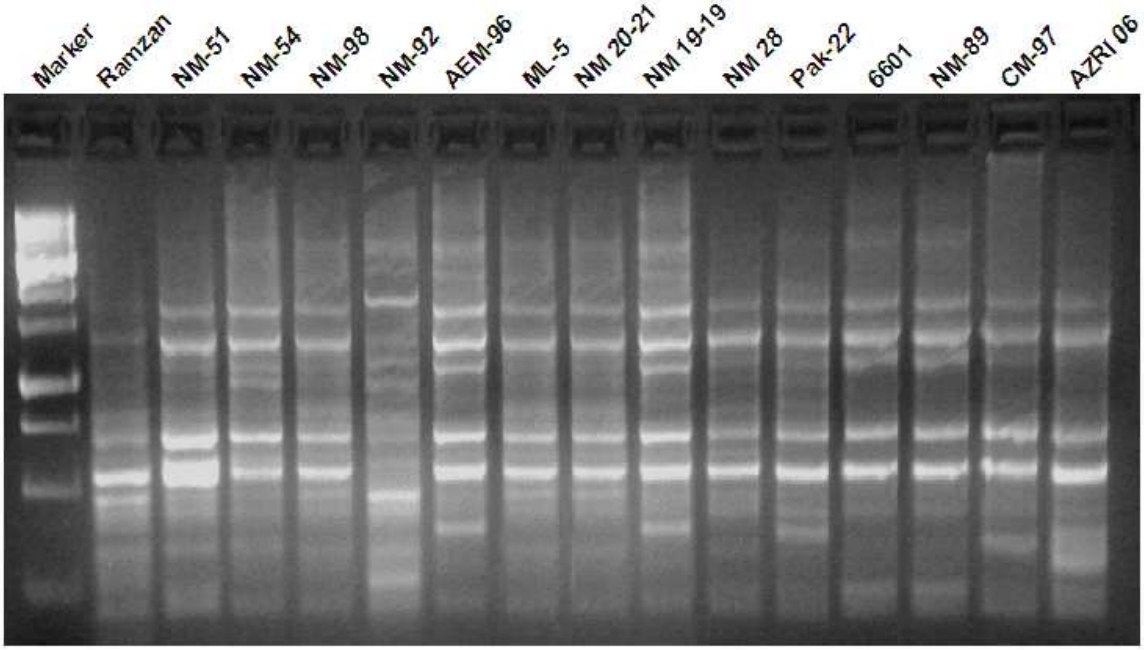

Figure 2D. Amplification products obtained using RAPD Primer OPH-05

Table 4. Similarity matrix for Jaccard coefficients of 15 mungbean genotypes obtained from RAPD marker analysis

	Ramzan	NM-51	NM-54	NM-98	NM-92	AEM-96	ML-5	NM 20-21	NM19-19	NM-28	Pak-22	6601	NM-89	CM -97	AZRI M6
Ramzan	1.00														
NM-51	0.67	1.00													
NM-54	0.65	0.86	1.00												
NM-98	0.65	0.82	0.83	1.00											
NM-92	0.69	0.60	0.55	0.60	1.00										
AEM-96	0.58	0.72	0.74	0.74	0.56	1.00									
ML-5	0.63	0.57	0.53	0.55	0.69	0.50	1.00								
NM 20-21	0.60	0.75	0.75	0.76	0.59	0.74	0.57	1.00							
NM 19-19	0.60	0.76	0.75	0.77	0.53	0.74	0.54	0.77	1.00						
NM-28	0.61	0.75	0.78	0.81	0.58	0.72	0.51	0.76	0.76	1.00					
Pak-22	0.62	0.76	0.75	0.75	0.55	0.74	0.48	0.74	0.77	0.82	1.00				
6601	0.58	0.72	0.71	0.74	0.61	0.72	0.54	0.73	0.75	0.82	0.81	1.00			
NM-89	0.60	0.72	0.72	0.76	0.59	0.71	0.50	0.78	0.76	0.78	0.76	0.76	1.00		
CM-97	0.60	0.70	0.70	0.72	0.58	0.70	0.52	0.70	0.72	0.70	0.72	0.68	0.76	1.00	
AZRI M6	0.63	0.76	0.73	0.74	0.57	0.70	0.55	0.75	0.74	0.74	0.73	0.74	0.77	0.75	1.00

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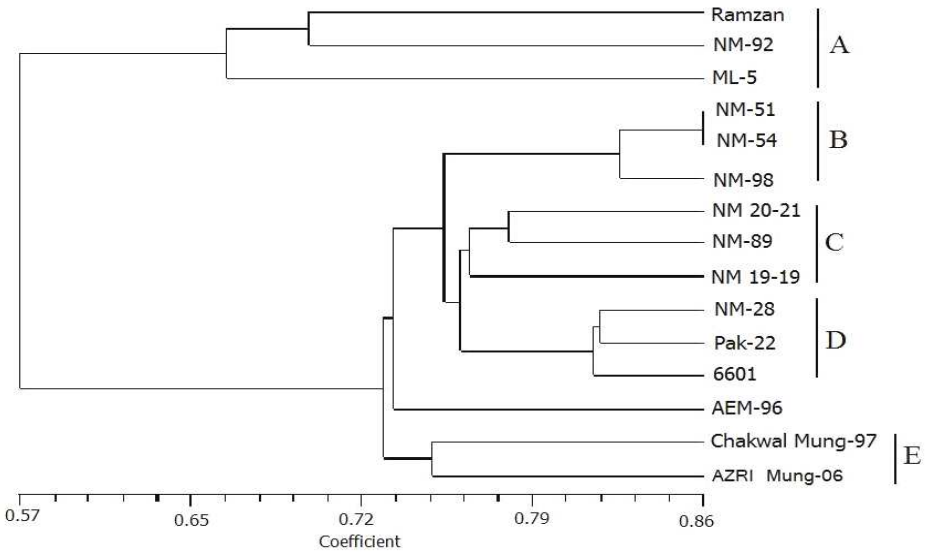

Figure 3. Dendrogram of 15 mungbean genotypes developed from RAPD data using Unweighted Pair Group Method of Arithmetic means (UPGMA).

References

Afzal, M.A., Haque, M.M., Shanmugasundaram, S. 2004. Random amplified polymorphic DNA (RAPD) analysis of selected mungbean (*Vigna radiata* L. Wilczek) cultivars. Asian J. Pl. Sci. **3**: 20–24.

Arunachalam, V. 1981. Genetic distance in plant breeding. Indian J. Genet. 14: 226-236.

Bisht, I.S., Mahajan R.K., Kawalkar, T.G. 1998. Diversity in mungbean (Vigna radiata L. Wilczek) germplasm collection and its potential use in crop improvement. Ann. Appl. Biol. 132: 301– 312.

Galvan, M.Z., Bornet, B., Balatti, P.A., Branchard, M. 2003. Inter simple sequence repeat (ISSR) markers as a tool for the assessment of both genetic diversity and gene pool origin in common bean (Phaseolus vulgaris L.). Euphytica 132: 297–301.

Ghosh, S., Karanjawala, Z.E., Hauser, E.R. 1997. Methods for precise sizing, automated inning of alleles and reduction or error rates in large scale genotyping using fluorescently labeled dinucleotide markers. Genome Res. 7: 165-178.

Jaccard, P. 1908. Nauvelles recherches sur la distribution florale. Bull Soc Vaudoise Sci Nat. 44: 223-270.

Lakhanpaul, S., Chadha, S., Bhat, K.V. 2000. Random amplified polymorphic DNA analysis in Indian mungbean (Vigna radiata L. Wilczek) cultivars. Genetica. 109: 227–234.

MINFAL, 2007. Agricultural Statistics of Pakistan.

Multani, D.S., Lyon, B.R. 1995. Genetic fingerprinting of Australian cotton cultivars with RAPD markers. Genome. 38: 1005-1008.

Muthusamy, S., Kanagarajan, S., Shanmugasundaram, P. 2008. Efficiency of RAPD and ISSR markers system in accessing genetic variation of rice bean (Vigna umbellata) landraces. Electronic J. Biotech. 3 (11): 1-10.

Newbury, H.J., Ford-Lloyd, B.V. 1993. The use of RAPD for assessing variation in plants. Plant Growth Regulation. 12: 43-51.

Roopa, L.G., Jyoti, S., Shirish, A.R. 2008. Molecular assessment of genetic diversity in mungbean germplasm. J. Genet. (87) 1: 65-74.

Saghai-Maroof, M.A., Soliman, K.M., Jorgensen, R.A., Allard, R.W. 1984. Ribosomal DNA spacer length polymorphism in barley: Mendelian inheritance, chromosomal location and population dynamics. Proc. Nat. Acad. Sci., USA. 81: 8014-8018.

Saini, A., Reddy, K.S., Jawali, N. 2004. Evaluation of long primers for AP-PCR analysis of mungbean [Vigna radiata L. Wilczek]: Genetic relationships and finger printing of some genotypes. Indian J. Biotech. 3: 511–518.

Santalla, M., Power, J.B., Davey, M.R. 1998. Genetic diversity in mungbean germplasm revealed by RAPD markers. Plant Breed. 117: 473–478.

Smartt, J. 1985. Evolution of grain legumes III. Pulses in the genus Vigna. Exp. Agric. 21: 87-100.

Vavilov, N.I. 1951. The origin, variation, immunity and breeding of cultivated plants. (Translated by K.S Chester). Chronica Botanica 13: 1-364.

Williams, J.G.K., Kubelik, A.R., Levak, K.J., Rafalski, J.A., Tingey, S.V. 1990. DNA polymorphism amplification by arbitrary primers are useful as genetic markers. Nucleic Acid Res. 18: 6531-6535.

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Two new Ascomycetes records from Mediterranean part of Turkey

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Abstract

Hymenoscyphus lutescens and *Trichophaea hemisphaerioides* were collected in fir forest. *Trichophaea hemisphaerioides* is new record at genus level and the latter species is new record at species level. The map showing collection sites and pictures of macro and micro morphology for fungi have been given.

Key words: *Hymenoscyphus, Trichophaea, New records, Turkey*

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Türkiye'nin Akdeniz Yöresinden iki yeni Askomiset kaydı

Özet

Hymenoscyphus lutescens ve *Trichophaea hemisphaerioides* göknar ormanından toplandı. *Trichophaea hemisphaerioides* cins seviyesinde ikincisi tür seviyesinde yeni kayıttır. Toplama yerlerini gösteren harita ve mantarların makroskobisi ve mikroskobisine ait fotoğrafları verilmiştir.

Anahtar Kelimeler: *Hymenoscyphus, Trichophaea, Yeni kayıtlar, Türkiye*

1. Introduction

The needle litter and wood debris of *Abies* trees are very suitable for the growth of small macrofungi species, especially cup shaped Ascomycets, by its soft structure. *Abies cilicica* forests are widespread in Mediterranean part of Turkey. There are two subsp. of *Abies cilicica* in Turkey; *Abies cilicica* subsp. *isaurica* Coode & Cullen and *A. cilicica* (Ant. & Kotschy) Carr. subsp. *cilicica*. *A. cilicica* subsp. *isaurica* is an endemic species and grows in the area of West Taurus Mountain and the latter grows in the area of East Taurus Mountain. The fir forests in the Taurus mountain are both pure stands or mixed with *Cedrus libani* A.Rich., *Juniperus excelsa* M. Bieb., *J. foetidissima* Willd. and *Pinus nigra* J.F. Arnold subsp. *nigra* var. *caramanica* (Loudon) R. Businský

Till now, there are three data for *Hymenoscyphus* genus in Turkey. One is *H. calyculus* (Sowerby: Fr.) W. Phillips by Solak et al. (1997), other is *H. fructigenus* (Bull.: Fr.) Fr. by Aktaş et al. (2006) and last species is *Hymenoscyphus scutula* (Pers.) W. Phillips by Uzun et al. (2010). According to the analysis of the appropriate literatures, there is no data for the species of *Trichophaea hemisphaerioides* (Solak et al., 2007; Sesli and Denchev, 2009).

This study will contribute two new ascomycetous fungi to Turkish mycobiota.

2. Materials and methods

The fungal materials were collected from Antalya, Karaman and Adana provinces between 2006 and 2008 (Figure 1). Microscopic study of the fungi was done at × 40 and × 100 magnifications, with applying the conventional reagents; IKI, 5 % KOH and cotton blue. The following literatures were used for the species identification; Breitenbach

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and Kränzlin (1986) and Medardi (2006). The genera are taxonomically arranged according to the Cannon and Kirk (2007).

The materials are deposited in Fungarium of Mushroom Application and Research Centre at Selçuk University in Konya.

3. Results

Ascomycota
Leotiomycetes
Helotiales
Helotiaceae
Hymenoscyphus lutescens (Hedw.) W. Phillips, (1887)

Synonyms: *Calycina lutescens* (Hedw.) Kuntze, (1898)
Helotium lutescens (Hedw.) Fr., (1849)
Basionym*: Octospora lutescens* Hedw., (1789)

Fruitbody substipitate, with a short thick stalk, apothecia 0.5-1.5 mm diam, cup-to disc-shaped; disc and stipe pale yellow; outside paler with brownish base, turning reddish brown when dry (Figure 2).
Spores 10-15 × 3-5 µm, ellipsoid to cylindric, with 0-1 septate. **Asci** 70-90 × 7-8 µm, tips of paraphyses with yellowish oil inclusions (Figure 3).

Specimens collected: Antalya-Gazipaşa, Akçal plateau, kuyu yanı district, in mixed *Cedrus libani, A. cilicica* subsp. *isaurica* and *Pinus nigra* forest, on cone scales of *Pinus nigra,* 1700m, 08.12.2006, *HD2477*; Karaman-Ermenek, Koçaş forest, in mixed *C. libani* and *A. cilicica* subsp. *isaurica* forest, on cone scales of *A. cilicica* subsp. *isaurica*, 36470361D-404159K, 1750m, 14.11.2008, *HD4397.*

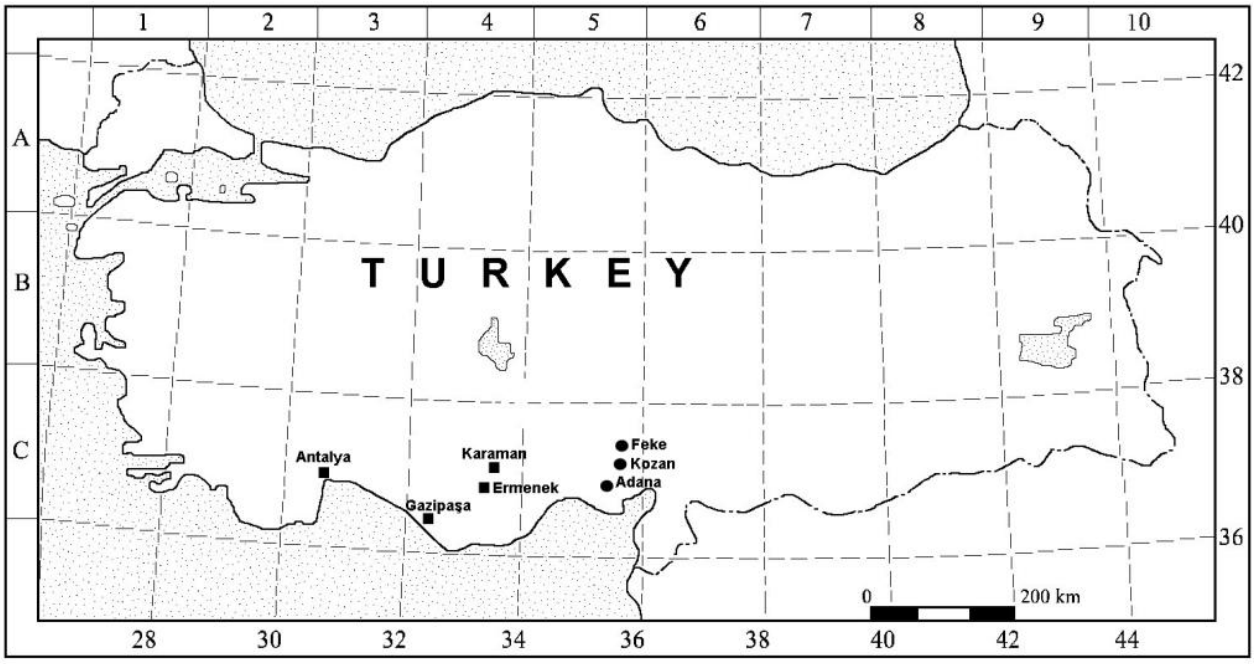

Figure 1. The collection areas for the species (■ *H. lutescens*, • *T. hemisphaerioides*)

Figure 2. Ascocarps of *H. lutescens.*

Figure 3. Ascospores and ascus of *H. lutescens.*

Pezizomycetes
Pezizales
Pyronemataceae
Trichophaea hemisphaerioides (Mouton) Graddon, (1960)

Synonym: *Humaria hemisphaerioides* (Mouton) Eckblad, (1968)
Basionym: *Lachnea hemisphaerioides* Mouton, (1897)

Apothecia 5-10 (15) mm diam, hemisphaerical-bladderlike at first, then remaining cup-shaped for a long time and later becoming flat, the ciliated margin always remaining turned upward, resting stalkless on the substrate (Figure 4). **Hymenium** white to gray-whitish, sometimes with bluish tint. Margin and underside with brown hairs. **Hairs** 200-400 × 5-15 µm, dark brown, thick walled, tapering to a point, multiple septate. Growing singly to gregariously.

Spores narrowly elliptical, hyaline, some finely punctuate and rough, with 2 drops, 13-18 × 5-7 µm. Asci eight spored, 175-200 × 7-8 µm (Figure 5). **Paraphyses** slender, forked at the base, septate, tips slightly thickened.

Specimens collected: Adana-Kozan, Görbiyes, Kuyunun gedik district, in *A. cilicica* subsp. *cilicica* forest on needle litter of *A. cilicica* subsp. *cilicica*, 36728229D-4185068K, 1341m, 27.10.2008, *HD4021*; Adana-Feke, Tapan, in mixed *C. libani* and *A. cilicica* subsp. *cilicica* forest on needle litter of *A. cilicica* subsp. *cilicica*, 37243075D-41864495K, 1596m, 27.10.2008, *HD4156.*

Figure 4. Ascocarps of *T. hemisphaerioides*

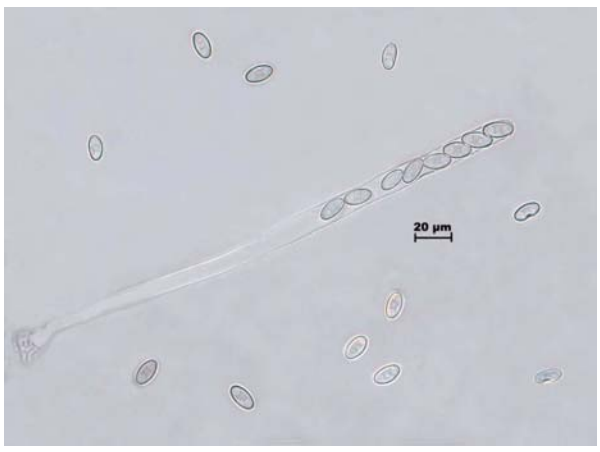

Figure 5. Ascospores and ascus of *T. hemisphaerioides.*

4. Conclusion and discussion

Although *H. lutescens* is similar to *H. calyculus*, *H. fructigenus* and *H. scutula* by its macroscopic features. There are several respectable discrepancies between them. *H. lutescens* has small ascospores than other three species and it has also short stalk while other species have long stalks.

T. hemisphaerioides is similar to *Humaria hemisphaerica* (F.H. Wigg.) Fuckel for its macroscopic features. But it is easy to separate them by their microscopic characters. The spores of the *T. hemisphaerioides* are smaller than *H. hemisphaerica* and there are no warts on the spores. The hairs of *T. hemisphaerioides* are thinner and smaller than *H. hemisphaerica.*

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References

Aktaş, S., Kaşık, G., Doğan, H.H., Öztürk, C. 2006. Two new taxa records for the macrofungi of Turkey. Turk J Bot. 30. 209-212.

Breitenbach, J., Kränzlin, F. 1986. Fungi of Switzerland. Volume 2, Verlag Mykologia, Luzern.

Cannon, P.F., Kirk, P.M. 2007. Fungal families of the world. Cabi Publishing, United Kingdom.

Medardi, G. 2006. Ascomiceti d'Italia. A.M.B., Vicensa, Italy.

Sesli, E., Denchev, C.M. 2009. Checklists of the myxomycetes, larger ascomycetes, and larger basidiomycetes in Turkey. Mycotaxon 106 [2008]: 65-67 + on-line version: 1-102 (http://www.mycotaxon.com/resources/checklists/sesli-v106-checklist.pdf).

Solak, M.H., Işıloğlu, M., Kalmış, E., Allı, H. 2007. Macrofungi of Turkey. Checklist, Volume-1, Üniversiteliler Ofset, İzmir.

Solak, M.H., Gücin, F., Işıloğlu, M., Kalmış, E. 1997. Wood-decaying fungi which were found in some provinces and their surroundings in the Northwest Anatolia. XI.World Forestry Congress, Antalya, 199.

Uzun, Y., Kaya, A., Akçay, M.E., Demirel, K., 2010. New additions to the Turkish macromycota from Bingöl province (Turkey). Turk J Bot. 34. 63-66.

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Seed Surface Analysis of Some Threatened Endemic Plants from Tahtalı Mountains (Adana-Kayseri/Turkey)

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Abstract

In this study, seeds morphology of the local endemic 8 species (*Anthemis antitaurica* Grierson, *Cirsium aytachii* H.Duman & R.R.Mill, *Jacobaea inops* (Boiss. & Balansa) B.Nord., *Grammosciadium confertum* Hub.-Mor. & Lamond, *Muscari macbeathianum* Kit Tan, *Silene balansae* Boiss., *Teucrium antitauricum* Ekim, *Verbascum hadschinense* Freny & Sint.) known only from Tahtalı range and the neighbouring mountains in South Anatolia were studied. These studied species has been presented with SEM pictures including both the general structures of the seeds and also the ornamentation details of them.

Key words: Endemic, ex-situ conservation, seed morphology, SEM, Turkey

Özet

Bu çalışmada, Güney Anadolu'da yer alan Tahtalı dağları ve yakın çevresinden bilinen 8 lokal endemik bitkinin (*Anthemis antitaurica* Grierson, *Cirsium aytachii* H.Duman & R.R.Mill, *Jacobaea inops* (Boiss. & Balansa) B.Nord., *Grammosciadium confertum* Hub.-Mor. & Lamond, *Muscari macbeathianum* Kit Tan, *Silene balansae* Boiss., *Teucrium antitauricum* Ekim, *Verbascum hadschinense* Freny & Sint.) tohum morfolojisi çalışılmıştır. Ayrıca çalışmada, tohumların genel görünüşleri ve ornamentasyon detaylarını gösteren SEM fotoğrafları da verilmiştir.

Anahtar kelimeler: Endemik bitki, ex-situ koruma, tohum morfolojisi, SEM, Türkiye

1. Introduction

Tahtalı mountains, containing a large number of regional and local endemic plants, are referred as an important endemism centre of Turkey. The 8 local endemic species, only known from Tahtalı range and neighbouring mountains, were studied in this article. These species are *Anthemis antitaurica* Grierson, *Cirsium aytachii* H.Duman & R.R.Mill and *Jacobaea inops* (Boiss. & Balansa) B.Nord. (Compositae), *Grammosciadium confertum* Hub.-Mor. & Lamond (Umbelliferae), *Muscari macbeathianum* Kit Tan (Liliaceae), *Silene balansae* Boiss. (Caryophyllaceae), *Teucrium antitauricum* Ekim (Labiatae) and *Verbascum hadschinense* Freny & Sint. (Scrophulariaceae). All these important endemic species have very small populations in their distribution areas. Also, they are under threat because of various reasons such as the lack of conservation measurements, serious habitat degradation and over grazing pressures. This study aims to collect the seeds, to determine their morphological characters and also to contribute the scientists who would like to study with these seed for any scientific purposes.

2. Material and Method

The seeds were collected by considering to sample the whole genetic diversity of the species during the dispersal season in 2008. All the specimens were identified by using some relevant literatures (Coode and Cullen, 1966; Davis and Parris, 1975; Davis et al., 1988; Ekim, 1982; Grierson and Yavin, 1975; Greuter and von Raab-Straube,

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2007; Güner et al., 2000; Hedge and Lamond, 1972; Huber-Morath, 1978; Tan, 1988; Matthews, 1975; Sruart and Davis, 1984). Also the following researches dealing with the seed morphology (Atera et al., 2007; Kaya and Dirmenci, 2008; Pınar et al. 2007; Prasad, 1976; Yıldız and Çırpıcı, 1998) were investigated. All the seed samples were sent to Central Research Institution Seed Bank in Ankara for conserving them under cold and dry conditions.

All the specimens were collected according to our previous phenological observations. The flowering time of *M. macbeathianum* in the mid March, whereas *C. aytachii* is flowered in late August. Moreover, the fruiting period varies from the mid May to the late September for each species. The dispersal seasons were determined as towards to the end of their fruiting periods (Figure 1).

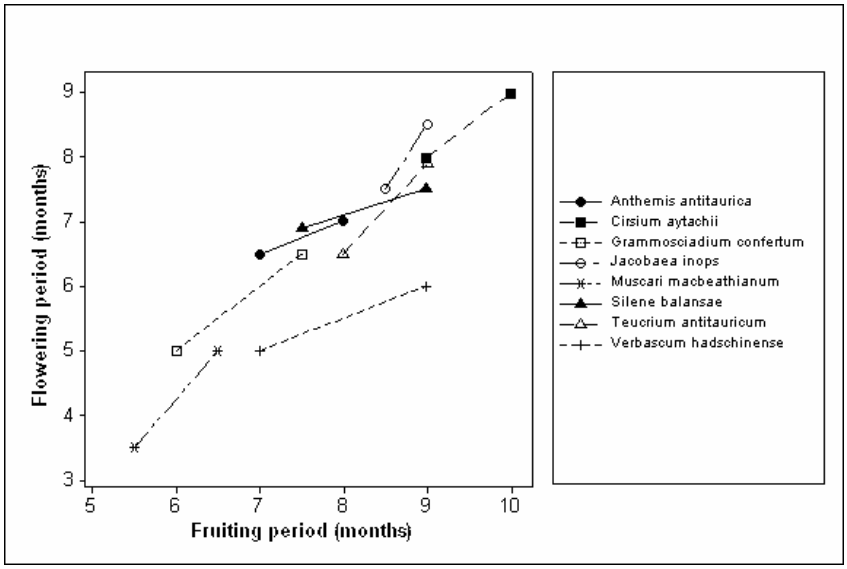

Figure 1. Relationship among flowering and fruiting seasons of the species

In order to determine the average seed sizes, 10 seeds from each species were measured (Table 1). For scanning electron microscopy (SEM) investigations (Figure 2-9), the seeds were examined with the model of Jeol JSM--6060 scanning electron microscope.

4. Results and discussion

Seeds of 8 threatened plant species from 6 families were studied. Among them, *A. antitaurica*, *M. macbeathianum* were gathered second times after type collection. These 2 species and also *G. confertum, J. inops* and *V. hadschinense* only distributed in Tahtalı mountains. While 3 of the species (*C. aytachii, S. balansae, T. antitauricum*) have also very small extent of occurrence in addition to Tahtalı mountains. *C. aytachii, S. balansae, T. antitauricum* were collected by several scientists from neighbouring areas which are very close to this range.

IUCN categories of the species are as follows; *C. aytachii, M. macbeathianum* are CR (Critically Endangered). *A. antitaurica, J. inops, S. balansae* and *V. hadschinense are* EN (Endangered), *G. confertum* and *T. antitauricum are* VU (Vulnerable) (Ekim et al., 2000).

4.1. Seed morphology of the species

Anthemis antitaurica

Achenes straw coloured to pale brown, oblong, 3.05-3.25 x 1-1.19 mm, 7 ribbed on both surfaces, corona 0.5-0.7 mm. Hilum elliptic; c. 0.5 mm. Sculpture ornamentation reticulate-alveolate. The ornamentation is characterised by the surface cells with mostly tetragonal walls and many transversal striae between lateral walls (Figure 2).

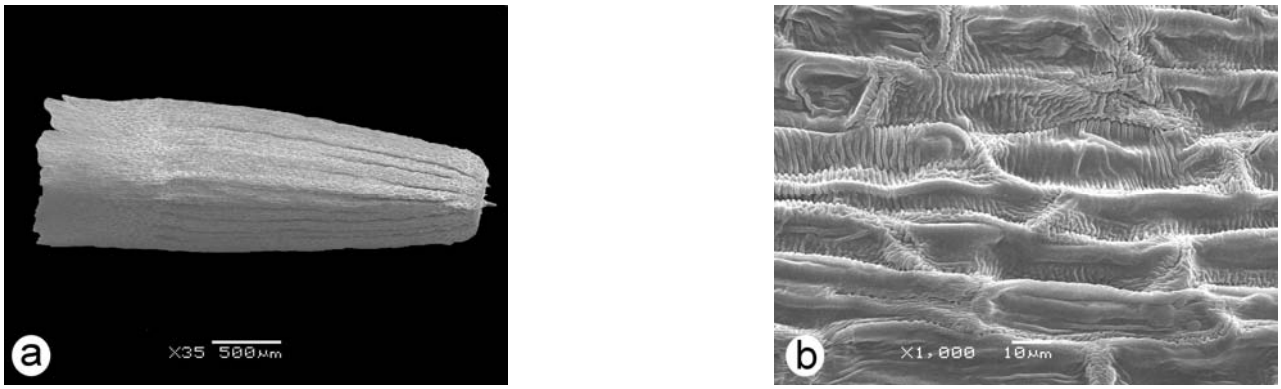

Figure 2. Achene of *Anthemis antitaurica*; general view (a), surface (b)

Cirsium aytachii

Achenes dark brown to blackish, elliptic, shiny, 5.5-6.16 x 2.2-2.5 mm. Hilum elliptic, oblique, 0.2-0.25 mm. Sculpture ornamentation finely striate (Figure 3).

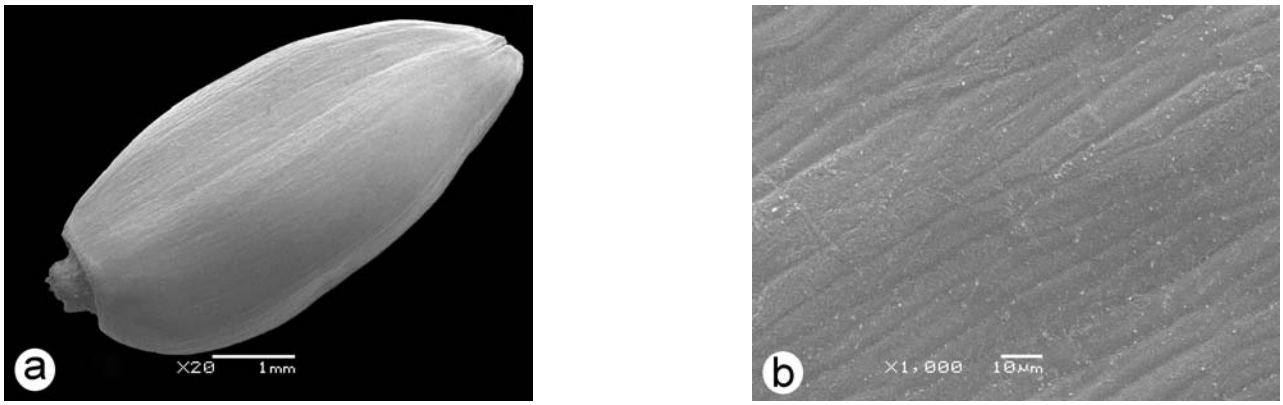

Figure 3. Achene of *Cirsium aytachii*; general view (a), surface (b)

Grammosciadium confertum

Mericarps straw coloured, narrowly oblong, narrowed towards the base, 9-13 x 1.5-2 mm. Hilum broadly elliptic to orbicular, 0.7-1.9 mm. Stylopodium 0.5-1 mm. Sculpture pattern irregularly arranged, finely striate and sparsely scrobiculate.

Mericarps dissimilar, outher mericarps with 5 primary ridges; second and fourth ridges ending in a horn. Inner with with 3 conspicuous and 2 incospicuous primary ridges; first, third and fifth ridges ending in a horn. Horns triangular and acute, 0.4-0.7 mm. Each mericarps with 4 filiform secondary ridges (Figure 4).

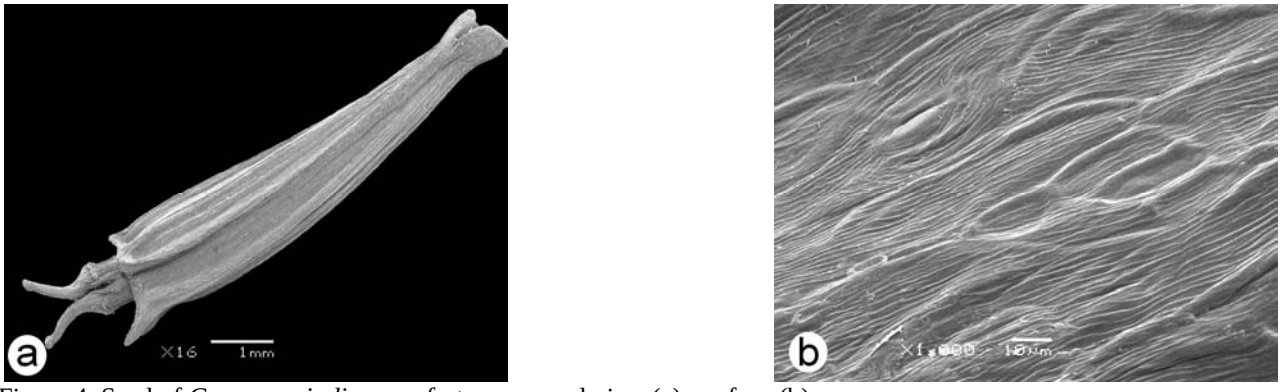

Figure 4. Seed of *Grammosciadium confertum*; general view (a), surface (b)

Muscari macbeathianum

Seeds black, elliptic, 1.4-2.4 x 0.6-0.9-1 mm. Hilum linear, oblique, 0.1-0.19 x 0.06-0.008 mm. Sculpture ornamentation rugose represented by irregular convex reticulated lines (Figure 5).

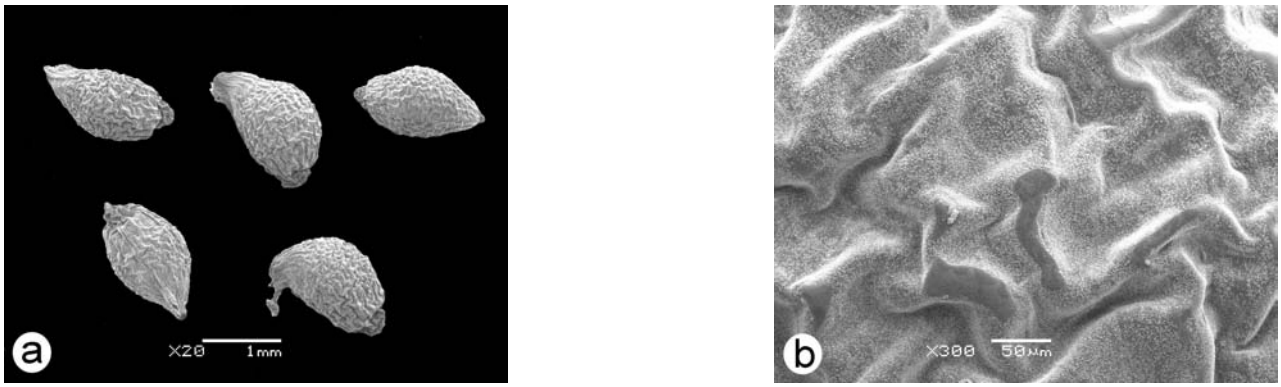

Figure 5. Seeds of *Muscari macbeathianum*; general view (a), surface (b)

Jacobaea inops

Achenes brown, oblong, hairy, 2-3 x 1.2-1.5 mm. Hilum elliptic. Sculpture ornamentation finely and irregularly striate (Figure 6).

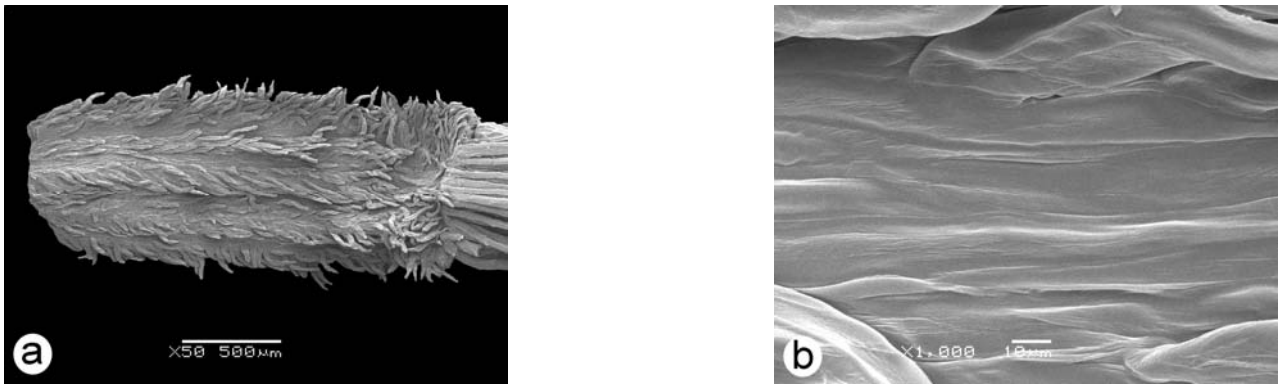

Figure 6. Achene of *Jacobaea inops*; general view (a), surface (b)

Silene balansae

Seeds pale to dark brown, reniform, 1.6-2.1 x 1-1.5 mm. Hilum semi-orbicular, 0.1-0.2 mm. Sculpture ornamentation pustulate which is characterised by the irregular surface cells with toothed margins (Figure 7).

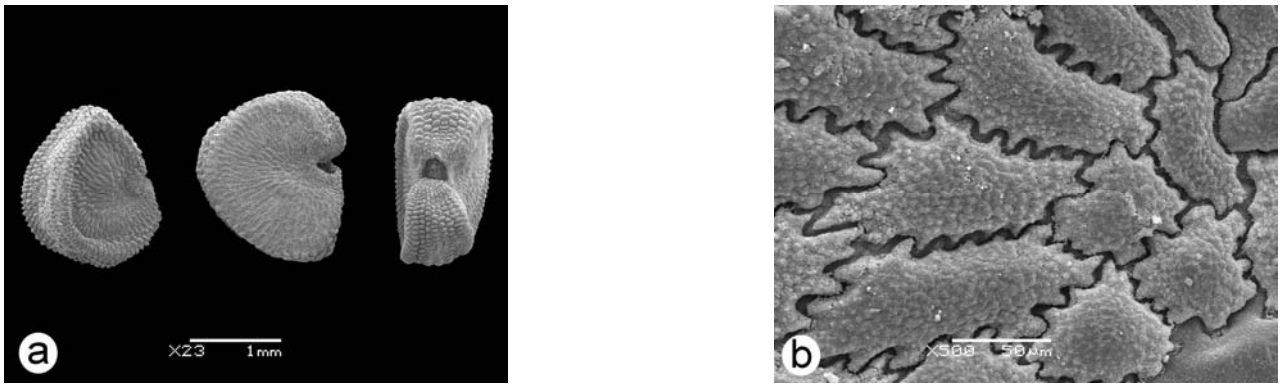

Figure 7. Seeds of *Silene balansae*; general view (a), surface (b)

Teucrium antitauricum

Nutlets brown, ovate to oblong, glandular, 1.2-1.9 x 0.5-1 mm. Hilum broadly ovate, 0.4-0.6 mm. Sculpture ornamentation reticulate-alveolate. The ornamentation is marked by pitted surface cells with mostly polygonal or orbicular walls (Figure 8).

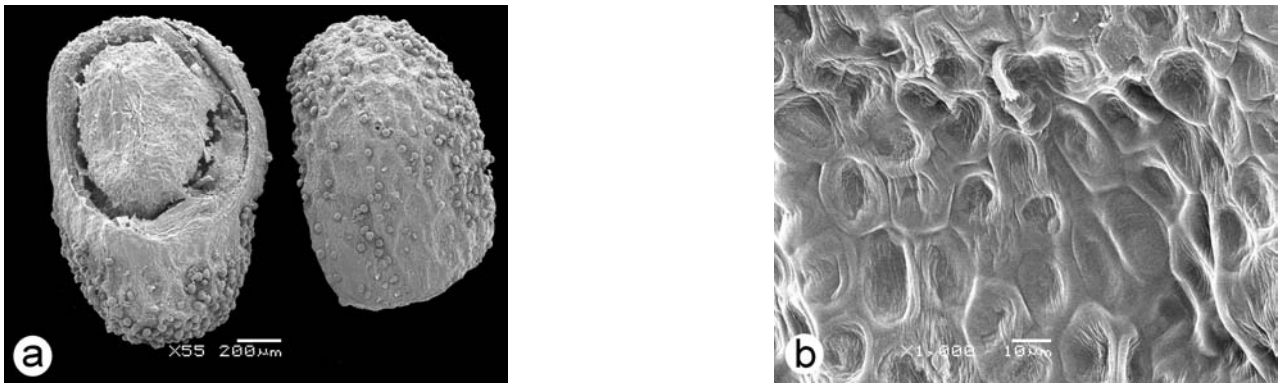

Figure 8. Nutlets of *Teucrium antitauricum*; general view (a), surface (b)

Verbascum hadschinense

Seeds dark brown, oblong, 0.6-0.8 x 0.4-0.5 mm. Hilum very small and orbicular. Seed coat sculpture is formed by tetragonal cells with regular radial walls showing a reticulate appearance. The walls surrounding each cell are characterized by blisters. The blisters are only found to the angles where two perpendicular walls reach each other (Figure 9).

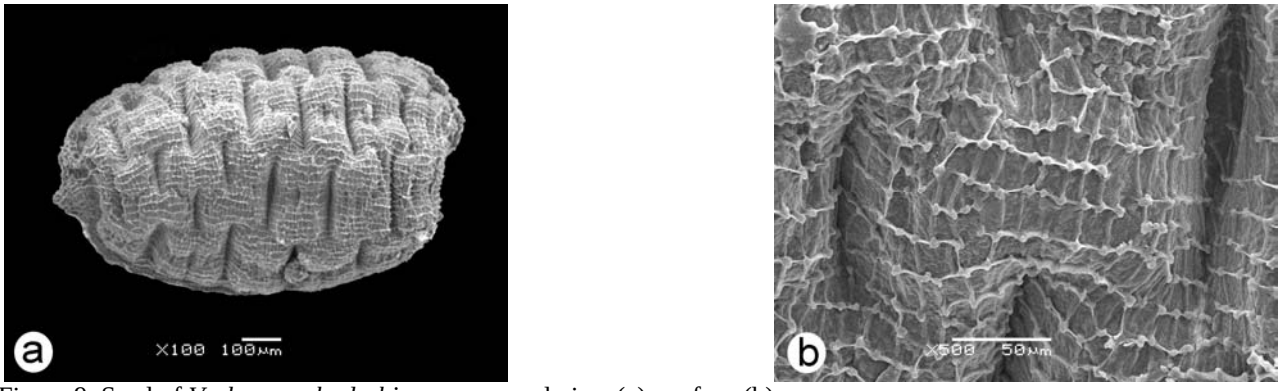

Figure 9. Seed of *Verbascum hadschinense*; general view (a), surface (b)

Table 1. Fruit types and seed characters

Species	Fruit type	Colour	Shape	Size (mm)	Surface	Average weight (mg)
A. antitaurica	achene	straw coloured to pale brown	oblong	3.05-3.25 x 1-1.19	reticulate-alveolate	0.935
C. aytachii	achene	dark brown to blackish	elliptic	5.5-6.16 x 2.2-2.5	finely striate	7.88
G. confertum	mericarp	straw coloured	narrowly oblong	9-13 x 1.5-2	finely striate and sparsely scrobiculate	10.26
M. macbeathianum	capsule	black	elliptic	1.4-2.4 x 0.6-0.9-1	rugose	0.545
J. inops	achene	brown	oblong	2-3 x 1.2-1.5	finely and irregularly striate	0.875
S. balansae	capsule	pale to dark brown	reniform	1.6-2.1 x 1-1.5	pustulate	1.43
T. antitauricum	nutlet	brown	ovate to oblong	1.2-1.9 x 0.5-1	reticulate-alveolate	0.36
V. hadschinense	capsule	dark brown	oblong	0.6-0.8 x 0.4-0.5	reticulate	0.11

Consequently, 4 fruit types (achene, capsule, nutlet and mericarp) and 7 ornamentation types (reticulate, reticulate-alveolate, finely striate, finely and irregularly striate, finely striate and sparsely scrobiculate, rugose, pustulate) were

determined. 4 of the seeds are oblong, 2 of them are elliptic, 1 of them are reniform and 1 of them is ovate to oblong in shape. Their average weights vary from 0.11 to 10.26 mg (Table 1). Also the relationship between seed length and seed width of the species is shown in Figure 10. *G. confertum* has the longest seeds, while the broadest seeds belong to *C. aytachii*. *V. hadschinense* has the shortest and the narrowest seeds (Figure 10).

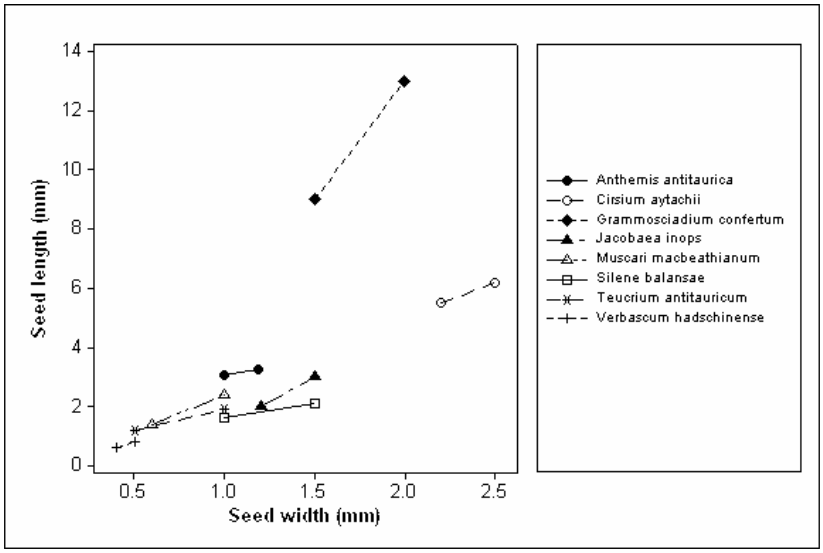

Figure 10. Relationship between seed length and seed width

References

Atara, F., Keshvaria, A., Ghahremana, A., Zarrea S., Aghabeigib, F. 2007. Micromorphological studies on *Verbascum* (Scrophulariaceae) in Iran with emphasis on seed surface, capsule ornamentation and trichomes. Flora-Morphology, Distribution, Functional Ecology of Plants. 202/2. 169-175.

Coode, M. J. E., Cullen, J. 1966. *Silene* L., In (Ed.) Davis, P. H., Flora of Turkey and the East Aegean Islands. Volume 2, 179-242. Edinburgh University Press, Edinburgh.

Davis, P. H., Parris, B. S. 1975. *Cirsium* Mill., In (Ed.) Davis, P. H., Flora of Turkey and the East Aegean Islands. Volume 5, 370-412. Edinburgh University Press, Edinburgh.

Davis, P. H., Mill, R. R., Tan, K. 1988. Flora of Turkey and the East Aegean Islands. Volume 10. Edinburgh University Press, Edinburgh.

Ekim, T. 1982. *Teucrium* L., In (Ed.) Davis, P. H., Flora of Turkey and the East Aegean Islands. Volume 7, 53-75. Edinburgh University Press, Edinburgh.

Greuter, W., von Raab-Straube, E. 2007. Euro+Med Notulae 3. Willdenowia. 37/1. 139 – 189.

Grierson, A. J. C., Yavin, Z. 1975. *Anthemis* L., In (Ed.) Davis, P. H., Flora of Turkey and the East Aegean Islands. Volume 5, 174-221. Edinburgh University Press, Edinburgh.

Güner, A., Özhatay, N., Ekim, T., Başer, K. H. C. 2000. Flora of Turkey and the East Aegean Islands. Volume 11. Edinburgh University Press, Edinburgh.

Hedge, I. C., Lamond, J. M. 1972. *Grammosciadium* DC., In (Ed.) Davis, P. H., Flora of Turkey and the East Aegean Islands. Volume 4, 318-321. Edinburgh University Press, Edinburgh.

Huber-Morath, A. 1978. *Verbascum* L., In (Ed.) Davis, P. H., Flora of Turkey and the East Aegean Islands. Volume 6, 461-603. Edinburgh University Press, Edinburgh.

Kaya, A., Dirmenci, T. 2008. Nutlet Surface Micromorphology of the Genus Nepeta L. (Lamiaceae) in Turkey. Turkish Journal of Botany. 32. 103-112.

Matthews, V. A. 1975. Senecio L., In (Ed.) Davis, P. H., Flora of Turkey and the East Aegean Islands. Volume 5, 145-168. Edinburgh University Press, Edinburgh.

Pınar, N. M., Adıgüzel, N., Geven, F. 2007. Seed Coat Macrosculpturing in Some Turkish *Aethionema* R.Br. (Brassicaceae). Pakistan Journal of Botany. 39/4. 1025-1036.

Prasad, K. 1976. Seed Coat Structure and Development in Certain Species of Cruciferae. New Botanist, III. 3-4. 95-103.

Stuart, D. C., Davis, P. H. 1984. *Muscari* Mill., In (Ed.) Davis, P. H., Flora of Turkey and the East Aegean Islands. Volume 8, 245-263. Edinburgh University Press, Edinburgh.

Tan, K. 1988. A New *Muscari* (Liliaceae) From Turkey. Herbertia. 44/1. 25-28.

Yıldız, K., Çırpıcı, A. 1998. Seed morphological studies in *Silene* L., from Turkey. Pakistan Journal of Botany. 30/2. 173-188.

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Leaf epidermal anatomy of the genus *Silene* (Caryophyllaceae) from Pakistan

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Abstract

Anatomical studies of 16 species of the genus *Silene* have been carried out from Pakistan by light microscopy. There is considerable variation in leaf epidermal anatomy in the species of *Silene*. In anatomical studies type of stomata, shape and size of epidermal cells, trichomes and crystals are important to identify the taxa at specific level. In almost all the species abaxial surface was different from the adaxial surfaces. . Diacytic type of stomata is the diagnostic character of family Caryophyllaceae. In *Silene* basic type of stomata is diacytic but some other stomatal types are also present such as anisocytic and anomocytic. *S.arenosa* can be easily distinguished by cristarque type of crystal. Epidermal cells of *S. moorcroftiana* are larger in size i.e.125 µm in length while in *S. indica* length of epidermal cell is 30µm. In *S. villosa* 4 - 5 - celled glandular hairs are abundantly present that is its species- specific character. The study suggests that the genus *Silene* has both primitive as well as advanced characters. A dichotomous key is constructed for the species identification using the characters that have been studied.

Keywords: *Silene*, Caryophyllaceae, Stomata, Epidermis, Trichomes

1. Introduction

Silene is one of the largest genera of flowering plants in the world consisting of about 700 species (Greuter, 1995; Jurgens et al., 2002; Jurgens, 2004).In Pakistan the genus is represented by 28 species (Ghazanfar and Nasir, 1986). Arora and Panday (1996) and Bakshi (1984) reported the medicanal properties of genus *Silene.*

Anatomical features are of particular value to identify small scraps of plant material (Stace, 1980).Anatomical or endomorphic characters are not appreciably influenced by environmental changes and are basically uniform from one group to another (Bokhari, 1987). Different workers (Ahmad and Safa, 1995; Ahmad, 1997; Aranbari and Colares, 1993; Ataslar, 2004) have utilized epidermal and stomatal characteristics in the systematic studies of some families with some success. Rashid et al. (1987) have worked out the epidermal anatomy of some members of Family Convolvulaceae and Solanaceae. Similarly, Das (2002) worked on the ontogeny of stomata of some Indian mangroves. Gilani et al. (2002) investigated the leaf epidermal anatomy of selected *Digitaria* species. Metcalfe and chalk (1950) studied the anatomy of caryophyllaceae and reported that generally the stomata are diacytic i.e. caryophyllacous type but exceptions where stomata are anisocytic.Uniseriate glandular hairs were reported in *Silene.* Calcium oxalate crystals are found commonly in *Diathus* and *Silene.*

Davis (1967) investigated the anatomy of Caryophyllaceae and reported that the glandular and eglandular hairs are of diagnostic value in Caryophyllaceae. The previous anatomy studied on Caryophyllaceae had been done by Metcalfe and Chalk (1983). Akhter and Syed (2006) studied epidermal structures as taxonomic features in some members of Acanthaceae. Jafari et al. (2008) have utilized epidermal characters in the systematic studies of *Silene* species in Iran. Yildiz and Minareci (2008) reported glandular hairs and stomata on both surfaces of leaves of *Silene urvillei.*

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Although anatomical evidence has played an important role in discerning natural groups and understanding phylogenetic relationships, however there is a great need for knowledge of anatomical investigation in many plant families including Caryophyllaceae especially from Pakistan. The present study was undertaken to investigate the epidermal structure and to find out whether they can be used for taxonomic identification of some species in genus *Silene.* In this paper leaf epidermal anatomy of the genus *Silene* from Pakistan has been presented for the first time.

2. Material and methods

The anatomical investigations are based on the herbarium specimen obtained from Quaid-i-Azam University, Islamabad (ISL). For epidermal studies Shultze's method of maceration with improved technique was followed (Subrahmanyam, 1996). In a test tube, leaves were boiled with 4 ml of concentrated nitric acid to which 2g of potassium chloride and 1ml of distilled water was added as the epidermis was separated in the form of a thin pellicle, the content of the test tube were emptied in water. Epidermal strips were washed with water and placed on glass slide then poured one to two drops of lactic acid and covered with cover slip. The prepared slides were studied under the light microscope. Permanent slides for anatomical reference collection have been deposited in the Plant Taxonomy Lab, Department of Plant Sciences, Quaid-i-Azam University, Islamabad. Terminology used is after Easu (1965). The following species were studied:

S. apetala	*S. arenosa*	*S. brahuica*	*S. citrina*
S. conoidea	*S. falconariana*	*S. indica*	*S. kunawerensis*.
S. longisepala	*S. moorcoftiana*	*S. ovalifolia*	*S. pseudo-verticellata*
S. tennuis	*S. villosa*	*S. viscosa*	*S. vulgaris*

3. Results

Table 1 summarizes the features of leaf epidermal cells from the taxa examined. Light micrographs of *Silene* species are presented in Figs.1-17.

Size and Shape of Epidermal cells: The shape of epidermal cells is irregular, rectangular and polygonal with smooth, slightly wavy, wavy and highly undulating walls.

10 species viz. *S. apetala, S. citrina, S. conoidea, S. falconariana, S. indica, S. kunawerensis. S. moorcroftiana, S. pseudoverticillata* and *S. tennuis* and *S. viscosa* have irregular shape of cells. Similarly, 4 species viz. *S. arenosa,. S. ovalifolia, S. villosa* and *S. vulgaris* have polygonal cells. Epidermal cells of *S. brahuica* and *S. longisepala* are rectangular.

The size of epidermal cells of the species of *Silene* ranges from 30×18µm to 125×65µm. There is great variation in the size of the epidermal cells. Area of epidermal cell appear to be the largest (125×65µm) in *S. moorcroftiana,* and the smallest (30×18µm) in*. S. indica.*

Stomata: Stomata are of different types. Eight species viz. *S. arenosa, S. brahuica. S. conoidea, S. kunawerensis. S. longisepala, S. tennuis, S. viscosa* and *S. vulgaris* have diacytic type of stomata while rest of the species have variety of stomata i.e. diacytic, anomocytic and anisocytic. . *S. arenosa, S. viscosa* and *S. vulgaris* have less number of stomata on adaxial surface as compare to abaxial surface.

Trichomes: Trichomes are absent in *S. apetala* and *S. vulgaris.* Trichomes range from glandular to non- glandular and unicellular to multicellular hairs. *S. longisepala* and *S. moorcroftiana* have same 2-3 celled glandular hairs. Similarly, *S. arenosa, S. falconariana, S. kunawerensis, S. ovalifolia* and *S. viscosa* have non glandular hairs.

Crystals: *S. arenosa, S. conoidea, S. moorcroftiana, S. tennuis, S. viscosa* and *S. vulgaris* have different type of crystals on epidermal surface. *S. arenosa* have cristarque cell.
Based on the present observation and variation shown in epidermal structures following key is proposed for identification of investigated species.

Key to Silene species

1 + Cristarque cell is present……..……..... 1. *S. arenosa*
- Cristarque cell is absent……...…… 2

2 + Trichomes absent, numerous stomata on both surfaces……..…..... ..... 2. *S. apetala*
- Trichomes present, less stomata on adaxial surface……..... 3

3 + 3-4 celled nonglandular hairs on both surfaces……..... *3.* *S. viscosa*
- 5-6 celled glandular hairs on abaxial surface……..... 4

4 + Abaxial and adaxial surfaces have 5-6 celled and1-3 celled glandular hairs respectively .....
..... 4. *.S. brahuica*
- Nonglandular hairs are present……..... 5

5 + Highly undulating walls of epidermal cells with blunt ended trichomes….....
..... 5. *S. kunawerensis*
- Smooth walls of epidermal cells with non-blunt ended trichomes…..... 6

6 + Non-glandular trichomes abundant on abaxial and less on adaxial surface ..... 6. *S. vulgaris*
- Non-glandular trichomes abundant on both surfaces……..... 7

7 + 5-6 celled nonglandular hairs with polygonal epidermal cells shape …..... 7. *S. ovalifolia*
- 2-3 celled glandular hairs with rectangular epidermal cells shape …..... 8

8 + 2-3 celled glandular hairs with smooth walled epidermal cells …..... 8. *S. longisepala*
- 2-3 celled glandular hairs with wavy walled epidermal cells 9

9 + Trichomes abundantly present on both surfaces……..... 9. *S. citrina*
- Trichomes occasionally present on both surfaces……..... 10

10 + 1-celled trichome with highly undulating epidermal cell wall…….....…… 10. *S. tennuis*
- 4-5 celled trichome with smooth epidermal cell wall…….....… 11

11 + 4-5 celled glandular hairs…….....…… 11. *S. villosa*
- Trichomes absent……..... 12

12 + Epidermal wall of abaxial surface wavy…….....…. 12. *S. vulgaris*
- Epidermal wall of abaxial surface smooth to slightly wavy……..... 13

13 + Diacytic type of stomata with glandular and non-glandular hairs…….....…. 13. *S. conoidea*
- Diacytic, anomocytic and anisocytic stomata with glandular hairs…….....14

14 + Rudimentary trichome present…….....… 14. *S. pseudoverticillata*
- Rudimentary trichome absent …….....… 15

15 + Highly undulating wall of epidermal cells on adaxial surface……..... 15. *S. indica*
- Wavy wall of epidermal cells on adaxial surface…….....…. 16. *S. moorcroftiana*

4. Discussion

The present study was restricted mainly to stomatal complex, trichomes and its types, epidermal cell shape and cystoliths i.e. crystals. The results indicate certain facts of taxonomic and phylogenetic importance. The presence of trichomes in different species of genus *Silene* is obvious. Different types of trichomes are found in these species ranging from unicellular, peltate non-glandular to multicellular shaggy and glandular long multiseriate hairs.

The leaf epidermal anatomy of different species of Caryophyllaceae has proved to be of much importance in the identification at species level. Davis and Heywood (1963) emphasized the use of anatomical characters, as these are reliable and fairly constant within a taxon. In some species there is difference in the adaxial and abaxial surface. This character has been observed in a few species.

In *Silene* basic type of stomata is diacytic but some other stomatal types are also present such as anisocytic and anomocytic. The present study matches with the result of Grewal (2000) who reported diacytic type of stomata in Caryophyllaceae. Warming (1920) reported that caryophyllaceous type of stomata is found in certain species of Caryophyllaceae with elongated epidermal cells. Stomata sometimes tend to be of the Cruciferous type in these species.

In Caryophyllaceae genera can be segregated on the basis of smooth and highly undulating wall of epidermal cells. Jafari et al. (2008) repoted crenate subsidiary cells in *S. conoidea* and also entire walls in some species of Silene. The present studies are also in agreement with their findings as in *S. conoidea* smooth to slightly undulating wall is found on both surfaces. In some species of *Silene* there are smooth walls like *S. arenosa, S. apetala, S. brahuica, S. longisepala, S. ovalifolia* and *S. villosa* on both abaxial and adaxial surfaces. Abaxial and adaxial surfaces of *S. tennuis* and *S. kunawerensis* have highly undulating walls. In *S. indica* and *S. citrina* abaxial surfaces have highly undulating wall with irregular shape of cells while adaxial surfaces have smooth wall with angular cells. In *S. falconariana* abaxial and adaxial both surfaces have smooth walls with polygonal shape of cells and numerous stomata. While *S. viscosa* have wavy walls on abaxial surface and smooth wall on adaxial surface and less stomata.

Table 1: Leaf Epidermal Anatomical Features of *Silene* species

Taxon	Type of stomata	Stomata on abaxial	Stomata on adaxial	Trichome on abaxial	Trichome on adaxial	Shape of crystal	Wall of epidermal cell on abaxial	Wall of epidermal cell on adaxial	Shape of epidermal cell
Silene apetala	Diacytic , Anisocytic,anomocytic	Numerous	Numerous	absent	Absent	Absent	Smooth	Smooth	Irregular, rectangular
Silene arenosa	Diacytic	Numerous	Less	Short non-glandular with blunt end	Short non-glandular with blunt end	Cristarque cell	Smooth	Smooth	Polygonal
Silene brahuica	Diacytic	Numerous	Numerous	5-6 celled, glandular	1-3 celled glandular	Absent	Smooth	Smooth	rectangular
Silene citrine	Diacytic , anisocytic	Numerous	Numerous	5- 6 celled abundant,non-glandular + glandular	1 celled abundant, glandular non glandular	Absent	Smooth	Highly sinuous	Irregular ,polygonal
Silene conoidea	Diacytic	Numerous	Numerous	3 -4 celled abundant, non-glandular + glandular	3 -4 celled less,non glandular + glandular	Present	Smooth to slightly wavy	Smooth to slightly wavy	Irregular
Silene falconariana	Diacytic , Anisocytic, anomocytic	Numerous	Numerous	abundant, non-glandular	less,non glandular	Absent	Smooth to slightly wavy	Smooth	Irregular
Silene indica	Diacytic , Anisocytic ,anomocytic	Numerous	Numerous	1-celled,occasionally present	1-celled occasionallypresent	Absent	Smooth	Highly undulating wall	Irregular, angular
Silene kunawerensis	Diacytic	Numerous	Numerous	3 -4 celled non glandular , apex blunt	3 -4 celled non glandular , apex blunt	Absent	Highly undulating wall	Highly undulating wall	Irregular
Silene longisepala	Diacytic	Numerous	Numerous	2- 3 celled, glandular	2- 3 celled, glandular	Absent	Smooth	Smooth	Rectangular angular
Silene moorcroftiana	Diacytic , anisocytic	Numerous	Numerous	2- 3 celled, glandular	2- 3 celled, glandular	Present	± wavy wall	Wavy wall	Irregular angular
Silene ovalifolia	Diacytic , Anisocytic ,anomocytic	Numerous	Numerous	5- 6 celled abundant,non-glandular	5- 6 celled abundant, non - glandular	Absent	± smooth	± smooth	polygonal
Silene pseudoverticillata	Diacytic , Anisocytic, anomocytic	Numerous	Numerous	Rudimentary hairs	Rudimentary hairs	Absent	± wavy wall	Wavy wall	Irregular angular
Silene tennuis	Diacytic	Numerous	Numerous	1-celled occasionally present	1-celled occasionally present	Present	Highly undulating wall	Highly undulating wall	Irregular
Silene villosa	Diacytic , Anisocytic ,anomocytic	Numerous	Numerous	4- 5 celled glandular	4- 5 celled glandular	Absent	Smooth	Smooth	polygonal
Silene viscose	Diacytic	Numerous	Less	3 -4 celled abundant, non-glandular	3 -4 celled less non-glandular	Present	Smooth	wavy wall	Irregular
Silene vulgaris	Diacytic	Numerous	Less	Absent	Absent	Present	± wavy wall	Smooth	polygonal

±= more or less

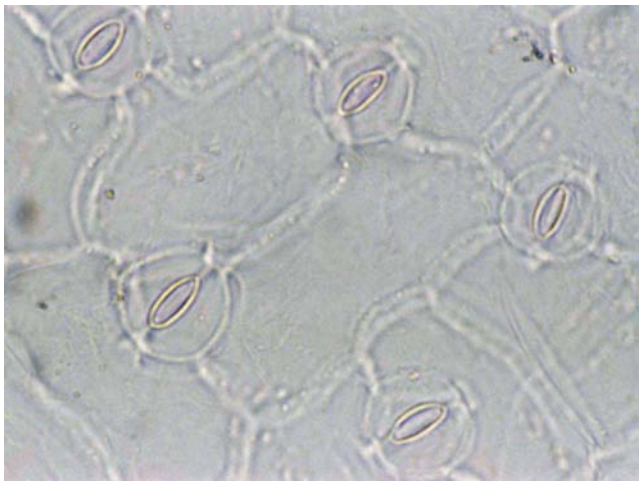

Fig 1:Abaxial surface of *Silene apetala* showing stomata and epidermal cells

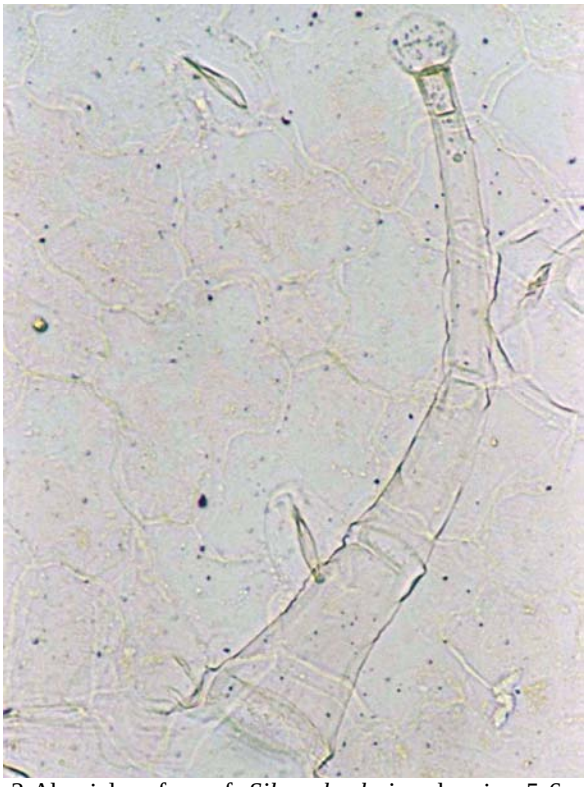

Fig 3:Abaxial surface of: *Silene brahuica* showing 5-6 celled glandular hair

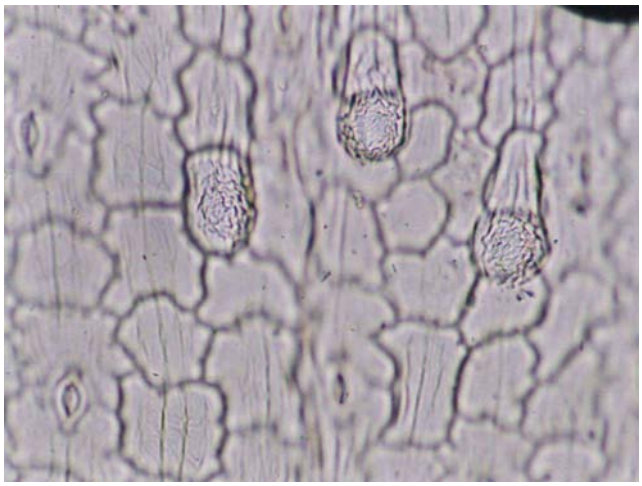

Fig 2:Adaxial surface of *Silene arenosa* showing cristarque cells, stomata and epidermal cells

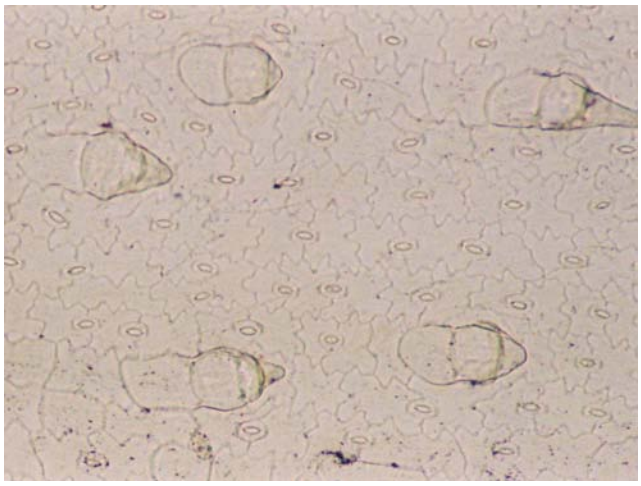

Fig 4: Adaxial surface of *Silene citrina* showing non glandular trichome , stomata and epidermal cells

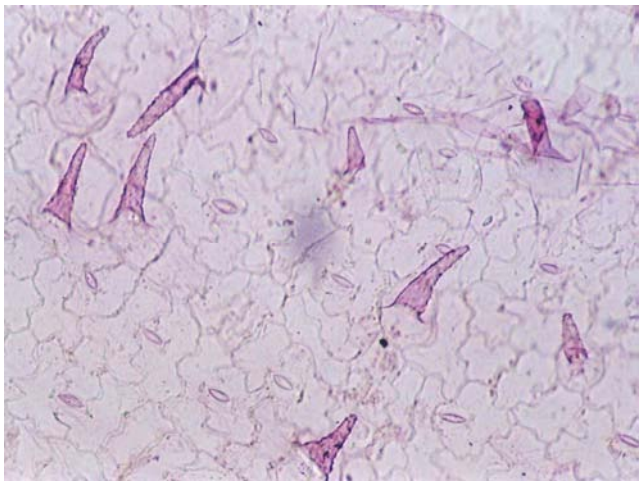

Fig 5: *Silene conoidea* showing trichomes, stomata and epidermal cells

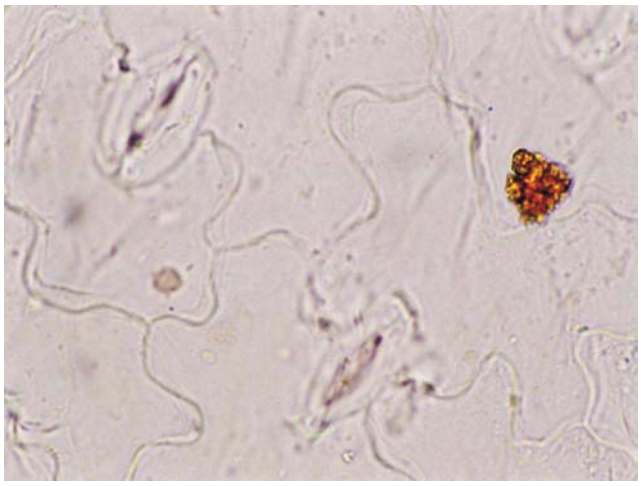

Fig. 7: Adaxial surface of Silene indica showing stomata and highly undulating wall

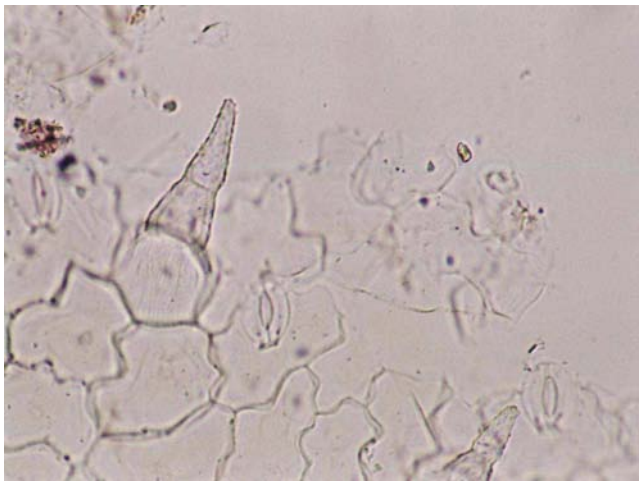

Fig 6: Abaxial surface of *Silene falconariana* showing trichomes, stomata and epidermal cells

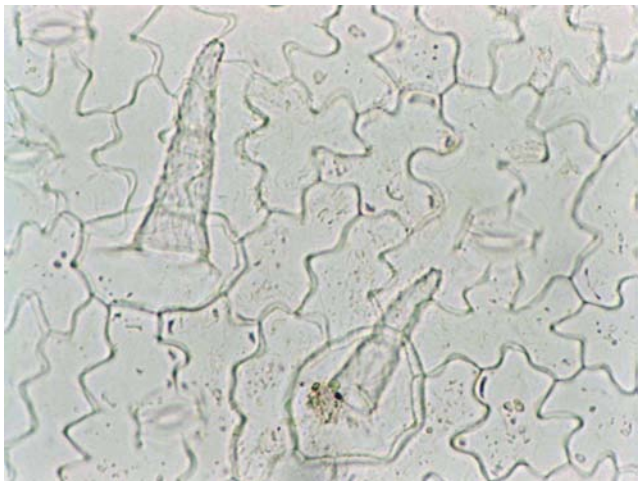

Fig. 8: *Silene kunawerensis* showing 3-4celled non glandular hairs, stomata and epidermal cells

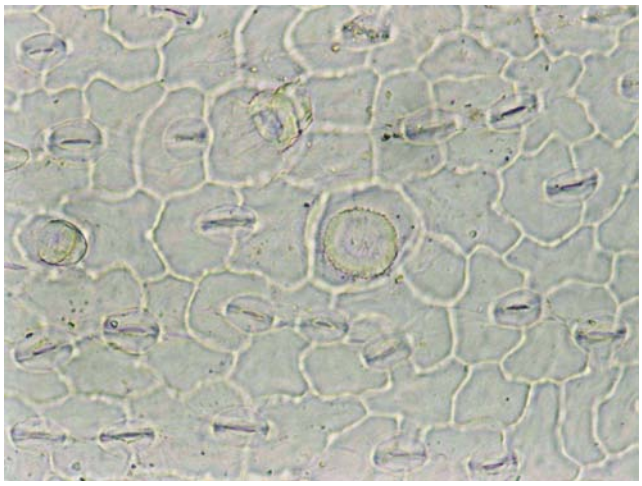

Fig. 9: *Silene longisepala* showing stomata and epidermal cells

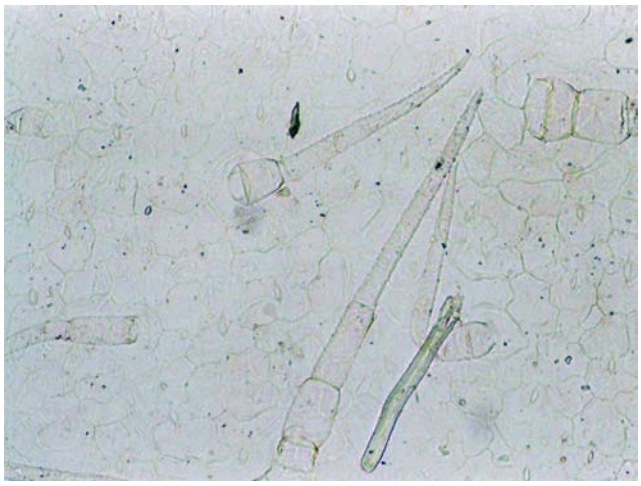

Fig. 11: *Silene ovalifolia* showing 5-6 celled non glandular hairs

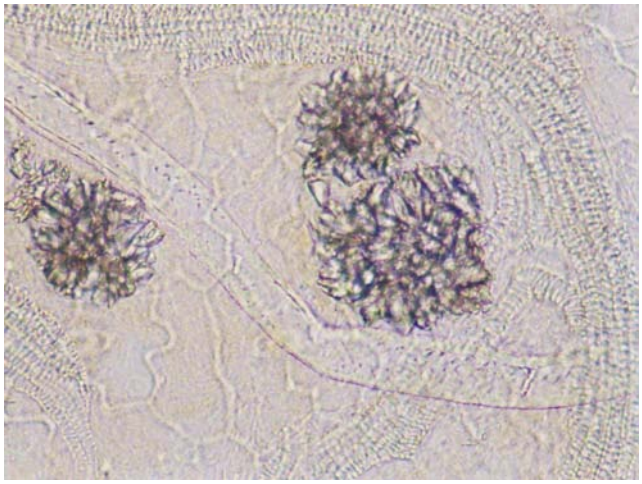

Fig. 10: Abaxial surface of *Silene moorcroftiana* showing crystals and epidermal cells

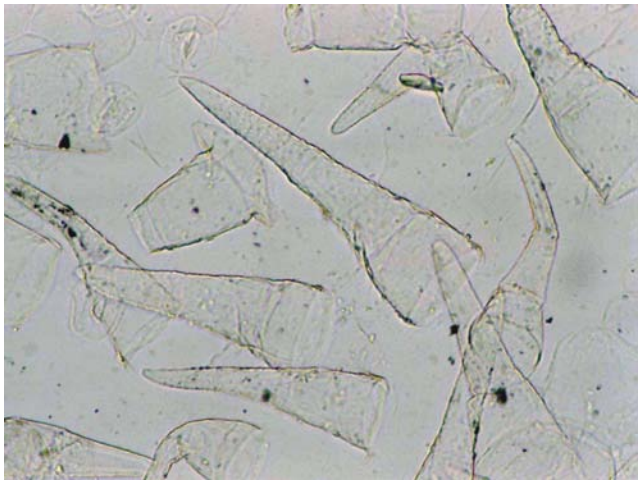

Fig. 12: *Silene pseudoverticillata* showing trichomes

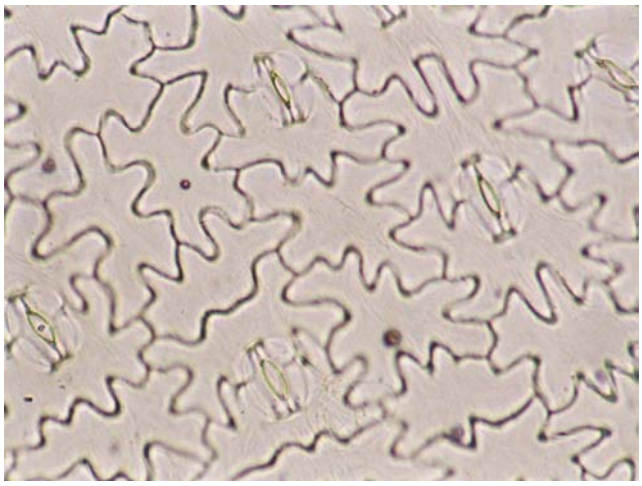

Fig. 13: *Silene tennuis* showing stomata and epidermal cells

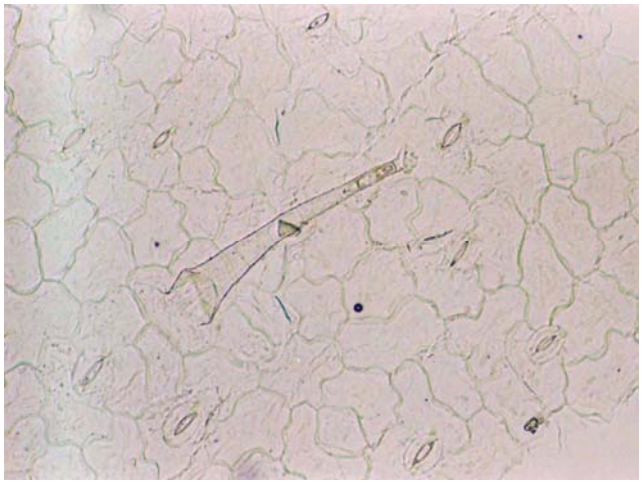

Fig. 14: *Silene villosa* showing 4-5 celled glandulatr hairs , stomata and epidermal cells

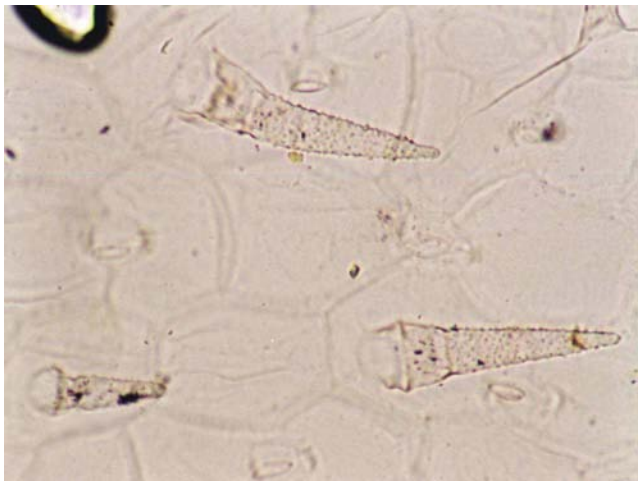

Fig. 15: *Silene viscosa* showing non glandular hairs

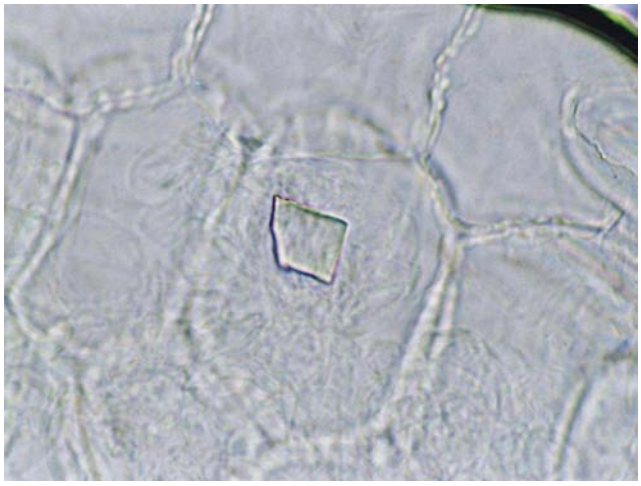

Fig. 16: *Silene viscosa* showing crystal

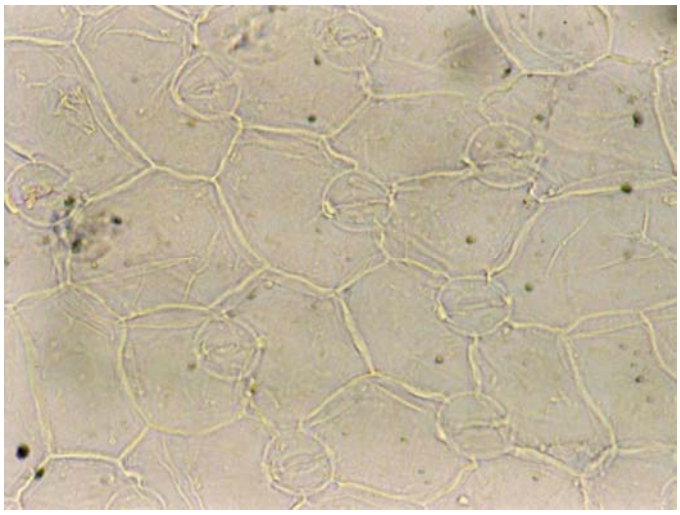

Fig. 17: *Silene vulgaris* showing stomata and epidermal cells

Stomatal variation in some cases is helpful at higher level of taxonomic hierarchy (Stace, 1965). *S. vulgaris* and *S.arenosa* have less number of stomata on adaxial surface as compare to abaxial.

Epidermal cells of *S. tennuis* are larger in size i.e.132 µm in length while in *S. vulgaris* length of epidermal cell is 30µm.This shows considerable variation between the two species.

Stomatal features are taxonomically important for identification and delimitation of various taxa at different taxonomic levels. 31 distinct patterns are found only in Pteriophytes (Dilcher, 1974). Diacytic type on both surfaces of stomata on both surfaces are found in *S. arenosa, , S. brahuica, S. longisepala, S. conoidea, S. vulgaris* and *S. viscosa*. Rest of the studied species have diacytic type of stomata along with anisocytic and anomocytic.

Trichome morphology and distribution can yield important clues regarding specific, generic, tribal and subfamilial relationship. In a number of instances, hairs are species- specific. The use of pubescence characters to support generic relationships or differences established on the basis of other characters have been established in a number of diverse families, including Asteraceae, Icacinaceae, Goodeniaceae, Ericaceae and Graminae (Dickison, 2000). In *S. indica, S. tennuis, S. apetala* and *S. vulgaris* trichomes are occasionally found. In *S. villosa* 4 – 5 - celled glandular hairs are abundantly present. In *S. conoidea* 3 – 4 - celled non-glandular hairs are abundant on abaxial while less on adaxial surface. In *S. brahuica* 5 – 6 - celled non-glandular hairs are found on abaxial while 1 – 3 - celled trichomes are present on adaxial surface. In *S. citrina* 5 – 6 - celled glandular and non-glandular hairs are found commonly while on adaxial surface 1-celled hairs are common.

Metcalfe and Chalk (1950) reported that uniseriate hairs with a glandular cell at apex recorded in *Silene* and hair structure believed to be of specific diagnostic value in different species of Caryophyllaceae. In *S. ovalifolia* 5 – 6 celled hook-like hairs with acute tip are abundantly present. In *S. longisepala* and *S. moorcrofitiana* 2 – 3 - celled glandular hairs are found on both surfaces. These results are in conformity with that of Yildiz & Minareci (2008). In *S. arenosa* short hairs with mucronate or blunt ends are found. In *S. pseudoverticellata* rudimentary trichomes are present.

Stace (1980) found that trichome anatomy is of immense importance in the family Combretaceae and it proved helpful in classification at all levels from the family down to the separation of species and even varieties.

Crystalline substances of varied form and chemical composition are found in the cells, cell walls and intercellular spaces of plant tissues. An unusual crystal cell of special taxonomic significance is the cristarque cell. Cristarque cell are highly diagnostic because they occur only in few families (Dickison, 2000). Metcalfe and Chalk (1950) reported that calcium oxalates are commonly present in the form of large conspicuous cluster crystals in many genera and species including *Silene*. The abundance of the crystals some times varies within single species in specimens from different localities.

In *S. arenosa* cristarque cells are present on adaxial surface that is the species-specific character. Different types of crystals are found in *S. vulgaris, S. conoidea, S. tennuis, S. viscosa* and *S. moorcroftiana*. These anatomical features observed on the leaves are consistent with those of Metcalfe and Chalk (1950).

From this preliminary study of genus *Silene* it appears that it is an advanced genus having mostly anomocytic, anisocytic and diacytic stomata, and unicellular to shaggy multiseriate trichomes. The present results are in agreement with Takhtajan (1980), who reported that stomata with two subsidiary cells are more primitive features and those without subsidiary cells are advanced features.

It is concluded that anatomical epidermal features can help in identification and classification of taxa up to the species level in the genus Silene.

References

Ahmad, K., Safa, A. 1995. The genus Chenopodium L. in Egypt II. Anatomical characters as a systematic tool. Ann. Agric. Sci. Cairo. 40. 505 – 513.

Ahmad, K. J. 1997. Taxonomic significance of epidermal characters in Acanthaceae in "Progress in Plant Research" Silver Publication. National Botanical Research Institute, Lucknow, India. 1. 135 – 166.

Akhter, N., Syed, A. 2006. Epidermal structures as taxonomic features in some members of Acanthaceae.Pak. J. Pl. Sci. 12/2. 163-166.

Aranbari A. M. & Colares M.I. 1993. Lotus corniculates and Lotus tenuis anatomy of leaf. Lotus Newsletter. 24. 38 – 40.

Arora, R. K., Pandey, A. 1996. Wild Edible Plants of India. Ind. Council of Agri. Research. 77.

Ataslar, E. 2004. Morphological and Anatomical Investigations on the Saponaria kotschyana Boiss. (Caryophyllaceae). Turk. J. Bot. 28. 193 – 199.

Bakshi, D. N. 1984. "Flora of Murshadabad District and West Bangal", India scientific publisher, India. 58.
Bokhari, M. H. 1987. Recent Trends in Angiosperm Taxonomy. Mod. Trends Pl. Sci. Res. Pak. Department of Botany, University of Peshawar, Peshawar: 248 – 252.
Das, S. 2002. The ontogeny stomata and glandular hairs in some Indian Mangroves. Acta Bot. Croat. 61. 199 – 205.
Davis, P. H., Heywood, V. H. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd. Edinburgh. 181-203.
Davis, P. H. 1967. Flora of Turkey and the East Aegen Island. Edinburgh University Press. 2. 99-143.
Dickison, W. C. 2000. Integrative Plant Anatomy. Harcourt Academic Press, New York. 225 – 229.
Dilcher, D. L. 1974. Approaches to the Identification of Angiosperms Leaf remains. Bot. Rev. 40. 1-15.
Easu, K. 1965. Plant Anatomy. 2nd Edition. John Wiley & Sons, New York. 95-98.
Ghazanfar, S. A., Nasir, Y. J. 1986. Caryophyllaceae. Fl. Pak. 175.1-125.
Gilani, S. S., Khan, M. M., Shinwari, Z. K., Yousaf, Z. 2002. Leaf epidermal anatomy of selected Digitaria species Tribe Paniceae, Family Poaceae of Pakistan. Pak. J. Bot. 34. 257 – 273.
Greuter, W. 1995. Silene L. (Caryophyllaceae) in Greece: a subgeneric and sectional classification. Taxon. 44. 543–581.
Grewal, R. C. 2000. Plant Anatomy. Campus Books International, Delhi. 386 – 388.
Jafari, A., Zokai, M., Fathi, Z. 2008. A Biosystematical Investigation on Silene L. Species in North East of Iran. Asi. J. Pl. Sci. 7/4. 394-398.
Jurgens, A., Witt, T., Gottsberger, G. 2002. Flower scent composition in night flowering Silene species (Caryophyllaceae). Biochem. Syst. Ecol. 30/5. 383-397.
Jurgens, A. T. 2004. Flower scent composition in diurnal Silene species (Caryophyllaceae): Phylogenetic constraints or adaptation to flower visitors. Biochem. Syst. Ecol. 32/10. 841-859.
Metcalfe, C. R., Chalk, L.1950. Anatomy of the Dicotyledons. Oxford at the Clarendon Press. UK. 1. 147-152.
Metcalfe, C.R., Chalk, L.1983. Anatomy of the Dicotyledons. Vol. 2. Calerdon Press. Oxford.
Rashid, A., Ahmad, I., Beg, A. R. 1987. Importance of Trichomes and Stomata in Taxonomy and phylogeny of convolvulaceae and solanceae. Mod. Trend Pl. Sci. Res. Pak. Department of Botany, University of Peshawar, Peshawar: 233 – 239.
Stace, C. A. 1965. The Significance of the Leaf Epidermis in the Taxonomy of Combritaceae, I. A. general review of tribal, general and specific characters. J. Linn. Soc. Bot. 229-252.
Stace, C. A. 1980. Plant Taxonomy and Biosystematics. Edward Arnold. UK.
Subrahmanyam, N. S. 1996. Labortary Manual of Plant Taxonomy. Vikas Publishing house Pvt. Ltd. New Delhi. 153-156.
Takhtajan, A. 1980. Outlines of the classification of flowering plants. Bot. Rev. 46. 225 – 359.
Warming, E. 1920. A Handbook of Systematic Botany. 2nd Edition. M.C. Potter, London. 92-103.
Yildiz, K., Minareci, E. 2008. Morphological, Anatomical, Palynological and Cytological Investigation on Silene urvillei Schott. (Caryophyllaceae). J. Appl. Biol. Sci. 2 /2. 41-47

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Contribution to the Flora of Sakarat Mountain (Amasya/Turkey)

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Abstract

In this article, the floristical characteristics of Sakarat Mountain (Amasya) are given and the vascular plant species growing there are documented. The research was carried out between 2004 and 2005. 2000 plant specimens were collected from the area. At the end of the study, 494 taxa (at specific and infraspecific ranks) belonging to 78 families and 286 genera were identified. The largest family was found to be *Asteraceae* (70 species) and the second largest one was *Fabaceae* (46 species). The largest genera were *Astragalus* L. (8 species); *Veronica* L., *Bromus* L., *Galium* L. (7 species each). The phytogeographic elements are represented in the study area as follows: Euro-Siberian 127 (25.71 %), Irano-Turanian 43 (8.70 %), Mediterranean 24 (4.86 %), multi-regional or of unknown phytogeographic origin 300 (60.73 %). 40 (8.1 %) species collected in the area are endemics.

Key words: Vascular plants, Flora, Sakarat Mountain, Amasya

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Sakarat Dağı Florasına Katkılar (Amasya-Türkiye)

Özet

Bu araştırmada, Sakarat Dağı (Amasya-Türkiye) ve çevresinin floristik özellikleri ve burada yetiştiği saptanan damarlı bitki taksonlarının listesi verilmiştir. Araştırma 2004-2005 yılları arasında yapılmıştır. Yöreden toplanan 2000 bitki örneğinin değerlendirilmesi ile 78 familyadan 286 cins ve 494 tür ve türaltı seviyede takson saptanmıştır. En büyük familya *Astreaceae* (70 tür), ikinci *Fabaceae* (46 tür)'dir. En büyük cinsler ise 8 türle *Astragalus* L. ve 7'şer türle *Veronica* L., *Bromus* L. ve *Galium* L.'dur. Araştırma alanında fitocoğrafik elementlerin dağılımı ise şöyledir; Avrupa-Sibirya 127 (% 25.71), İran-Turan 43 (% 8.70), Akdeniz 24 (% 4.86), geniş yayılışlı veya bilinmeyen 300 (% 60.73). Araştırma alanından toplanan türlerin 40'ı (% 8.1) endemiktir.

Anahtar kelimeler: Vasküler bitkiler, Flora, Sakarat Dağı, Amasya

1. Giriş

Ülkemiz coğrafi konumu, jeomorfolojik yapısı, çok çeşitli toprak tiplerine sahip oluşu ve değişik iklim tiplerinin tesiri altında bulunması nedeniyle farklı vejetasyon tiplerine ve zengin bir floristik yapıya sahiptir. Bu araştırmada Amasya ilinin güneydoğusunda yer alan Sakarat Dağı'nın floristik özellikleri belirlenmeye çalışılmıştır. Amasya ili Karadeniz Bölgesinin Orta Karadeniz bölümünde yer almakta Doğu ve Batı Karadeniz Bölgelerinin tam ortasında kalmaktadır. Topografya olarak Amasya ortalama 425 m., rakımlı, engebeli bir yayla görünümündedir. İlin arazisi, volkanik ve tektonik olaylar sonucu oluşmuş, oldukça kıvrımlı ve kırıklı bir yapıya sahiptir. Bu sıra dağların en

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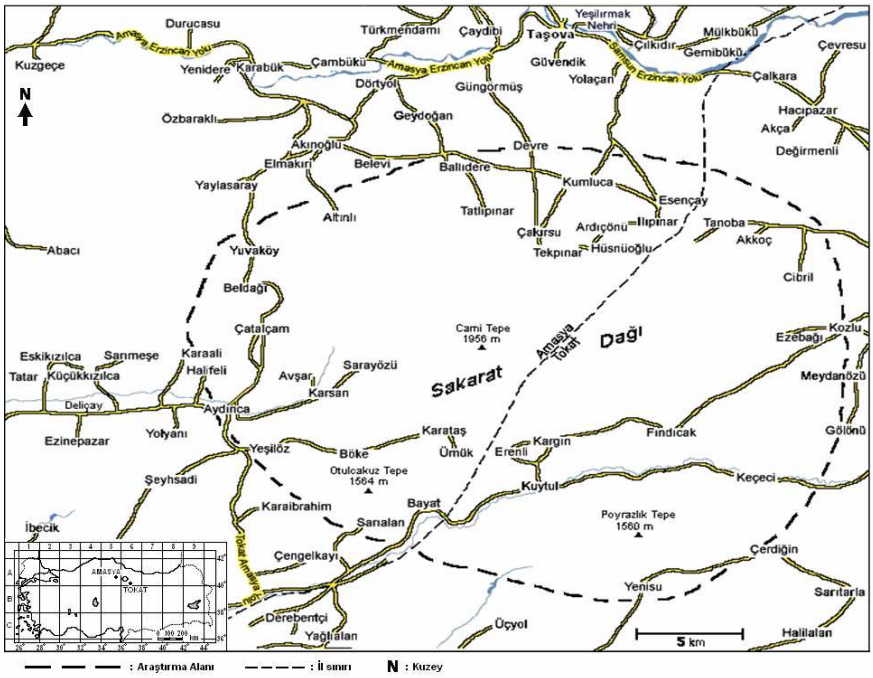
önemlisi Akdağ olup, yüksekliği 2062 m.'ye varmaktadır. Akdağ dışında, ildeki diğer belli başlı dağlar ise Karaömer Dağı (1979 m.), Sakarat Dağı (1956 m.), Tavşan Dağı (1901 m.), İnegöl Dağı (1873 m.), Eğerli Dağı (1776 m.), Karadağ (1524 m.), Buzlu Dağ (1392 m.), Çakır Dağı (1375 m.) ve Sarıtaş Dağı (1159 m.)'dır (http:// www.amasya.gov.tr/).

Bölgenin topografik durumunu gösterebilmek için Tuhum tarafından Harita Genel Müdürlüğü için hazırlanan 1/25.000 ve 1/100.000 ölçekli Türkiye Haritasının Yozgat ve Tokat paftalarından (Anonim, 1973a; Anonim, 1973b) ve T.C. Çevre ve Orman Bakanlığı, Orman Genel Müdürlüğü, Harita ve Fotogrametri Müdürlüğü'nden yararlanılmıştır. Ayrıca GARMIN MapSource (6.15.4 Sürümü © 1999–2009 Garmin Ltd. or its subsidiaries) programından ve internetteki Google Maps adlı harita arama motorundan da faydalanılmıştır. Harita adı geçen kaynaklardan sadeleştirilerek hazırlanmıştır. Buna göre, Sakarat Dağı; Amasya-Tokat illeri arasında yer alır (Şekil 1). Sakarat Dağı; doğuda Fındıcak, Ezebağı, Cibril ve Akkoç köyleri, batıda Çatalçam, Beldağı ve Yuvaköy köyleri, kuzeyde Esençay, Kumluca ve Tatlıpınar köyleri, kuzeybatıda Altınlı köyü, güneyde Karataş, Erenli, Kargın ve Kuytul köyleri ve güneybatıda Sarayözü köyü ile çevrelenmiştir. En yüksek yeri Cami Tepe olup 1956 m yüksekliktedir. Araştırma alanındaki diğer belli başlı tepeler ise şunlardır: Otulcakuz T. (1564 m.), Poyrazlık T. (1560 m.).



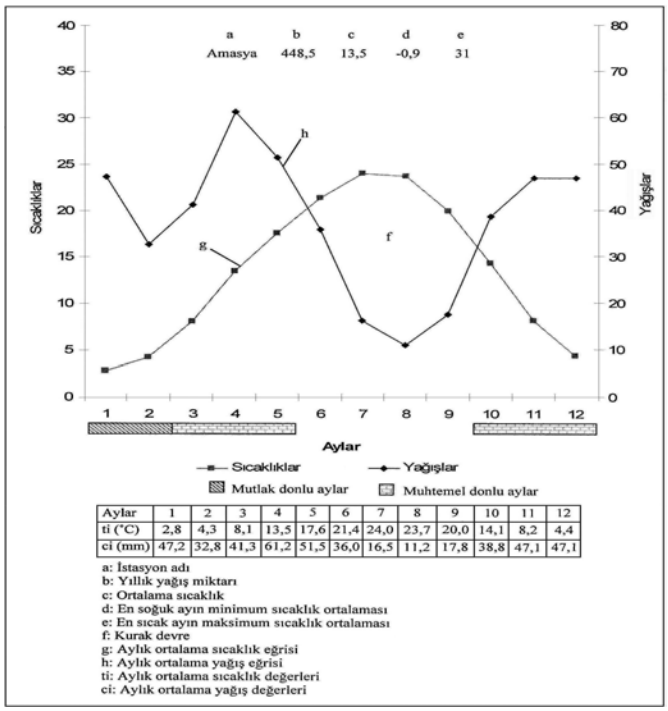
Şekil 1. Araştırma alanının konumu

Orta Karadeniz bölgesinin güneyinde yer alan Amasya ili diğer Karadeniz illerine nazaran sert bir iklime sahiptir. Bununla beraber; Amasya bölgenin diğer illeriyle kıyaslanırsa kurak sayılır. İl içinde yağış kuzeyden güneye inildikçe azalmaktadır (Tarım Orman ve Köy İşleri Bakanlığı, 1991). Kısacası Amasya'da geçit bölgesi iklimi egemendir. İklim belirli bir bölgede, uzun süre içindeki atmosfer olaylarının bir bileşkesi veya sentezi olup, ısı, nem veya yağış, basınç ve rüzgâr faktörlerinin karşılıklı etkilerinin toplamıdır. Araştırma bölgesinin iklimini tanımlayabilmek için, bölgeye en yakın 3 meteoroloji istasyonunun verileri kullanılmıştır. Araştırma bölgesini çevreleyen bu istasyonlar; batısında Amasya, kuzeyinde Taşova, güneydoğusunda Turhal (Tokat) istasyonlarıdır.

Sakarat Dağı (Amasya)'nın araştırma alanı olarak seçilmesinin en önemli nedeni, şimdiye dek araştırma alanının flora ve vejetasyonu üzerinde herhangi bir çalışmanın gerçekleştirilmemiş olmasıdır. Ayrıca araştırma alanının büyük bir kısmı, P.H.Davis tarafından yurdumuzun floristik yönden iyi bilinmeyen bölgeleri arasında gösterilmiştir (Davis ve Hedge, 1975). Araştırma alanı olarak seçilen Sakarat Dağı (Amasya)'nın yurdumuzun İç ve Kuzey Anadolu bölgeleri aynı zamanda İran-Turan ve Avrupa-Sibirya fitocoğrafik bölgeleri arasında geçit bölgesi oluşu da bu alanın çalışılmasına bir başka sebep oluşturmuştur. Bu tip geçiş alanları bir yandan Karadeniz'in nemli, diğer yandan İç Anadolu'nun kurak ikliminin etkisi altında bulunması sebebiyle her iki bölgeye ait bitki türlerini de içermektedir. Bu sebeple de geçiş bölgeleri gerek vejetasyon, gerekse flora ve bitki coğrafyası bakımından oldukça ilginç özellikler göstermektedir. Araştırma alanının seçiminde aynı zamanda, alanın Anadolu Diyagonaline yakınlığı (batısında yer alması) da önemli bir faktör olarak rol oynamıştır.

Araştırma bölgesine ait iklim verileri Devlet Meteoroloji İşleri Genel Müdürlüğü Elektronik Bilgi İşlem Merkezi (EBİM)'nden temin edilmiştir. Araştırma alanının doğal bitki örtüsü ve vejetasyonunun yapısı bölgenin

Akdeniz ikliminin etkisi altında olduğunu göstermektedir. Biyoiklim katları; Emberger'in Akdeniz Bölgesi için geliştirdiği Q=2000.P/(M+m+546,4).(M-m) formülü ile kurak mevsimi tanımlamak için geliştirdiği S=PE/ME formülüne göre, Akman ve Daget'in çalışmalarından yararlanılarak belirlenmiştir (Akman ve Daget, 1971). Amasya iline ait iklim diyagramı (Şekil 2)'nda da görüleceği gibi Haziran-Ekim ayları arasında bir kurak devre sözkonusudur. Buna göre; Amasya, Taşova ve Turhal (Tokat) istasyonlarına ait klimatik veriler Tablo 1'de özetlenmiştir.



Şekil 2. Amasya istasyonuna ait iklim diyagramı

Tablo 1. Biyoiklimsel sentez

İSTASYON	ENLEM (N)	BOYLAM (E)	YÜK. (m)	P (mm)	M	m	PE	Q	S	YAĞIŞ REJİMİ	BİYOİKLİM KATI / TİPİ
Amasya	40° 39'	35° 50'	412	448.5	31	-0.9	63.7	48.8	2.05	İ. K. S. Y.	Yarı-Kurak Üst Soğuk Akdeniz İklimi
Taşova	40° 46'	36° 20'	200	511.1	31.5	0.1	60	56.3	1.9	İ. K. S. Y.	Yarı-Kurak Üst Soğuk Akdeniz İklimi
Turhal (Tokat)	40° 24'	36° 05'	500	442.5	30.1	-1.7	61.7	48.4	2.04	İ. K. S. Y.	Yarı-Kurak Üst Soğuk Akdeniz İklimi

P : Ortalama yıllık yağış (mm)
M : En sıcak ayın maksimum sıcaklık ortalaması (°C)
m : En soğuk ayın minimum sıcaklık ortalaması (°C)
PE : Yaz yağışı toplamı (mm)
Q : Yağış-Sıcaklık emsali (Q=2000.P/(M+m+546,4).(M-m)
S : Kuraklık indisi (Kurak devreyi ifade eder: S=PE/M)

Araştırma bölgesi İran-Turan floristik bölgesinin İran-Anadolu Provensi'nin İç Anadolu Sektörü'nün kuzey-doğusunda yer almaktadır. Bu nedenle Öksin bölge ile bir geçiş alanı oluşturmaktadır. İç Anadolu stebini kuzeyden çevreleyen bu geçiş kuşağı Öksin ağaç ve çalıları da barındırması ve her iki bölgenin müşterek özelliklerini göstermesi nedeni ile Zohary tarafından Ksero-Öksin kuşak olarak adlandırılmıştır (Zohary, 1973).

Araştırma alanının vejetasyonu genel olarak, orman vejetasyonu (iğne yapraklı ve yaprak döken karışık ormanlar ile yaprak döken ormanlar), subalpin vejetasyonu ve step vejetasyonu olmak üzere 3 farklı grup altında incelenebilir. Orman vejetasyonu, *Pinus sylvestris*'in dominant ve ko-dominant olduğu karışık ormanlar; *Fagus orientalis*'in hâkim olduğu karışık ormanlar; *Carpinus orientalis*'in ko-dominant olduğu karışık ormanlar; *Quercus infectoria* subsp. *boissieri* ile *Quercus pubescens* ve *Quercus macranthera* subsp. *syspirensis* ile *Quercus cerris* var. *cerris*'in oluşturduğu farklı tiplerdeki karışık ormanlardan ibarettir. Çalışma alanında subalpin vejetasyonunu *Juniperus communis* subsp. *saxatilis* toplulukları oluşturmaktadır. Step vejetasyonu ise alanda, öncelikle *Astragalus* ve ikinci sırada da *Acantholimon* türleri ile temsil edilmektedir. Alandaki bir diğer yaygın step bitkisi de *Convolvulus assyricus*'tur. Ayrıca araştırma alanında yer yer kaya vejetasyonu ile sulak çayır (higrofil) vejetasyonu da görülebilmektedir (Bingöl vd., 2007).

Araştırma alanı Paleozoik ve kısmen Mesozoik temel üzerinde yayılan daha genç formasyonlardan meydana gelmiştir. Zemin yapısı kalker, yeşil kayaçlar ve yamaç molozları ile alüvyondan oluşmuştur. Yapının diğer bir özelliği ise kalker arazisinin geniş bir yer tutmasıdır. Siluriyen öncesi yaşlı yeşilşist fasiyesindeki metamorfitler en eski oluşumlar olarak görülmektedir. Bölgede Hersiniyen ve Alpin dağ oluşum hareketleri etkin olmuştur. Bölge orta siluriyende denizle kaplanmış olup Permiyen sonlarında tekrar kara durumuna geçmiştir. Ön alpin hareketleri ile Lias başlarında bölgeye yerleşen deniz Üst Kretase sonuna kadar sürmüştür. Eosen'de sığ bir denizle kaplanan alan Pliyosen'de tekrar kara durumuna geçmiştir (Haznedar, 1989).

Amasya'da bugüne dek pek çok flora çalışması yürütülmüştür (Alpınar, 1979; Peker, 1988; Kurt vd., 1998; Korkmaz vd., 2005; Cansaran ve Aydoğdu, 1998; Cansaran, 2002; Celep vd., 2006; Yücel, 2005; Cansaran vd., 2007a; Yıldırım, 2009). Bu çalışmanın da bugüne dek yapılan diğer araştırmalar gibi Amasya Florası'na katkı sağlayacağına ve ileride yürütülecek olan floristik çalışmalara ışık tutacağına inanılmaktadır.

2. Materyal ve metod

Bu çalışmada 2004-2005 yılları arasında 2000 bitki örneği toplanarak değerlendirilmiştir. Bitkilerin teşhisinde "Flora of Turkey and The East Aegean Islands (Volume: 1–9)" (Davis, 1965–1985), "Flora of Turkey and The East Aegean Islands (Supplement) (Volume: 10)" (Davis vd., 1988) ve "Flora of Turkey and The East Aegean Islands (Supplement 2) (Volume: 11)" (Güner vd., 2000) adlı eserlerden yararlanılmıştır. Türkiye Florası'nın yetersiz kaldığı durumlarda diğer flora kitaplarına müracaat edilmiştir (Evan ve Townsend, 1968; Heywood ve Tutin, 1964-1981; Heywood, 1978). Teşhislerde ayrıca Ankara Üniversitesi Fen Fakültesi Biyoloji Bölümü Herbaryumu'ndan (ANK) da faydalanılmıştır.

Bitki taksonları "Türkiye Florası"ndaki sisteme uygun olarak sıralanmıştır. Taksonların isimlerinden sonra sırasıyla, fitocoğrafik bölgeleri (varsa), hayat formları, toplayıcı numaraları, lokalite numaraları ve endemizm durumları (varsa) verilmiştir. Tüm taksonlar Davis'in Grid sistemine göre "A6: Amasya-Tokat" karesi içindedir, tekrardan kaçınmak amacıyla bu bilgi tüm taksonlar için ayrı ayrı yazılmamıştır. Ayrıca tüm taksonlar "Bingöl&Cansaran" tarafından toplanmış olup, bitki listesi verilirken toplayıcı ismi belirtilmemiş sadece toplayıcı numaraları yazılmıştır. Floristik listede kullanılan "kısaltmalar" ve "lokaliteler" (Tablo 2) aşağıda verilmiştir:

Kısaltmalar:

ES: Avrupa-Sibirya
M: Akdeniz
IT: İran-Turan
End.: Endemik
Ph: Fanerofit
Ch: Kamefit
G: Geofit
Th: Terofit
Vp: Vasküler Parazit
H: Hemikriptofit

R: Lokalite no
m: Metre
km: Kilometre
K: Kuzey
G: Güney
B: Batı
D: Doğu
KB: Kuzeybatı
GB: Güneybatı
KD: Kuzeydoğu
GD: Güneydoğu

Tablo 2. Lokaliteler

Lokalite No	Lokalite
R1	Sarayözü köyü üstü, Kayın ormanı, 1074 m., KB kesimler, 04.06.2004.
R2	Karataş Yaylası üstü. Taşova yaylalarına giden yol üzeri, *Pinus sylvestris* ormanı, 1600 m., KB kesimler, 04.06.2004.
R3	Karataş Köyü yaylasının üst kısımları, Taşova yaylalarına giden yol üzeri, *Juniperus* topluluğu açıklığı, 1780 m., 04.06.2004.
R5	Sarayözü Köyü'nün 2-2.5 km. üstü, Kayın ormanı, 1340 m., KB kesimler, 04.06.2004.
R6	Sarayözü Köyü'nün 1 km üstü, Kayın ormanı, 1215 m., KB kesimler, 04.06.2004.
R7	Çakırsu Köyü'nün yaklaşık 2.5-3 km. üstü, Cami Tepe'nin etekleri, karışık orman, 1060 m., K kesimler, 05.06.2004.
R8	Çakırsu Köyü'nün yaklaşık 2.5-3 km. üstü, Cami Tepe'nin etekleri, karışık orman, 1050 m., K kesimler, 05.06.2004.
R9	Çakırsu Köyü'nün yaklaşık 3.5-4 km. üstü, Cami Tepe'nin etekleri, karışık orman, 1140 m., 05.06.2004.
R10	Çakırsu Köyü'nün yaklaşık 7.5-8 km. üstü, Cami Tepe'nin etekleri, karışık orman, 1330 m., 05.06.2004.
R11	Çakırsu Köyü'nün yaklaşık 7.5-8 km. üstü, Cami Tepe'nin etekleri, karışık orman, 1350 m., K kesimler, 05.06.2004.
R12	Çakırsu Köyü'nün üst kısımları, Camii Tepe Zirve etekleri, yüksek dağ çayırı, KB kesimler, 1890 m., 05.06.2004.
R13	Camii Tepe ile Esençay göleti yol üzeri, Kayın ormanı, 1506 m., KB kesimler, 05.06.2004.
R14	Camii Tepe ile Esençay göleti yol üzeri, Kayın ormanı, 1386 m., KB kesimler, 05.06.2004.
R15	Camii Tepe ile Esençay göleti yol üzeri, Kayın ormanı, 858 m., KB kesimler, 05.06.2004.
R16	Böke köyü'nün yaklaşık 1-1.5 km. üstü, Otulcakuz Tepe, *Pinus sylvestris* ormanı, kalker ana kaya, 1295 m., GD kesimler, 26.09.2004.
R17	Böke köyü'nün yaklaşık 1-1.5 km. üstü, Otulcakuz Tepe, *Pinus sylvestris* ormanı, kalker ana kaya, 1310 m., KB kesimler, 26.09.2004.
R18	Sarayözü Köyü üstü, Kayın ormanı, Karataş köyü üstleri, K-KB kesimler, 1575 m., 26.09.2004.
R19	Karataş köyü yaylası üstü. Taşova yaylalarına giden yol üzeri, *Pinus sylvestris* ormanı, 1510 m., G-GB kesimler, 26.09.2004.
R20	Amasya-Turhal yolu üzeri, Aydınca-Bayat istikameti ile Kuytul köyü üstü, Poyrazlık Tepe, 925 m., KD kesimler, 26.09.2004.
R21	Sarayözü köyü üstü, Kayın ormanı, 1145 m., K kesimler, 14.07.2005.
R22	Sarayözü köyü üstü, Kayın ormanı, 1199 m., K kesimler, 14.07.2005.
R23	Sarayözü köyü üstü, Kayın ormanı, 1180 m., K kesimler, 14.07.2005.
R24	Karataş köyü yaylası üstü, Taşova yaylalarına giden yol üzeri, yüksek dağ stebi, 1595 m., G-GD kesimler, 14.07.2005.

Tablo 2. (Devam ediyor)

R25 Karataş köyü yaylasının üst kısımları, Taşova yaylalarına giden yol üzeri, *Juniperus* topluluğu açıklığı, 1785 m., 14.07.2004.
R26 Karataş köyü yaylası üstü. Taşova yaylalarına giden yol üzeri, *Pinus sylvestris* ormanı, 1606 m., KB kesimler, 14.07.2005.
R27 Çakırsu Köyü'nün yaklaşık 2-2.5 km. üstü, 1032 m., K kesimler, 15.07.2005.
R28 Çakırsu Köyü'nün yaklaşık 3.5 km. üstü, 1020 m., GB kesimler, 15.07.2005.
R29 Çakırsu Köyü'nün yaklaşık 6-6.5 km. üstü, 1145 m., GB kesimler, 15.07.2005.
R30 Çakırsu Köyü'nün yaklaşık 9 km. üstü, 1156 m., KD kesimler, 15.07.2005.
R31 Çakırsu Köyü'nün yaklaşık 10 km. üstü, 1419 m., K kesimler, 15.07.2005.
R32 Amasya-Aydınca-Böke istikameti ile, Karataş Köyü'nün yaklaşık 2 km üzeri 1416 m., GB kesimler, 06.08.2005.
R33 Amasya-Böke Köyü'nün yaklaşık 1-1.5 km üstü, Otulcakuz Tepe, kalker ana kaya, step alanı, 1365 m., GB kesimler, 06.08.2005.
R34 Böke köyü'nün yaklaşık 1-1.5 km üstü, Otulcakuz Tepe, *Pinus sylvestris* ormanı, kalker ana kaya, 1380 m., KB kesimler, 06.08.2005.
R35 Kuytul köyü çıkışı, dere kenarı, 907 m., 06.08.2005.
R36 Amasya-Turhal yolu üzeri, Aydınca-Bayat istikameti ile Kuytul köyü üstü, Poyrazlık Tepe, 1008 m., KB kesimler, 06.08.2005.
R37 Sarayözü köyü üstü, Kayın ormanı, 1142 m., KB kesimler, 07.08.2005.
R38 Sarayözü köyü üstü, Kayın ormanı, üst kesimler, 1205 m., KB kesimler, 07.08.2005.
R39 Çakırsu Köyü'nün yaklaşık 5-5.5 km üstü, Cami Tepe'nin etekleri, karışık orman, 1270 m., 07.08.2005.
R40 Çakırsu Köyü'nün yaklaşık 5.5-6 km üstü, Cami Tepe'nin etekleri, karışık orman, 1320 m., 07.08.2005.
R41 Karataş köyü yaylası üstü, sulak ve nemli alan, 1601 m., B alanlar, 07.08.2005.
R42 Camii Tepe ile Esençay göleti yol üzeri, Kayın ormanı, 1265 m., KB kesimler, 07.08.2005.
R43 Camii Tepe ile Esen çay göleti yol üzeri, 1065 m., KD kesimler, 07.08.2005.
R44 Camii Tepe ile Esen çay göleti yol üzeri, 940 m., KB kesimler, 08.08.2005.
R49 Amasya-Çakırsu ile-Esençayı bağlayan dağ-yayla yolu üzeri, 1670 m., KD kesimler, 08.08.2005.
R53 Böke Köyü üstü, 1277 m. KB kesimler, 08.08.2005.
R54 Taşova-Esençay yolu, yol kenarları, 305 m., 08.08.2005.
R56 Camii Tepe ile Esen çay göleti yol üzeri, , Esençay'a 3,5 km kala, 1285 m., KD kesimler, 07.08.2005.
R58 Sarayözü köyü üstü, Kayın ormanı, üst kesimler, 1350 m., KB kesimler, 09.08.2005.
R59 Karataş Yaylası üstü, Taşova yaylalarına giden yol üzeri, *Pinus sylvestris* ormanı, 1675 m., GB kesimler, 09.08.2005.
R61 Karataş Yaylası üstü, Taşova yaylalarına giden yol üzeri, *Pinus sylvestris* ormanı, 1613 m., GB kesimler, 09.08.2005.
R63 Karataş köyü yaylası üstü, Taşova yaylalarına giden yol üzeri, *Pinus sylvestris* ormanı, 1529 m., GB kesimler, 09.08.2005.
R64 Karataş köyü yaylası üstü, Taşova yaylalarına giden yol üzeri, *Pinus sylvestris* ormanı, 1599 m., GB kesimler, 09.08.2005.
R65 Karataş köyü yaylası üstü, Taşova yaylalarına giden yol üzeri, *Pinus sylvestris* ormanı, 1700 m., B kesimler, 09.08.2005.
R66 Karataş köyü yaylasının üst kısımları, Taşova yaylalarına giden yol üzeri, *Juniperus* topluluğu açıklığı, 1796 m., 10.08.2005.
R67 Karataş köyü yaylasının üst kısımları, Taşova yaylalarına giden yol üzeri, *Juniperus* topluluğu açıklığı, 1809 m., 10.08.2005.
R68 Karataş köyü yaylasının üst kısımları, Taşova yaylalarına giden yol üzeri, *Juniperus* topluluğu açıklığı, 1804 m., 10.08.2005.
R69 Karataş köyü yaylasının üst kısımları, Taşova yaylalarına giden yol üzeri, *Juniperus* topluluğu açıklığı, 1793 m., 10.08.2005.
R70 Karataş köyü yaylasının üst kısımları, Taşova yaylalarına giden yol üzeri, *Juniperus* topluluğu açıklığı, 1781 m., 10.08.2005.
R71 Karataş köyü yaylasının üst kısımları, Taşova yaylalarına giden yol üzeri, *Juniperus* topluluğu açıklığı, 1789 m., 10.08.2005.
R72 Karataş köyü yaylasının üst kısımları, Taşova yaylalarına giden yol üzeri, *Juniperus* topluluğu açıklığı, 1819 m., 10.08.2005.
R73 Karataş köyü yaylasının üst kısımları, Taşova yaylalarına giden yol üzeri, *Juniperus* topluluğu açıklığı, 1869 m., 10.08.2005.
R74 Camii Tepe ile Esen çay göleti yol üzeri, 1373 m., K kesimler, 10.08.2005.
R76 Böke köyü'nün yaklaşık 1-1.5 km. üstü, Otulcakuz Tepe, *Pinus sylvestris* ormanı, kalker ana kaya, 1297 m., KB kesimler, 10.08.2005.
R77 Böke köyü'nün yaklaşık 1-1.5 km. üstü, Otulcakuz Tepe, *Pinus sylvestris* ormanı, kalker ana kaya, 1300 m., KB kesimler, 10.08.2005.
R78 Böke köyü'nün yaklaşık 1-1.5 km. üstü, Otulcakuz Tepe, *Pinus sylvestris* ormanı, kalker ana kaya, 1363 m., KB kesimler, 10.08.2005.
R80 Böke köyü'nün yaklaşık 1-1.5 km. üstü, Otulcakuz Tepe, *Pinus sylvestris* ormanı, kalker ana kaya, 1470 m., KB kesimler, 10.08.2005.
R82 Böke köyü'nün yaklaşık 1-1.5 km. üstü, Otulcakuz Tepe, *Pinus sylvestris* ormanı, kalker ana kaya, 1570 m., KB kesimler, 10.08.2005.
R83 Amasya-Böke Köyü'nün yaklaşık 1-1.5 km. üstü, Otulcakuz Tepe, kalker ana kaya, step alanı, 1344 m., GB kesimler, 10.08.2005.
R86 Amasya-Böke Köyü'nün yaklaşık 1-1.5 km. üstü, Otulcakuz Tepe, kalker ana kaya, step alanı, 1347 m., GB kesimler, 10.08.2005.
R88 Amasya-Böke Köyü'nün yaklaşık 1-1.5 km. üstü, Otulcakuz Tepe, kalker ana kaya, step alanı, 1354 m., GB kesimler, 10.08.2005.
R90 Amasya-Böke Köyü'nün yaklaşık 1-1.5 km. üstü, Otulcakuz Tepe, kalker ana kaya, step alanı, 1362 m., GB kesimler, 10.08.2005.
R92 Amasya-Turhal yolu üzeri, Aydınca-Bayat istikameti ile Kuytul köyü üstü, Poyrazlık Tepe, 1067 m., K kesimler, 11.08.2005.
R94 Amasya-Turhal yolu üzeri, Aydınca-Bayat istikameti ile Kuytul köyü üstü, Poyrazlık Tepe, 1129 m., K kesimler, 11.08.2005.
R95 Amasya-Turhal yolu üzeri, Aydınca-Bayat istikameti ile Kuytul köyü üstü, Poyrazlık Tepe, 1264 m., K kesimler, 11.08.2005.
R96 Amasya-Turhal yolu üzeri, Aydınca-Bayat istikameti ile Kuytul köyü üstü, Poyrazlık Tepe, 1197 m., KD kesimler, 11.08.2005.
R98 Amasya-Turhal yolu üzeri, Aydınca-Bayat istikameti ile Kuytul köyü üstü, Poyrazlık Tepe, 1353 m., K kesimler, 11.08.2005.
R101 Karataş köyü yaylası üstü, Taşova yaylalarına giden yol üzeri, yüksek dağ stebi, 1513 m., G kesimler, 11.08.2005.
R103 Karataş köyü yaylası üstü, Taşova yaylalarına giden yol üzeri, yüksek dağ stebi, 1459 m., GD kesimler, 11.08.2005.
R105 Karataş köyü yaylası üstü, Taşova yaylalarına giden yol üzeri, yüksek dağ stebi, 1347 m., GD kesimler, 11.08.2005.
R107 Karataş köyü yaylası üstü, Taşova yaylalarına giden yol üzeri, yüksek dağ stebi, 1272 m., GD kesimler, 11.08.2005.
R108 Karataş köyü yaylası üstü, Taşova yaylalarına giden yol üzeri, yüksek dağ stebi, 1187 m., GD kesimler, 11.08.2005.

Bu araştırmada toplanan tüm bitki örnekleri Ankara Üniversitesi Fen Fakültesi Biyoloji Bölümü Herbaryumu'nda (ANK) muhafaza edilmektedir. Çalışma sahasının floristik açıdan değerlendirilmesinde Cansaran vd., 2007b ile Yıldırım vd., 2007 çalışmalarından da faydalanılmıştır.

3. Bulgular

HYPOLEPIDACEAE

Pteridium aquilinum (L.) Kuhn H, 4421, R2.

PINACEAE

Pinus sylvestris L. var. *hamata* ES, Ph, 4318, R6.

P. nigra J.F. Arnold subsp. *nigra* var. *caramanica* Ph, 4640, R23.

CUPPRESSACEAE

Juniperus communis L. var. *saxatilis* Pall. Ph, 4437, R3.

J. oxycedrus L. subsp. *oxycedrus* Ph, 4321, R19.

RANUNCULACEAE

Actaea spicata L. H, 4704, R21.
Consolida regalis S.F. Gray subsp. *regalis* Th, 4392, R22.
Clematis vitalba L. Ph, 4535, R29.
Adonis aestivalis L. subsp. *aestivalis* Th, 4446, R25.
Ranunculus brutius Ten. ES, H, 4605, R10.
R. constantinopolitanus (DC.) Urv. H, 4600, R40.
R. argyreus Boiss. H, 4702, R105.
R. arvensis L. Th, 4423, R26.

PAEONIACEAE

Paeonia mascula (L.) Miller subsp. *mascula* H, 4559, R29.

PAPAVERACEAE

Chelidonium majus L. ES, H, 4596, R31.
Papaver rhoeas L. Th, 4494, R39.
Corydalis solida (L.) Swartz subsp. *solida* G, 4698, R105.

CRUCIFERAE (BRASSICACEAE)

Thlaspi perfoliatum L. Th, 4743, R66.
Capsella bursa-pastoris (L.) Medik. Th, 4584, R30.
Fibigia eriocarpa (DC.) Boiss. H, 4648, R36.
Alyssum desertorum Stapf. var. *desertorum* Th, 4328, R20.
A. minus (L.) Rothm. var. *micranthum* (Meyer) Dudley Th, 4380, R3.
A. repens Baumg. var. *stenophyllum* Hal. H, 4329, R10.
A. tortuosum Willd. ES, Ch, 4734, R24.
Draba rigida Willd. var. *rigida* H, 4438, R3, **End.**
Erophila verna (L.) Chevall. subsp. *verna* Th, 4610, R12.
Arabis sagittata (Bertol.) DC. H, 4621, R15.
Cardamine hirsuta L. Th, 4528, R11.
Hesperis bicuspidata (Willd.) Poiret H, 4341, R9.
Erysimum cuspidatum (Bieb.) DC. H, 4397, R26.
E. pulchellum (Willd) Gay H, 4339, R5.
E. diffusum Ehrh. ES, H, 4708, R21.
E. crassipes Fisch. & Mey. H, 4725, R22.
E. smyrnaeum Boiss. & Bal. H, 4776, R36.

RESEDACEAE

Reseda luteola L. H, 4805, R43.

CISTACEAE

Cistus creticus L. Ph, 4453, R25.
Helianthemum nummularium (L.) Miller subsp. *nummularium* Ch, 4340, R38.
H. nummularium (L.) Mill. subsp. *tomentosum* (Scop.) Schinz & Thellung Ch, 4786, R34.
H. nummularium (L.) Mill. subsp. *ovatum* (Viv.) Schinz & Thellung Ch, 4726, R69.
H. canum (L.) Baumg. Group a. H, 4401, R16.

VIOLACEAE

Viola odorata L. H, 4578, R8.
V. suavis Bieb. H, 4505, R21.
V. sieheana Becker H, 4483, R17.
V. arvensis Murray Th, 4482, R3.

POLYGALACEAE

Polygala supina Schreb. H, 4475, R25.
P. anatolica Boiss. & Heldr. H, 4561, R9.

CARYOPHYLLACEAE

Arenaria gypsophiloides L Mant. var. *glabra* Fenzl IT, H, 4382, R3.
A. ledebouriana Fenzl var. *ledebouriana*, H, 4383, R3, **End.**
Minuartia juniperina (L.) Marie & Petitm. H, 4471, R25.
Stellaria holostea L. ES, H, 4322, R26.
Cerastium anomalum Waldst. & Kit. Th, 4586, R8.
C. purpurascens Adams H, 4452, R25.
C. brachypetalum Pers. subsp. *roeseri* (Boiss. & Heldr.) Nyman Th, 4451, R3.
Dianthus multicaulis Boiss. & Huet IT, H, 4444, R3.
D. armeria L. subsp. *armeria* ES, Th, 4543, R7.
D. calocephalus Boiss. H, 4667, R23.
Silene italica (L.) Pers. H, 4430, R17.
S. spergulifolia (Desf.) Bieb. IT, H, 4355, R1.
S. vulgaris (Moench) Garcke subsp. *vulgaris* H, 4480, R3.
S. compacta Fischer H, 4638, R31.
S. alba (Miller) Krause subsp. *divaricata* (Reichb.) Walters H, 4429, R17.

ILLECEBRACEAE

Herniaria glabra L. H, 4593, R29.
H. incana Lam. H, 4683, R25.
Scleranthus annuus L. subsp. *annuus* H, 4478, R70.
S. uncinatus Schur H, 4479, R73.

POLYGONACEAE
Polygonum arenastrum Bor. Th, 4420, R15.
P. aviculare L. Th, 4562, R22.
P. bellardii All. Th, 4781, R34.
P. convolvulus L. Th, 4563, R7.
Rumex acetocella L. H, 4425, R3.
R. scutatus L. H, 4809, R53.
R. crispus L. H, 4566, R31.
R. conglomeratus Murray H, 4804, R41.
R. obtusifolius L. subsp. *subalpinus* (Schur) Celak. H, 4477, R25.
R. pulcher L. H, 4755, R29.

CHENOPODIACEAE
Chenopodium botrys L. Th, 4722, R22.
C. foliosum (Moench) Aschers. Th, 4706, R21.

AMARANTHACEAE
Amaranthus albus L. Th, 4675, R20.

TAMARICACEAE
Tamarix smyrnensis Bunge Ph, 4798, R35.

GUTTIFERAE (HYPERICACEAE)
Hypericum androsaemum L. Ch, 4553, R30.
H. linarioides Bosse H, 4439, R3.
H. montbretii Spach H, 4747, R28.
H. orientale L. H, 4403, R9.
H. perforatum L. H, 4404, R11.

MALVACEAE
Malvella sherardiana (L.) Jaub. & Spach H, 4808, R49.
Alcea pallida Waldst. & Kit. H, 4620, R36.

TILIACEAE
Tilia rubra DC. subsp. *caucasica* (Rupr.) V. Engler ES, Ph, 4799, R35.

LINACEAE
Linum austriacum L. subsp. *austriacum* H, 4603, R10.

GERANIACEAE
Geranium robertianum L. Th, 4592, R13.
G. tuberosum L. subsp. *tuberosum* G, 4552, R14.
G. asphodeloides Burm. fil. subsp. *asphodeloides* ES, H, 4465, R3.
G. cinereum Cav. subsp. *subcaulescens* (L'Hérit. ex DC.) Hayek var. *subacutum* (Boiss.) Davis & Roberts IT, H, 4551, R8, End.
Erodium cicutarium (L.) L'Hérit. subsp. *cicutarium* Th, 4546, R29.

ZYGOPHYLLACEAE
Peganum harmala L. H, 4748, R28.

RUTACEAE
Ruta montana (L.) L. H, 4426, R2.

ACERACEAE
Acer platanoides L. ES, Ph, 4516, R7.
A. campestre L. subsp. *campestre* Ph, 4319, R6.
A. hyrcanum Fisch. & Mey. subsp. *hyrcanum* ES, Ph, 4508, R11.

RHAMNACEAE
Paliurus spina-christi Miller Ph, 4687, R20.
Rhamnus catharticus L. ES, Ph, 4754, R29.

AQUIFOLIACEAE
Ilex colchica Poj. ES, Ph, 4509, R10.

CELASTRACEAE
Euonymus verrucosus Scop. Ph, 4597, R9.

LEGUMINOSAE (FABACEAE)
Chamaecytisus pygmaeus (Willd.) Rothm. ES, Ch, 4531, R27.
Genista tinctoria L. ES, Ch, 4591, R28.
Argyrolobium biebersteinii Ball H, 4523, R8.
Colutea cilicica Boiss. & Bal. Ph, 4624, R21.
Astragalus densifolius Lam. subsp. *amasiensis* (Freyn) Aytaç & Ekim IT, H, 4783, R34, **End.**
A. glycyphyllos L. subsp. *glycyphylloides* (DC.) VA Mathews ES, H, 4333, R1.
A. microcephalus Willd. IT, Ch, 4644, R18.
A. plumosus Willd. var. *plumosus* Ch, 4378, R2.
A. ponticus Pall. H, 4705, R21.

A. squalidus Boiss. & Noe H, 4448, R25.
A. campylosema Boiss. subsp. *campylosema*, IT, H, 4332, R3, **End.**
A. angustifolius Lam. subsp. *angustifolius* var. *angustifolius* Ch, 4377, R24.
Psoralea bituminosa L. M, H, 4635, R29.
Vicia cracca L. subsp. *tenuifolia* (Roth.) Gaudin H, 4504, R23.
V. cracca L. subsp. *stenophylla* Vel. H, 4434, R19.
V. sericocarpa Fenzl var. *sericocarpa* Th, 4436, R2.
V. pannonica Crantz var. *purpurascens* (DC.) Ser. Th, 4577, R9.
V. sativa L. var. *segetalis* (Thuill.) Ser. ex DC. Th, 4435, R3.
Lathyrus aureus (Stev.) Brandza ES, H, 4323, R1.
L. tukhtensis Czecz. H, 4408, R19, **End.**
L. laxiflorus (Desf.) O. Kuntze subsp. *laxiflorus* H, 4344, R1.
L. inconspicuus L. Th, 4407, R11.
Ononis pusilla L M, H, 4780, R33.
O. spinosa L. subsp. *leiosperma* (Boiss.) Sirj. H, 4625, R15.
Trifolium repens L. var. *repens* H, 4431, R15.
T. campestre Schreb. Th, 4361, R8.
T. physodes Stev. ex Bieb. var. *physodes* M, H, 4695, R36.
T. pratense L. var. *pratense* Boiss. & Bal. H, 4363, R12.
T. pannonicum Jacq. subsp. *elongatum* (Willd.) Zoh. H, 4362, R22, **End.**
T. arvense L. var. *arvense* Th, 4360, R5.
Melilotus officinalis (L.) Desr. H, 4411, R6.
M. alba Desr. H, 4713, R21.
Trigonella brachycarpa (Fisch.) Moris IT, H, R18.
Medicago lupulina L. H, 4320, R5.
M. sativa L. subsp. *sativa* H, 4594, R10.
Dorycnium graecum (L.) Ser. ES, Ch, 4367, R9.
D. pentaphyllum Scop. subsp. *herbaceum* (Vill.) Rouy Ch, 4544, R7.
Lotus corniculatus L. var. *tenuifolius* H, 4558, R36.
L. corniculatus L. var. *alpinus* Ser. H, 4410, R25.
L. aegaeus (Gris.) Boiss. IT, H, 4345, R27.
Anthyllis vulneraria L. subsp. *boissieri* (Sag.) Bornm. H, 4381, R19.
Coronilla orientalis Miller var. *orientalis* H, 4393, R86.
C. varia L. subsp. *varia* H, 4394, R13.
Hedysarum varium Willd. IT, H, 4709, R21.
Onobrychis bornmuelleri Freyn H, 4729, R23, **End.**
Ebenus laguroides Boiss. var. *laguroides* IT, H, 4642, R32, **End.**

ROSACEAE

Prunus divaricata Ledeb. subsp. *divaricata* Ph, 4476, R27.
Cerasus avium (L.) Moench Ph, 4623, R95.
C. mahaleb (L.) Miller var. *mahaleb* Ph, 4614, R14.
Rubus caesius L. Ph, 4758, R30.
R. sanctus Schreber Ph, 4628, R20.
R. discolor Weihe & Nees Ph, 4759, R30.
R. canescens DC. var. *canescens* Ph, 4627, R14.
R. hirtus Waldst. & Kit ES, Ph, 4352, R10.
Potentilla recta L. Group B H, 4652, R16.
P. cappadocica Boiss. ES, H, 4486, R25, **End.**
Fragaria vesca L. H, 4548, R7.
Geum urbanum L. ES, H, 4368, R19.
Agrimonia eupatoria L. H, 4674, R21.
Sanguisorba minor Scop. subsp. *muricata* (Spach) Briq. H, 4427, R26.
Alchemilla oligotricha Juz. H, 4487, R5.
A. holocycla Rothm. IT, H, 4766, R32, **End.**
Rosa pulverulenta Bieb. Ch, 4812, R25.
R. canina L. Ph, 4351, R11.
Cotoneaster nummularia Fisch. & Mey. Ph, 4539, R29.
Pyracantha coccinea Roemer Ph, 4689, R36.
Crataegus tanacetifolia (Lam.) Pers. Ph, 4723, R22, **End.**
C. monogyna Jacq. subsp. *monogyna* Ph, 4491, R12.
Sorbus aucuparia L. ES, Ph, 4569, R28.
S. umbellata (Desf.) Fritsch var. *umbellata* Ph, 4606, R44.
S. torminalis (L.) Crantz var. *torminalis* ES, Ph, 4630, R36.
Cydonia oblonga Miller Ph, 4724, R90.
Malus sylvestris Miller subsp. *orientalis* (A. Uglitzkich) Browicz var. *orientalis* Ph, 4728, R22.
Pyrus syriaca Boiss. var. *syriaca* Ph, 4626, R56.
P. elaeagnifolia Pallas subsp. *kotschyana* (Boiss.) Browicz Ph, 4690, R74.

LYTHRACEAE
Lythrum salicaria L. ES, H, 4684, R95.
ONAGRACEAE
Circaea lutetiana L. H, 4532, R30.
Epilobium hirsutum L. H, 4588, R37.
E. parviflorum Schreber H, 4545, R21.
E. montanum L. ES, H, 4707, R101.
E. lanceolatum Seb. & Mauri H, 4589, R56.
CUCURBITACEAE
Bryonia alba L. ES, H, 4791, R35.
DATISCACEAE
Datisca cannabina L. H, 4807, R44.
CRASSULACEAE
Sedum stoloniferum Gmelin ES, H, 4762, R31.
S. acre L. H, 4595, R31.
S. album L. H, 4567, R29.
S. pallidum Bieb. var. *bithynicum* (Boiss.) Chamberlain ES, H, 4428, R11.
UMBELLIFERAE (APIACEAE)
Sanicula europaea L. ES, H, 4371, R19.
Eryngium creticum Lam. M, H, 4647, R54.
E. campestre L. var. *virens* Link H, 4810, R16.
Chaerophyllum byzantinum Boiss. ES, H, 4390, R59.
Bunium microcarpum (Boiss.) Freyn subsp. *bourgaei* (Boiss.) Hedge & Lamond IT, G, 4450, R3.
Pimpinella anthriscoides Boiss. var. *anthriscoides* IT, H, 4417, R19.
Falcaria vulgaris Bernh. H, 4472, R83.
Angelica sylvestris L. var. *sylvestris* ES, H, 4802, R41.
Malabaila secacul Banks & Sol. Group A H, 4779, R34.
Tordylium maximum L. H, 4719, R21.
Laser trilobum (L.) Borkh. H, 4711, R21.
Torilis japonica (Houtt.) DC. Th, 4782, R36.
T. leptophylla (L.) Reichb. Th, 4503, R22.
Turgenia latifolia (L.) Hoffm. Th, 4720, R21.
ARALIACEAE
Hedera helix L. Ph, 4598, R40.
CORNACEAE
Cornus sanguinea L. subsp. *australis* (C.A.Meyer) Jav ES, Ph, 4538, R15.
C. mas L. ES, Ph, 4673, R20.
CAPRIFOLIACEAE
Sambucus ebulus L. ES, Ph, 4353, R44.
Viburnum lantana L. ES, Ph, 4602, R29.
V. opulus L. ES, Ph, 4613, R14.
Lonicera caucasica Pallas subsp. *orientalis* (Lam.) Chamb. & Long Ph, 4579, R15, **End.**
L. etrusca Santi var. *hispidula* Boiss. M, Ph, 4753, R29.
RUBIACEAE
Crucianella angustifolia L. M, Th, 4540, R7.
Asperula involucrata Wahlenb. ES, H, 4384, R26.
Galium rotundifolium L. ES, G, 4399, R26.
G. odoratum (L.) Scop. ES, G, 4463, R25.
G. verum L. subsp. *verum* ES, H, 4400, R13.
G. paschale Forsskal M, H, 4550, R28.
G. spurium L. subsp. *spurium* ES, Th, 4649, R17.
G. aparine L. Th, 4462, R43.
G. floribundum Sm. subsp. *floribundum* Th, 4549, R28.
Cruciata taurica (Pallas ex Willd.) Ehrend. IT, H, 4456, R68.
VALERIANACEAE
Valeriana alliariifolia Adams H, 4763, R98.
Centranthus longiflorus Stev. subsp. *longiflorus* IT, H, 4784, R82.
Valerianella coronata (L.) DC. Th, 4432, R19.
V. vesicaria (L.) Moench Th, 4696, R96.
MORINACEAE
Morina persica L. IT, H, 4736, R24.
DIPSACACEAE
Scabiosa columbaria L. subsp. *ochroleuca* (L.) Celak var. *ochroleuca* (L.) Coulter H, 4715, R107.
S. argentea L. H, 4656, R33.
S. micrantha Desf. Th, 4756, R29.
S. rotata Bieb. IT, Th, 4657, R17.
COMPOSITAE (ASTERACEAE)

Telekia speciosa (Schreber) Baumg. ES, H, 4750, R28.
Inula salicina L. ES, H, 4554, R95.
I. oculus-christi L. ES, H, 4668, R20.
I. vulgaris (Lam.) Trevisan ES, H, 4501, R27.
I. aschersoniana Janka H, 4778, R88.
Pulicaria dysenterica (L.) Bernh. H, 4636, R15.
Helichrysum plicatum DC. subsp. *plicatum* H, 4402, R19.
H. arenarium (L.) Moench subsp. *aucheri* (Boiss.) Davis & Kupicha IT, H, 4732, R33, **End.**
Filago pyramidata L. H, 4398, R24.
Logfia arvensis (L.) Holub H, 4409, R64.
Solidago virgaurea L. subsp. *virgaurea* H, 4481, R25.
Erigeron acer L. subsp. *pycnotrichus* (Vierh.) Grierson ES, H, 4800, R36.
Bellis perennis L. ES, H, 4524, R30.
Doronicum orientale Hoffm. H, 4338, R37.
Senecio vernalis Waldst. & Kit. Th, 4739, R31.
Tussilago farfara L. ES, H, 4573, R44.
Petasites hybridus (L.) Gaertner ES, H, 4757, R30.
Anthemis cretica L. subsp. *albida* (Boiss.) Grierson H, 4522, R9.
A. cretica L. subsp. *anatolica* (Boiss.) Grierson H, 4330, R15.
A. cotula L. Th, 4521, R30.
A. tinctoria L. var. *tinctoria* H, 4331, R3.
Achillea biserrata Bieb. ES, H, 4580, R39.
A. millefolium L. subsp. *millefolium* ES, H, 4325, R1.
A. nobilis L. subsp. *neilreichii* (Kerner) Formanek ES, H, 4665, R22.
Tanacetum poteriifolium (Ledeb.) Grierson ES, H, 4357, R26.
T. parthenium (L.) Schultz Bip. H, 4717, R21.
T. vulgare L. H, 4718, R21.
Matricaria chamomilla L. var. *recutita* (L.) Grierson Th, 4633, R15.
Artemisia absinthium L. Ch, 4497, R18.
Arctium minus (Hill) Bernh. subsp. *pubens* (Babington) Arenes ES, H, 4496, R21.
Onopordum tauricum Willd. ES, H, 4737, R24.
Cirsium vulgare (Savi) Ten. H, 4768, R32.
C. hypoleucum DC. ES, H, 4533, R27.
C. pseudopersonata Boiss. & Bal. subsp. *pseudopersonata* ES, H, 4534, R30, **End.**
C. arvense (L.) Scop. subsp. *arvense* H, 4490, R22.
C. arvense (L.) Scop. subsp. *vestitum* (Wimmer & Grab.) Petrak H, 4775, R33.
Picnomon acarna (L.) Cass. M, H, 4660, R17.
Carduus nutans L. var. *leiophyllus* (Petr.) Stoj.&Stef. H, 4622, R43.
C. pycnocephalus L. subsp. *albidus* (Bieb.) Kazmi Th, 4676, R92.
Jurinea pontica Hausskn. & Freyn ex Hausskn. IT, H, 4787, R34, **End.**
Centaurea virgata Lam. Group A H, 4500, R20.
C. solstitialis L. subsp. *solsitialis* Th, 4645, R34.
C. hypoleuca DC. ES, H, 4585, R8.
C. pichleri Boiss. subsp. *pichleri* H, 4773, R76.
Crupina crupinastrum (Moris) Vis. Th, 4745, R27.
Cnicus benedictus L. var. *benedictus* Th, 4454, R25.
Carthamus lanatus L. Th, 4677, R20.
Carlina oligocephala Boiss. & Kotschy subsp. *oligocephala* H, 4529, R83.
Xeranthemum annuum L. Th, 4619, R22.
Chardinia orientalis (L.) O. Kuntze IT, Th, 4774, R88.
Echinops sphaerocephalus L. subsp. *sphaerocephalus* ES, H, 4632, R15.
Cichorium intybus L. H, 4489, R23.
Scorzonera eriophora DC. H, 4788, R34, **End.**
Tragopogon coloratus C.A. Meyer IT, H, 4359, R29.
Leontodon hispidus L. var. *hispidus* H, 4484, R39.
L. asperrimus (Willd.) J. Ball IT, H, 4556, R7.
L. crispus Vill. subsp. *asper* (Waldst. & Kit.) Rohl. var. *asper* H, 4609, R29.
Sonchus asper (L.) Hill. subsp. *glauscens* (Jordan) Ball H, 4568, R36.
Hieracium pannosum Boiss. M, H, 4777, R33.
H. umbellatum L. H, 4467, R3.
Pilosella hoppeana (Schultes) C.H. & F.W. Schultz. subsp. *pilisquama* (NP.) Sell & West H, 4473, R10.
P. piloselloides (Vill.) Sojak subsp. *piloselloides* H, 4416, R26.
P. piloselloides (Vill.) Sojak subsp. *megalomastix* (NP.) Sell&West H, 4415, R19.
Lactuca saligna L. H, 4664, R32.
Lapsana communis L. subsp. *alpina* (Boiss.&Bal.) Sell ES, H, 4406, R33.
L. communis L. subsp. *intermedia* (Bieb.) Hayek H, 4470, R9.
Taraxacum crepidiforme DC. subsp. *crepidiforme* IT, H, 4358, R12.

T. buttleri Van Soest H, 4769, R33.
Chondrilla juncea L. var. *juncea* H, 4679, R20.
Crepis foetida L. subsp. *rhoeadifolia* Th, 4455, R33.

CAMPANULACEAE
Campanula lyrata Lam. subsp. *lyrata* H, 4583, R30, **End.**
C. latifolia L. ES, H, 4499, R6.
C. rapunculoides L. subsp. *rapunculoides* ES, H, 4386, R23.
C. glomerata L. subsp. *hispida* (Witasek) Hayek ES, H, 4615, R13.
C. alliariifolia Willd. ES, H, 4536, R31.
C. latiloba A.DC. subsp. *latiloba* ES, H, 4527, R31, **End.**
Asyneuma limonifolium (L.) Janchen subsp. *pestalozzae* (Boiss.) Damboldt H, 4374, R3, **End.**

ERICACEAE
Rhododendron luteum Sweet ES, Ph, 4506, R11.
Vaccinium myrtillus L. ES, Ch, 4731, R23.
V. arctostaphylos L. ES, Ph, 4612, R14.
Pyrola chlorantha Swartz H, 4372, R26.
Orthilia secunda (L.) House H, 4414, R2.

PRIMULACEAE
Primula vulgaris Huds. subsp. *vulgaris* ES, H, 4350, R36.
Androsace maxima L. Th, 4661, R17.
Cyclamen coum Miller var. *coum* G, 4663, R21.
Lysimachia vulgaris L. H, 4712, R30.
Anagallis foemina Miller M, Th, 4519, R29.

OLEACEAE
Jasminum fruticans L. M, Ph, 4555, R29.
Fraxinus angustifolia Vahl subsp. *oxycarpa* (Bieb. ex Willd.) Franco & Rocha Afonso ES, Ph, 4794, R35. *Ligustrum vulgare* L. ES, Ph, 4746, R28.

ASCLEPIADACEAE
Cionura erecta (L.) Griseb. M, Ph, 4792, R35.

GENTIANACEAE
Centaurium erythraea Rafn subsp. *erythraea* ES, H, 4530, R7.

CONVOLVULACEAE
Convolvulus cantabrica L. Ch, 4537, R29.
C. assyricus Griseb. IT, Ch, 4646, R17, **End.**
C. arvensis L. Ch, 4536, R14.
Calystegia sylvatica (Kit.) Griseb. Ch, 4510, R23.

CUSCUTACEAE
Cuscuta campestris Yuncker Vp, 4785, R76.

BORAGINACEAE
Heliotropium europaeum L. M, Th, 4682, R20.
Lappula barbata (Bieb.) Gürke IT, H, 4343, R22.
Rochelia disperma (L. fil.) C. Koch var. *disperma* H, 4424, R61.
Myosotis ramosissima Rochel ex Schultes subsp. *ramosissima* Th, 4346, R37.
M. alpestris F.W. Schmidt subsp. *alpestris* H, 4485, R25.
M. lithospermifolia (Willd.) Hornem. H, 4413, R64.
Cynoglossum creticum Miller H, 4541, R15.
Lithospermum officinale L. ES, H, 4599, R11.
Echium vulgare L. ES, H, 4459, R40.
Onosma armenum DC. H, 4347, R29, **End.**
Cerinthe minor L. subsp. *auriculata* (Ten.) Domac H, 4488, R22.
Symphytum bornmuelleri Bucknall ES, H, 4742, R25, **End.**
Trachystemon orientalis (L.) G. Don ES, G, R25.
Cynoglottis chetikiana Vural & Kit Tan subsp. *paphlagonica* (Hausskn. ex Bornm.) Vural.& Kit Tan. H, 4680, R20, **End.**
Anchusa leptophylla Roemer & Schultes subsp. *incana* (Ledeb.) Chamb. IT H, 4520, R9, **End.**
A. azurea Miller var. *azurea* H, 4495, R33.

SOLANACEAE
Solanum nigrum L. subsp. *nigrum* Th, 4693, R96.
Atropa belladonna L. ES, H, 4581, R21.
Hyoscyamus niger L. H, 4342, R38.

SCROPHULARIACEAE
Verbascum ponticum (Boiss.) O. Kuntze ES, H, 4607, R31, **End.**
V. spectabile Bieb. var. *spectabile* ES, H, 4364, R1.
V. pyramidatum Bieb. ES, H, 4433, R14.
V. armenum Boiss. & Kotschy var. *tempskyanum* (Freyn & Sint.) Murb. H, 4770, R105.
V. abieticolum Bornm. ES, H, 4574, R9, **End.**
V. glomeratum Boiss. IT, H, 4697, R98.
Scrophularia scopoli [Hoppe ex] Pers. var. adenocalyx Somm. & Lev. ES, H, 4354, R38.

S. canina L. subsp. bicolor (Sm.) Greuter M, H, 4771, R32.
Chaenorhinum litorale (Bernh.) Fritsch subsp. *pterosporum* (Fisch & Mey.) Davis M, Th, 4678, R20, **End.**
Linaria genistifolia (L.) Miller subsp. *genistifolia* ES, H, 4370, R26.
L. corifolia Desf. IT, H, 4375, R2, **End.**
Digitalis ferruginea L. subsp. *ferruginea* ES, H, 4337, R18.
D. lamarckii Ivan. IT, H, 4681, R22, **End.**
Veronica gentianoides Vahl ES, H, 4611, R12.
V. bozakmanii M.A. Fischer IT, Th, 4608, R10.
V. filiformis J.E. Smith ES, H, 4764, R31.
V. chamaedrys L. ES, H, 4760, R30.
V. magna M.A. Fischer ES, H, 4575, R40.
V. multifida L. IT, H, 4365, R7, **End.**
V. officinalis L. ES, H, 4576, R8.
Melampyrum arvense L. var. *arvense* H, 4634, R15

OROBANCHACEAE

Orobanche purpurea Jacq. Vp, 4761, R31.
O. minor Sm. Vp, 4604, R24.

GLOBULARIACEAE

Globularia trichosantha Fisch. & Mey. H, 4511, R16.

VERBENACEAE

Verbena officinalis L. H, 4751, R14.
Vitex agnus-castus L. M, Ph, 4629, R14.

LABIATAE (LAMIACEAE)

Ajuga orientalis L. H, 4327, R37.
A. chamaepitys (L.) Schreber subsp. *chia* (Schreber) Arcangeli var. *ciliata* Briq. H, 4326, R21.
Teucrium orientale L. var. *orientale* IT, H, 4694, R96.
T. chamaedrys L. subsp. *syspirense* (C. Koch) Rech. fil. IT, H, 4658, R19.
T. polium L. Ch, 4659, R16.
Scutellaria salviifolia Bentham H, 4692, R36, **End.**
Phlomis russeliana (Sims) Bentham ES, H, 4803, R95, **End.**
P. armeniaca Willd. IT, H, 4651, R80, **End.**
Lamium purpureum L. var. *purpureum* ES, Th, 4469, R67.
L. album L. ES, H, 4468, R25.
Marrubium vulgare L. H, 4685, R94.
Sideritis montana L. subsp. *montana* M, Th, 4512, R24.
S. dichotoma Huter H, 4797, R35, **End.**
S. amasiaca Bornm. H, 4669, R44, **End.**
S. germanicopolitana Bornm. subsp. *germanicopolitana* H, 4733, R24, **End.**
Stachys byzantina C. Koch ES, H, 4376, R26.
S. sylvatica L. ES, H, 4570, R7. *S. annua* (L.) L. subsp. *annua* var. *lycaonica* Bhattacharjee H, 4356, R95.
Melissa officinalis L. subsp. *officinalis* H, 4618, R42.
Nepeta nuda L. subsp. *albiflora* (Boiss.) Gams H, 4373, R3.
Prunella vulgaris L. ES, H, 4565, R27.
Origanum vulgare L. subsp. *viride* (Boiss.) Hayek H, 4672, R36.
Clinopodium vulgare L. subsp. *arundanum* (Boiss.) Nyman H, 4391, R95.
Acinos rotundifolius Pers. Th, 4517, R33.
Thymus sipyleus Boiss. subsp. *rosulans* (Borbas) Jalas Ch, 4445, R16.
T. longicaulis C. Presl. subsp. *longicaulis* var. *subisophyllus* Ch, 4443, R34.
Mentha longifolia (L.) Hudson subsp. *longifolia* H, 4686, R32.
Ziziphora capitata L. IT, Th, 4366, R37.
Z. persica Bunge IT, Th, 4789, R34.
Salvia tomentosa Miller M, H, 4654, R36.
S. sclarea L. H, 4653, R78.
S. forskahlei L. ES, H, 4691, R95.
S. virgata Jacq. IT, H, 4655, R77.
S. verticillata L. subsp. *amasiaca* (Freyn & Bornm.) Bornm. IT, H, 4641, R23.

PLUMBAGINACEAE

Plumbago europaea L. ES, H, 4688, R20.
Acantholimon acerosum (Willd.) Boiss. var. *acerosum* IT, Ch, 4643, R76.

PLANTAGINACEAE

Plantago major L. subsp. *major* H, 4560, R27.
P. lanceolata L. H, 4418, R28.

THYMELAEACEAEA

Daphne pontica L. ES, Ch, 4369, R26.
D. glomerata Lam. ES, Ch, 4457, R68.

SANTALACEAE

Thesium arvense Horvatovszky ES, H, 4572, R31.

EUPHORBIACEAE
Euphorbia stricta L. ES, Th, 4703, R21.
E. herniarifolia Willd. var. *glaberrima* Hal. H, 4752, R29.
E. rigida Bieb. M, H, 4793, R35.
E. amygdaloides L. var. *amygdaloides* ES, H, 4460, R40.
URTICACEAE
Urtica dioica L. ES, H, 4601, R20.
JUGLANDACEAE
Juglans regia L. Ph, 4795, R35.
PLATANACEAE
Platanus orientalis L. Ph, 4796, R35.
FAGACEAE
Fagus orientalis Lipsky ES, Ph, 4317, R1.
Castanea sativa Miller Ph, 4515, R9.
Quercus macranthera Fisch. & Mey. ex Hohen. subsp. *syspirensis* (C. Koch) Menitsky Ph, 4514, R8, **End.**
Q. petraea (Mattuschka) Liebl. subsp. *iberica* (Steven ex Bieb.) Krassiln. Ph, 4730, R28.
Q. infectoria Olivier subsp. *boissieri* (Reuter) Ph, 4513, R15.
O. Schwarz Ph, 4513, R15.
Q. pubescens Willd. Ph, 4639, R16.
Q. cerris L. var. *cerris* Ph, 4422, R7.
CORYLACEAE
Carpinus orientalis Miller subsp. *orientalis* Ph, 4507, R11.
Corylus colurna L. ES, Ph, 4442, R10.
C. avellana L. var. *avellana* ES, Ph, 4721, R22.
BETULACEAE
Alnus glutinosa (L.) Gaertner subsp. *glutinosa* ES, Ph, 4790, R35.
SALICACEAE
Salix alba L. ES, Ph, 4806, R42.
S. caprea L. ES, Ph, 4714, R44.
Populus tremula L. ES, Ph, 4349, R22.
LILIACEAE
Polygonatum orientale Desf. ES, G, 4564, R11.
Allium olympicum Boiss. ES, G, 4518, R34, **End.**
A. scorodoprasum subsp. *rotundum* (L.) Stearn M, G, 4379, R26.
Ornithogalum oligophyllum E.D. Clarke G, 4472, R40.
O. sigmoideum Freyn et Sint. G, 4701, R105.
Muscari armeniacum Leichtlin ex Baker G, 4412, R26.
M. neglectum Guss. G, 4699, R105.
Colchicum speciosum Steven ES, G, 4666, R18.
IRIDACEAE
Crocus speciosus Bieb. subsp. *ilgazensis* Mathew ES, G, 4492, R105, **End.**
ORCHIDACEAE
Cephalanthera epipactoides Fisch. & Mey. M, G, 4389, R2.
C. rubra (L.) L.C.M. Richard G, 4336, R30.
Epipactis helleborine (L.) Crantz G, 4590, R27.
Orchis punctulata Steven ex Lindley M, G, 4700, R105.
O. anatolica Boiss. M, G, 4348, R38.
O. mascula (L.) L. subsp. *pinetorum* (Boiss. et Kotschy) G. Camus M, G, 4493, R58.
O. pallens L. ES, G, 4502, R6.
Dactylorhiza romana (Seb.) Soó subsp. *georgica* (Klán) Soó ex Renz & Taub. ES, G, 4801, R38.
DIOSCOREACEAE
Tamus communis L. subsp. *communis* G, 4571, R31.
JUNCACEAE
Juncus alpigenus C. Koch ES, H, 4710, R21.
CYPERACEAE
Cyperus esculentus L. H, 4395, R2.
Carex divulsa Stokes subsp. *divulsa* ES, H, 4387, R19.
C. ovalis Good. ES, H, 4388, R63.
C. echinata Murray ES, H, 4767, R32.
GRAMINEAE (POACEAE)
Brachypodium sylvaticum (Hudson) P. Beauv. ES, H, 4662, R17.
Agropyron cristatum (L.) Gaertner subsp. *pectinatum* (Bieb.) var. *pectinatum* H, 4765, R108.
Aegilops speltoides Tausch var. *ligustica* (Savignone) Bornm. Th, 4616, R15.
Hordeum murinum L. subsp. *glaucum* (Steudel) Tzvelev Th, 4617, R13.
H. bulbosum L. H, 4650, R23.
Taeniatherum caput-medusae (L.) Nevski subsp. *crinitum* (Schreber) Melderis IT, Th, 4716, R22.
Bromus hordeaceus L. subsp. *hordeaceus* Th, 4334, R37.

B. japonicus Thunb. subsp. *japonicus* Th, 4324, R12.
B. danthoniae Trin. Th, 4525, R33.
B. tectorum L. Th, 4335, R58.
B. tomentellus Boiss. IT, H, 4449, R25.
B. ramosus Huds. H, 4582, R8.
B. erectus Hudson H, 4735, R24.
Avena fatua L. var. *fatua* Th, 4498, R21.
Helictotrichon pubescens (Hudson) Besser ex Schultes & Schultes fil. subsp. *pubescens* ES, H, 4466, R70.
Gaudinia fragilis (L.) P. Beauv. ES, Th, 4464, R68.
Koeleria cristata (L.) Pers. H, 4505, R26.
Deschampsia flexuosa (L.) Trin. ES, H, 4587, R8.
D. caespitosa (L.) P. Beauv. H, 4458, R28.
Agrostis capillaris L. var. *capillaris* H, 4447, R72.
Phleum montanum C. Koch subsp. *montanum* H, 4738, R103.
Festuca drymeja Mertens & Koch ES, H, 4547, R8.
F. heterophylla Lam. ES, H, 4440, R71.
F. valesiaca Schleicher ex Gaudin H, 4461, R69.
Lolium perenne L. H, 4727, R108.
L. temulentum L. var. *temulentum* Th, 4557, R11.
Poa pratensis L. H, 4749, R29.
P. nemoralis L. H, 4474, R25.
P. bulbosa L. H, 4419, R19.
Eremopoa songarica (Schrenk) Roshev. IT, Th, 4671, R65.
Puccinellia distans (Jacq.) Parl. subsp. distans H, 4441, R15.
Dactylis glomerata L. subsp. *glomerata* ES, H, 4396, R3.
Cynosurus echinatus L. Th, 4542, R30.
Briza media L. H, 4385, R36.
Echinaria capitata (L.) Desf. Th, 4631, R42.
Setaria italica (L.) P. Beauv. Th, 4637, R44.
Bothriochloa ischaemum (L.) Keng H, 4740, R67.

4. Sonuçlar ve tartışma

Araştırma alanı olarak seçilen "Sakarat Dağı" P. H. Davis'in Grid sistemine göre A6 karesi içerisine girmektedir ve İç Anadolu bölgesinin kuzeydoğusunda yer almaktadır. 500–1956 m'ler arasında değişen yüksekliklere ve farklı habitatlara sahiptir.

Araştırma bölgesinden toplanan yaklaşık 2000 bitki örneğinin teşhis edilmesi sonucunda 78 familyaya ait 287 cins ve 494 tür (bu sayıya tür altı taksonlar da dahil edilmiştir) tespit edilmiştir. Araştırma alanından toplanan taksonların büyük bitki gruplarına göre dağılımları Tablo 3'de gösterilmiştir.

Tablo 3. Araştırma Alanından Toplanan Türlerin Büyük Bitki Gruplarına Göre Dağılımları

	Familya Sayısı	**Cins Sayısı**	**Toplam taxon sayısı**
Pteridophyta	1	1	1
Spermatophyta	77	285	493
Gymospermae	2	2	4
Angiospermae	75	283	489
Dicotyledones	68	245	429
Monocotyledones	7	38	60
TOPLAM	**78**	**286**	**494**

Araştırma alanındaki en zengin familyalar, *Compositae* (*Asteraceae), Leguminosae (Fabaceae), Gramineae (Poaceae), Labiatae (Lamiaceae), Rosaceae, Scrophulariaceae, Cruciferae (Brassicaceae), Boraginaceae, Caryophyllaceae* ve *Umbelliferae (Apiaceae)* şeklinde sıralanmaktadır. Çalışma alanında en çok tür içeren familya olan *Compositae* (*Asteraceae)* Türkiye Florası'nın da en geniş familyasıdır. Bu familya üyelerinin ekolojik toleransları oldukça fazladır ve tohumları da kolaylıkla yayılabilmektedir. Aynı şekilde, tür sayısı bakımından çalışma alanında 2. sırada gelen *Leguminosae (Fabaceae)* familyası Türkiye Florası'nın da 2. büyük familyasıdır ve çok tür ihtiva eden büyük cinsleri kapsamaktadır. Alandaki, toplam tür sayısının % 60.52'sini en zengin 10 familya oluşturmaktadır. Geri kalan 68 familyaya dağılmış türlerin oranı ise % 39.47'dir (Tablo 4).

Çalışma alanından toplanan cinslerin, tür zenginliklerine göre sıralanması ise Tablo 5'de verilmiştir. Bu tablo incelendiğinde, alanda tür sayısı bakımından en zengin cinsin *Astragalus* olduğu görülür. Bunun sebebi; alandaki hem step hem de orman vejetasyonlarında, bu cinsin oldukça zengin tür ile temsil edilmesidir. Aynı zamanda *Astragalus* L. Tür sayısı açısından Türkiye Florası'nın da en zengin cinsidir.

Tablo 4. Araştırma Bölgesinden Toplanan Türlerin Familyalara Göre Dağılımları

Familya	**Tür Sayısı**	**%**
Compositae (Asteraceae)	70	14.17
Leguminosae (Fabaceae)	46	9.31
Gramineae (Poaceae)	37	7.49
Labiatae (Lamiaceae)	34	6.88
Rosaceae	29	5.87
Scrophulariaceae	21	4.25
Cruciferae (Brassicaceae)	17	3.44
Boraginaceae	16	3.24
Caryophyllaceae	15	3.04
Umbelliferae (Apiaceae)	14	2.83
Diğer	195	39.47
TOPLAM	**494**	**100**

Tablo 5. Araştırma Alanında En Çok Tür İçeren Cinsler

Cins	**Tür Sayısı**
Astragalus	8
Veronica	7
Bromus	7
Galium	7
Campanula	6
Verbascum	6
Rumex	6
Trifolium	6
Salvia	5
Rubus	5

Araştırma sahasına ait bitki türlerinin Raunkier'in Hayat Formları'na göre dağılım yüzdeleri ise Tablo 6'da verilmiştir. Tablodan da görüleceği gibi araştırma alanında "hemikriptofitler" hakim durumda olup biyolojik spektrumda 2. sırayı terofitler almaktadır.

Tablo 6. Türlerin Hayat Formlarına Göre Dağılımları

Hayat Formu	**Tür Sayısı**	**%**
Hemikriptofit (H)	296	59.92
Terofit (Th)	78	15.79
Fanerofit (Ph)	67	13.56
Kamefit (Ch)	25	5.06
Geofit (G)	25	5.06
Vasküler Parazit (Vp)	3	0.61
TOPLAM	**494**	**100**

Tablo 7. Türlerin Fitocoğrafik Bölgelere Göre Dağılımları

Fitocoğrafik Bölge	**Tür Sayısı**	**%**
Avrupa-Sibirya (ES)	127	25.71
İran-Turan (IT)	43	8.70
Akdeniz (M)	24	4.86
Geniş yayılışlılar ve bilinmeyenler	300	60.73
TOPLAM	**494**	**100**

Taksonların fitocoğrafik dağılımlarına göre, alanda 127 takson ile Avrupa-Sibirya kökenli bitkiler çoğunluktadır (% 25.71). İran-Turan kökenli türlerin de belli bir oranla (43 tür - % 8.70) alanda yer alması, çalışma sahasının Avrupa-Sibirya ile İran-Turan fitocoğrafik bölgeleri arasında bir geçiş zonunda yer aldığını göstermektedir (Tablo 7). Ayrıca Sakarat Dağı'nda tespit edilen türlerin % 8.1'i (40 tür) endemiktir.

Sakarat Dağı'ndaki toplam örnek, familya, cins ve takson sayılarının Amasya'da gerçekleştirilen diğer floristik araştırmalarla karşılaştırılması Tablo 8'de verilmiştir.

Tablo 8. Sakarat Dağı ve Amasya'daki Diğer Floristik Araştırmalarda Toplam Örnek, Familya, Cins ve Takson sayıları

Araştırma Alanı	**Toplam Örnek sayısı**	**Toplam Familya Sayısı**	**Toplam Cins Sayısı**	**Toplam Takson sayısı**
Sakarat Dağı (Cansaran vd., 2009)	**2000**	**78**	**286**	**494**
Akdağ (Alpınar, 1979)	-	96	424	887
Kuşpınartepe (Peker, 1988)	770	86	313	488
Amasya-Yozgat-Çorum Arası (Kurt vd., 1998)	1200	61	296	536
Vermiş-Yuvacık Köyleri ve Amasya Kalesi Arası (Cansaran ve Aydoğdu, 1998)	670	75	287	420
Eğerli Dağı (Cansaran, 2002)	2000	70	298	650
Tavşan dağı (Korkmaz vd., 2005)	1507	77	307	594
Aşağı Tersakan Vadisi (Celep vd., 2006)	1000	74	301	457
Çakır Dağı (Yücel, 2005)	450	36	131	195
Direkli-Yassıçal-Abacı Arası (Cansaran vd., 2007a)	645	56	221	379
İnegöl Dağı (Yıldırım, 2009)	1700	71	291	661

Görüldüğü gibi; toplam örnek sayısı belli olmamasına rağmen alanda, en çok familya (96), en çok cins (424) ve en çok takson (887) içeren çalışma Akdağ'da yapılan çalışmadır (Alpınar, 1979). Bu durum Akdağ'ın Amasya'nın en yüksek noktası olması, oldukça geniş bir alana yerleşmiş olması ve iklim, toprak ve vejetasyon yapısı açısından çeşitlilik göstermesi ile açıklanabilir. Buna karşılık toplam örnek, familya, cins ve takson sayısı açısından en fakir alan olarak "Çakır Dağı" (Yücel, 2005) görülmektedir. Çakır Dağı, Çorum şehir merkezinden başlayıp Amasya Kalesi'ne kadar uzanan bir dağdır (http:// www.amasya.gov.tr/). Böyle büyük bir dağda daha farklı rakamlara ulaşılmış olması beklenebilir. Bu durum, o alanda çalışma yapılan dönemlerdeki klimatik koşullardan kaynaklanabilir. Araştırma alanımıza en yakın bölgeler olan Eğerli Dağı, İnegöl Dağı ve Tavşan Dağı'nın toplam örnek, familya, cins ve takson sayısı açısından bulguları bizim bulgularımıza benzerlik göstermektedir.

Sakarat Dağı ve Amasya'daki diğer floristik çalışmalarda belirlenen taksonların fitocoğrafik bölgelere dağılımları ve endemizm oranları ise Tablo 9'de görülmektedir. Burada belirtilen fitocoğrafik bölgelere girmeyen türler ya kozmopolit ya da fitocoğrafik bölgeleri bilinmeyen taksonlardır.

Tablo 9. Sakarat Dağı ve Amasya'daki Diğer Floristik AraştırmalardaTaksonların Fitocoğrafik Bölgelere Dağılımları ve Endemizm Oranları

Araştırma Alanı	Iran-Turan	Avrupa-Sibirya	Akdeniz	Endemizm
Sakarat Dağı (Cansaran vd., 2009)	43 (% 8.70)	127 (% 25.71)	24 (% 4.86)	40 (% 8.1)
Akdağ (Alpınar, 1979)	-	-	-	62 (% 7)
Kuşpınartepe (Peker, 1988)	43 (% 8.98)	51(% 10.64)	45(% 9.39)	33 (% 6.89)
Amasya-Yozgat-Çorum Arası (Kurt vd., 1998)	100 (% 18.65)	71 (% 13.25)	41 (% 7.65)	38 (% 7.09)
Vermiş-Yuvacık Köyleri ve Amasya Kalesi Arası (Cansaran ve Aydoğdu, 1998)	70 (% 15.71)	31 (% 7.38)	40 (% 9.52)	46 (% 11)
Eğerli Dağı (Cansaran, 2002)	102 (% 15.69)	97 (% 14.92)	46 (% 7.07)	80 (% 12.30)
Tavşan dağı (Korkmaz vd., 2005)	71 (% 11.95)	141 (% 23.73)	30 (% 5.04)	65 (% 10.94)
Aşağı Tersakan Vadisi (Celep vd., 2006)	77 (% 16.8)	39 (% 8.5)	35 (% 7.6)	50 (% 10.94)
Çakır Dağı (Yücel, 2005)	23 (% 11.79)	12 (% 6.15)	10 (% 5.12)	18 (% 9.23)
Direkli-Yassıçal-Abacı Arası (Cansaran vd., 2007a)	51 (% 13.4)	45 (% 11.8)	35 (% 9.2)	44 (% 11.6)
İnegöl Dağı (Yıldırım, 2009)	99 (% 15.0)	103 (% 15.6)	43 (% 6.5)	77 (% 11.65)

Tablo 9 incelendiğinde; Kuşpınartepe (Peker, 1988), Tavşan Dağı (Korkmaz vd., 2005), İnegöl Dağı (Yıldırım, 2009) ve çalışma alanı olan Sakarat Dağı'nda Avrupa-Sibirya fitocoğrafik bölgesi elementlerinin; diğer tüm alanlarda ise İran-Turan fitocoğrafik bölgesi elementlerinin 1. sırada yer aldığı görülmektedir. Amasya ili İran-Turan ve Avrupa-Sibirya fitocoğrafik bölgeleri arasında bir geçiş alanında bulunduğu için bu sonuçlar normaldir. İran-Turan bölgesi elementlerinin genelde ilk sırayı almış olması, Amasya'nın tahribatı yüksek bir alan olduğunu göstermektedir. Çünkü İran-Turan bölgesi elementleri daha çok açık ve stebik alanlarda yayılırken; Avrupa-Sibirya bölgesi elemetleri daha çok nemli alanlar, çayırlıklar, çalılıklar ve ormanlık alanları tercih etmektedir. Sakarat Dağı'nın iyi gelişmiş orman formasyonlarına sahip olması Avrupa-Sibirya fitocoğrafik bölgesi elementlerinin burada ilk sıraya yerleşmesinde önemli rol oynamıştır. Amasya'da gerçekleştirilmiş olan tüm çalışmalarda, Akdeniz elementlerinin de kendini göstermesi (bazı çalışmalarda 3. sırada da olsa) Amasya'nın ortasında uzanan Yeşilırmak nehrinin etkisinin bir sonucudur. Akdeniz fitocoğrafik bölgesi elementleri, Yeşilırmak vadisi boyunca, daha çok alçak kesimlerdeki alüvyal alanlarda yerleşmişlerdir. Endemik bitkiler açısından bakıldığında ise Amasya'daki çalışmalarda %6.89 ile %12.30 arasında değişen endemizm oranları Türkiye ortalamasından (%31) (Güner vd., 2000) oldukça düşüktür. Sakarat Dağı da % 8.1'lik endemizm oranı ile oldukça az sayıda endemik tür ihtiva etmektedir.

Sakarat Dağı ve Amasya'daki diğer floristik araştırmalarda tespit edilen en büyük ilk 3 familya ve ilk 3 cins ise Tablo10'da gösterilmektedir.

Tablo 10. En büyük İlk 3 Familya ve İlk 3 Cinse GöreAmasya'daki Floristik Çalışmaların Karşılaştırılması

Araştırma Alanı	En Büyük 3 Familya (Tür sayısı / Tür yüzdesi)	En Büyük 3 Cins (Tür Sayısı)
Sakarat Dağı (Cansaran vd., 2009)	*Asteraceae*: 70 (% 14.17) *Fabaceae*: 46 (% 9.31) *Poaceae*: 37 (% 7.49)	* *Astragalus* (8) * *Veronica - Bromus – Galium* (7) * *Campanula, Verbascum*, Rumex, *Trifolium* (6)
Kuşpınartepe (Peker, 1988)	*Asteraceae*: 58 (% 12.1) *Fabaceae*: 54 (% 11.3) *Lamiaceae*: 33 (% 6.9)	* *Astragalus* (10) **Vicia-Trifolium-Ranunculus* (7) **Geranium-Alyssum* (6)
Amasya-Yozgat-Çorum Arası (Kurt vd., 1998)	*Fabaceae*: 85 (% 15.85) *Asteraceae*: 82 (% 15.29) *Poaceae*: 39 (% 7.27)	* *Astragalus* (29) * *Trifolium* (12) **Silene-Lathyrus* (7)
Vermiş-Yuvacık Köyleri ve Amasya Kalesi Arası (Cansaran ve Aydoğdu, 1998)	*Asteraceae*: 46 (% 11.1) *Lamiaceae*: 38 (% 9.2) *Fabaceae*: 33 (% 8.0)	**Astragalus* (10) **Salvia* (9) **Convolvulus.–Euphorbia- Silene–Verbascum* (5)
Eğerli Dağı (Cansaran, 2002)	*Asteraceae*: 78 (% 12.6) *Fabaceae*: 77 (% 12.4) *Poaceae* : 42 (% 6.7)	**Astragalus* (23) **Silene–Lathyrus* (10) **Trifolium–Galium–Onosma- Salvia* (8)
Tavşan dağı (Korkmaz vd., 2005)	*Asteraceae*: 78 (% 12.9) *Fabaceae* : 56 (% 9.2) *Lamiaceae*: 53 (% 8.8)	**Veronica* (13) **Salvia–Alyssum* (11) **Centaurea* (10)
Aşağı Tersakan Vadisi (Celep vd., 2006)	*Asteraceae*: 56 (% 12.2) *Fabaceae*: 42 (% 9.2) *Lamiaceae*: 35 (% 7.6)	* *Astragalus-Alyssum* (7) * *Vicia-Salvia* (6) * *Centaurea* (5)
Çakır Dağı (Yücel, 2005)	*Asteraceae*: 33 (% 16.92) *Fabaceae*: 27 (% 13.84) *Lamiaceae*: 17 (% 8.71)	**Astragalus-Centaurea* (6) **Ornithogalum-Onobrychis* (4) * *Dianthus* (3)
Direkli-Yassıçal-Abacı Arası (Cansaran vd., 2007a)	*Asteraceae*: 47 (% 12.6) *Fabaceae*: 38 (% 10.2) *Lamiaceae*: 36 (% 9.7)	**Astragalus-Silene* (8) **Centaurea* (7) * *Lathyrus* (6) **Salvia-Viola-Euphorbia* (5)
İnegöl Dağı (Yıldırım, 2009)	*Asteraceae*: 87 (% 13.2) *Fabaceae*: 69 (% 10.4) *Lamiaceae* 60 (% 9.1)	**Astragalus* (17) * *Verbascum-Centaurea* (12) * *Silene-Salvia* (10)

Tablo 10 incelendiğinde; Kuşpınartepe (Peker, 1988), Tavşan Dağı (Korkmaz vd., 2005), Aşağı Tersakan Vadisi (Celep vd., 2006), Çakır Dağı (Yücel, 2005), Direkli-Yassıçal-Abacı Arası (Cansaran vd., 2007a) ve İnegöl dağı (Yıldırım, 2009)'nda yapılan çalışmalarda ortaya çıkan en büyük 3 familyanın aynen Türkiye Florası'nda (Güner vd., 2000) olduğu gibi sıralandığı görülmektedir: (*Asteraceae*, *Fabaceae*, *Lamiaceae*). Diğer floristik araştırmalarda ise, bu familyalardan en az ikisi ilk üçe girmektedir. Amasya'daki çalışmalarda ilk üçe giren bir diğer familya ise Türkiye Florası'nda (Güner vd., 2000) 5. sırada yer alan Poaceae familyasıdır ki Sakarat Dağı'nda da bu familya *Asteraceae* ve *Fabaceae*'den sonra alanda kendisine 3. sırada yer bulmuştur.

Araştırma alanında en fazla tür içeren ilk üç cins sırası ile *Astragalus* (8), *Veronica-Bromus-Galium* (7) ve *Campanula-Verbascum-Rumex-Trifolium* (6)'dur. Ayrıca, Sakarat Dağı ve yakın çevresinde yapılan çalışmalarda, tür yönünden en zengin cinsler sıralamasında, Türkiye Florası'na (Güner et al, 2000) göre ilk üç sırada yer alan *Astragalus* (1.), *Verbascum* (2.) ve *Centaurea* (3.) cinslerinden en az bir tanesi ilk üç sıraya yerleşmiştir.

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Kaynakça

Akman, Y., Daget, P.H. 1971. "Quelques aspects synoptiques des climats de la Turquie" Bull. Soc.Long.Georg. Tome 5, Fasc. 3, 269–300.

Alpınar, K. 1979. Akdağ (Amasya) Bitkileri, İstanbul Üniversitesi Eczacılık Fakültesi. Doktora Tezi. İstanbul.

Anonim, 1973a. 1/250.000 ölçekli Türkiye Haritası'nın Yozgat Paftası. Pafta No: NK–36/4, Harita Genel Müdürlüğü, Ankara.

Anonim, 1973b. 1/250.000 ölçekli Türkiye Haritası'nın Tokat Paftası. Pafta No: NK–37/13, Harita Genel Müdürlüğü, Ankara.

Bingöl, M.Ü., Geven, F., Güney, K. 2007. Sakarat Dağı (Amasya)'nın Bitki Ekolojisi ve Bitki Sosyolojisi Yönünden Araştırılması. Türkiye Bilimsel ve Teknik Araştırma Kurumu (TÜBİTAK). Proje No: TOVAG-HD 105O018.

Cansaran, A., Aydoğdu, M. 1998. Flora of the Area between Amasya Castle and the Villages of Vermiş and Yuvacık. Doğa Tr. J.of Botany, 22, 269–283.

Cansaran, A. 2002. The Flora of Eğerli Mountain (Amasya-Turkey). Doğa Tr. J.of Botany. 26, 453–475.

Cansaran A,, Peker, S., Yıldırım, C. 2007a. Floristic Characters of the Area between the Direkli (Göndes) Village, Yassıçal (Ebemi) Town and Abacı Village (A5/6 Amasya–TURKEY). International Journal of Botany. 3, 3, 240-250.

Cansaran A., Yıldırım, C., Peker, S. 2007b. Amasya'da bugüne dek yapılmış olan tüm floristik araştırma sonuçlarının karşılaştırılarak değerlendirilmesi. I. Amasya Araştırmaları Sempozyumu Bildirileri (2. Kitap), 1017-1030, Amasya Valiliği, Amasya.

Celep F., Aytaç Z., Karaer F. 2006. Plant diversity and distribution in the lower Tersakan Valley (Amasya-Turkey). Flora Mediterranea. 16: 295-332.

Davis, P.H. 1965-1985. Flora of Turkey and the East Aegean Islands. vol. 1-9. Edinburgh: Univ. Press.

Davis, P.H., Hedge, IC. 1975. The Flora of Turkey: past, present and future. Candollea. 30: 331-351.

Davis. P.H., Mill R.R., Tan, K. 1988. Flora of Turkey and the East Aegean Islands vol. 10. Edinburgh: Univ. Press.

Evan, G, Townsend, C.C. 1968. Flora of Iraq. Vol. 1-5. Baghdad.

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

Heywood, V.H., Tutin, G.T. 1964-1981. (Ed.). Flora Europaea. vol. 1-5, Cambridge : Univ. Press.

Heywood, V.H. 1978. (Ed.). Flowering Plants of The World. London: Oxford Univ. Press.

Haznedar, Ş. 1989. Amasya Doğu Yöresinin Jeolojisi, Karadeniz Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, Trabzon.

Korkmaz, H., Yalçın, E., Engin, A., Yıldırım, C. 2005. Flora of Tavşan Mountain (Merzifon - Amasya). OT Sistematik Botanik Dergisi. 12, 2, 103-140.

Kurt, L., Ketenoğlu, O., Aydoğdu, M., Kurt, F., Seren, S., Bingöl, Ü. 1998. Amasya-Yozgat-Çorum Arasında Kalan Bölgenin (Kardağ, Kırlar ve Buzluk Dağları) Florasına Katkı. F.Ü. Fen ve Müh. Bil. Derg. 10 (1), 83–108.

Peker, S. 1988. Kuşpınartepe (Amasya)'nın Florası, Gazi Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, Ankara.

Tarım Orman ve Köy İşleri Bakanlığı. 1991. Amasya İli Arazi Varlığı. Köy Hizmetleri Genel Müd, İl Rapor No: 05. Ankara.

Yıldırım, C., Cansaran, A., Peker, S. 2007. Amasya il sınırları içerisinde yayılış gösteren endemik bitkiler ve bunların tehlike kategorileri. I. Amasya Araştırmaları Sempozyumu Bildirileri (2. Kitap), 1047-1066, Amasya Valiliği, Amasya.

Yıldırım, C. 2009. İnegöl Dağı (Gümüşhacıköy-Amasya) ve Çevresinin Vejetasyonu Üzerinde Floristik, Fitososyolojik ve Ekolojik Bir Araştırma, Ondokuz Mayıs Üniversitesi Fen Bilimleri Enstitüsü, Doktora Tezi, Samsun.

Yücel, E. 2005. Çakır Dağı Florası (Merzifon), Gazi Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, Ankara.

Zohary, M., 1973. Geobotanical foundations of the Middle East. Vol: 1–2, Stuttgart.

http:// www.amasya.gov.tr (Amasya Valiliği'nin web sitesi)

http://maps.google.com/maps?f=q&source=s_q&hl=tr&geocode=&q=amasya&sll=-2

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Response to selection for grain yield under maydis leaf blight stress environment in maize (*Zea mays*)

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Abstract

Maydis leaf blight (MLB), caused by *Bipolaris maydis*, is one of the most important diseases in maize. The objectives of this study were to quantify the progress for maydis leaf blight resistance improvement by estimating selection differential, expected and observed responses to selection after two cycles of S_1 line recurrent selection, and to estimate heritability for various morphological and yield traits in "Azam" composite maize population. This study was conducted at the research farm of Agricultural University, Peshawar, Pakistan during summer 2006 and 2007. In cycle-3 about one hundred S_1 lines while in cycle-4 196 S_1 lines of maize population Azam were evaluated under epiphytotic conditions along with their progenies in lattice square design with two replications. Highly significant variations were observed among the S_1 lines for grain yield, MLB, plant height, ear height, ear length, kernel rows cob^{-1}, and maturity traits in two cycles. In cycle-3 the expected and observed responses for grain yield (432, 2144 kg ha^{-1}), MLB (-0.53, -0.65), plant height (1.65, 28cm), ear height (-0.43, 10 cm), ear length (0.78, 5 cm), kernel rows cob^{-1} (-0.29, 2), pollen shedding (-0.21, -5 days) and silking (-0.09, -4 days) were observed, while in cycle-4 expected and observed responses were (715, 2762 kg ha^{-1}), (-0.01, -0.13), (1.15, 41 cm), (0.44, 23 cm), (1.17, 3 cm), (0.07, 1), (-1.23, -2 days) and (-1.39, -1 days) for the above traits, respectively. In both cycles the heritability values were estimated for grain yield (0.50, 0.64), MLB (0.84, 0.52), plant height (0.62, 0.79), ear height (0.63, 0.47), ear length (0.58, 0.55), kernel rows cob^{-1} (0.63, 0.62), pollen shedding (0.83, 0.83) and silking (0.72, 0.82). The increased performance of the progenies of selected S_1 lines manifests the efficiency of breeding program and suggests that S_1 line recurrent selection would be the most efficient method for improving MLB resistance and grain yield simultaneously in maize population Azam.

Key words: *Bipolaris maydis, recurrent selection, observed response, heritability, Corn*

1. Introduction

Maize (*Zea mays* L.) is extensively grown in temperate, subtropical and tropical regions of the world. Its range of adaptation stretches from 50° N to 40° S latitude and can be grown at an altitude from sea level to 3300 meters above sea level (Shah *et al*., 2006). In Pakistan, during 2006-07, it was cultivated on 1016.9 thousand hectares with a total production of 3188.4 thousand tons and productivity of 3037 kg ha^{-1}. In NWFP maize was grown on 516.1 thousand hectares with total production of 918.6 thousand tons and productivity of 1780 kg ha^{-1} (MINFAL, 2007).

Despite its high yield potential, one of the major limiting factors to maize grain yield is its sensitivity to several diseases. Southern corn leaf blight (SCLB) or maydis leaf blight (MLB) caused by *Bipolaris maydis* (*Drechslera maydis*; telomorph: *Cochliobolus heterostrophus*) occurs widely on maize (Bekele and Sumner, 1983). *Bipolaris maydis* is a member of the ascomycetes, the sac fungi which produces a toxin that attacks the mitochondria and destroys the plants ability to capture energy from metabolism. Three races of *H. maydis* have been described (Carson, 1998; Wei *et al.,* 1988). Race 'O' is considered the most common and indigenous throughout most areas where SCLB occurs. This infects the leaves only, forms small (0.6 x 2.5 cm), tan and parallel-side lesions with buff or brown borders. On the other hand, race T, the cause of the 1970 SCLB epidemic in North America, is specifically virulent on Texas male sterile cytoplasm (cmsT) maize due to its ability to produce a polypeptide toxin (T toxin) to which cmsT maize is

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sensitive (Carson, 1998; Levings and Siedow, 1992). It attacks all above ground parts of maize plant. The lesions in this case are spindle shaped and surrounded by green or chlorotic halos (Agrios, 1997; Rahman *et al.*, 2005). Race C of *H. maydis*, specifically virulent on C male sterile cytoplasm (cmsC) maize, has been reported from China, but is not known to occur elsewhere (Gao *et al.*, 2005; Wei *et al.*, 1988). MLB is also prevalent in the maize growing regions of NWFP and accounts for about 20% or sometime even more yield losses to the crop in Pakistan (Hafiz, 1986).

Keeping in view the importance of maydis leaf blight disease, an experiment was conducted in field under epiphytotic conditions for screening and evaluation of S_1 lines against maydis leaf blight. The objectives of the study were to quantify the progress for maydis leaf blight resistance improvement by estimating expected and observed responses to selection after two cycles of S_1 line recurrent selection, and to estimate heritability for various morphological and yield traits in Azam maize composite population.

2. Materials and methods

2.1. Experimental material's development

The field experiment was conducted at Agricultural Research Farm of NWFP Agricultural University Peshawar during summer 2006 and 2007 (July-October). For S_1 lines production, Azam maize population was grown over an area of 600 m^2 in spring (February-June) 2006 and 2007. Plant spacing between rows was 0.75 m, while 0.25 m was within the row. Two seeds $hill^{-1}$ were planted, which were later thinned to maintain one plant $hill^{-1}$, when the plants were 10-15 cm tall. Standard cultural practices were applied to get healthy and vigorous plants for selfing. At maturity the selfed ears were individually harvested, shelled and numbered separately. Half of the seed of each S_1 line was planted in replicated trial for evaluation in summer season (2006), while the other half was kept as a remnant for recombination phase. Square lattice design was used in the field for S_1 lines evaluation. The recombined seed were used as a base population for next cycle. The S_1 lines production and planting methodology in the next cycle was the same as discussed earlier.

2.2. Inoculation procedure

The S_1 lines were planted in replicated trial along with local checks. All the lines were inoculated with spores of *H. maydis* along with their respective checks, at four to six leaves stage. The inoculum was prepared by grinding leaves infected with maydis leaf blight collected from previous crop (Shah *et al*. 2006; Gao *et al*. 2005; Lambert and White, 1997; Sumner and Littrell, 1973).

2.3. Data Recording

2.3.1 Disease ratings

Whole plots were visually rated four times in both the cycles for percent MLB severity beginning at two weeks post anthesis with one week interval (Shah *et al*., 2006; Carson *et al*,, 2004; Carson, 1998). For recording disease data a scale of 0-5 was used following the CIMMYT procedure, i.e. 0 for no lesion and 5 for heavily blighted leaves. Rating of 0.0-1.4 were considered resistant, 1.5-2.4 moderately resistant and 2.5-5.0 susceptible (CIMMYT, 1985), As the disease reaction was rather uncertain to fall exactly in each of the mentioned classes, an arbitrary gradation of 10 classes scale i.e. 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5 and 5.0 was used to measure the disease severity more accurately (Shah *et al*. 2006).

2.3.2 Grain yield (kg ha^{-1})

After physiological maturity (black layer formation at hilum), ears from each entry were harvested to obtain yield data. Grain yield (kg ha^{-1}) was obtained using the following formula relationship (Carangal *et al., 1971).*

$$\text{Grain yield (kg ha}^{-1}\text{)} = \frac{\text{F.wt.} \times (100\text{-MC}) \times 0.80 \times 10{,}000\text{m}^2}{(100\text{-}15) \times 3.37\ \text{m}^2}$$

2.3.3 Plant height (cm)

Height of each plant was measured with the help of a measuring rod as the distance from ground level to the auricle of the flag leaf (Guzman and Lamkey, 2000) on 10 randomly selected plants was then converted to per plot by taking their averages.

2.3.4 Ear height (cm)

It was measured as the distance from soil to the node bearing primary ear (uppermost) as mentioned by Guzman and Lamkey (2000) on randomly selected plants.

2.3.5 Ear length (cm)

Length of the above randomly chosen ears from each plot was measured with measuring tap and recorded as average ear length (John, 1991).

2.3.6 Number of kernel rows ear^{-1}

Grain rows of randomly selected ears mentioned above were counted and recorded as number of kernel rows ear^{-1} for each plot.

2.3.7 Days to 50% pollen shedding

In each plot the number of days from planting to 50% pollen shedding was recorded when pollen shedding started after dehiscence of anthers on central branch of the tassel on 50 % plants in a plot (Khan, 1986 and Ihsan *et al*., 2005).

2.3.7 Days to 50% silk emergence

Silking date was recorded when the first day silks became visible on the topmost ear of at least 50% of plants in a plot (Tollenaar *et al*., 2004 and Lee *et al*., 2005). The number of days from planting to 50% silk emergence was then recorded as days to 50 % silk emergence (Hinze and Lamkey, 2003 and Khan *et al*., 2004).

2.4 Statistical analysis

Analysis of variance was conducting according to Steel and Torrie (1984). Microsoft Excel program was used for calculation of expected and observed responses, and graphs. Estimates of genotypic and phenotypic variance components were calculated from ANOVA to estimate heritability on an entry mean basis (Carson *et al.*, 2004; Penny and Eberhart, 1971).

3.Results and discussion

3.1. Grain yield (kg ha^{-1})

Grain yield exhibited highly significant differences ($P<0.01$) among S_1 lines in both the cycles (Table 2). It was found that mean grain yield in cycle-3 (3629 kg ha^{-1}) was comparatively less than that of cycle-4 (4105 kg ha^{-1}). Likewise the average grain yield of the selected S_1 lines of cycle-3 was 4491 kg ha^{-1} while in cycle-4 it was 5223 kg ha^{-1}. Whereas the grain yield obtained from the progenies of the selected S_1 lines in both the cycles was 5773 and 6867 kg ha^{-1} respectively (Table 1). With the expected responses in cycle-3 (432 kg ha^{-1}) and cycle-4 (715 kg ha^{-1}), prediction were made which were confirmed from the resultant observed responses 2144 and 2762 kg ha^{-1} (Table 20) in both the cycles respectively. Our results are in agreement with those of De Leon *et al.* (1993) who also reported highly significant increase in grain yield i.e. 507 kg cycle^{-1}. Similarly Vales *et al.* (2001) also reported significant increase in grain yield due to selection. Heritability for the said trait in cycle-3 and cycle-4 were 0.50 and 0.64, respectively (Table 2). The heritability values for grain yield were normally low because of the large number of genes involved and the high level of environmental interaction (Welsh, 1981). The increased performance of the progenies of the selected S_1 lines manifests both the efficiency of breeding program and the heterosis after recombination of the selected S_1 lines.

Table 1. Mean values for population (μ), Selected S_1 lines (μS), Progenies (μP) and Check for different traits in two cycles of S_1 line recurrent selection.

Traits	**Cycle-3**				**Cycle-4**			
	μ	**μS**	**μP**	**check**	**μ**	**μS**	**μP**	**check**
Yield (kg ha^{-1})	3629	4491	5773	5117	4105	5223	6867	6603
Maydis leaf blight	1.15	0.5	0.5	0.625	0.63	0.60	0.5	1.5
Plant height (cm)	131	134	159	151	129	130	170	183
Ear height (cm)	57	56	67	78	60	61	83	98
Ear length (cm)	11	13	17	14	13	15	17	18
Kernel rows ear^{-1}	14	14	16	13	13	14	14	14
Days to pollen shedding	52	52	47	48	54	53	52	52
Days to silking	52	52	48	48	55	53	54	54

2.3. Maydis leaf blight

Maydis leaf blight (MLB) caused by *Bipolaris maydis* occurs widely on maize (Bekele and Sumner 1983). Recurrent mass and S_1 family selection for quantitative disease resistance in corn (*Zea mays* L.) have been highly effective. Statistical analysis exhibited highly significant variations ($P<0.01$) for maydis leaf blight (MLB) among S_1 lines in both the cycles (Table 2). The mean value for MLB in cycle-3 was 1.15 while in cycle-4 it was 0.63 (Disease

scale 0.0-5.0). The lower disease score in cycle-4 as compared with cycle-3 reflects the genetic improvement of the population against maydis leaf blight disease as well as efficacy of the recurrent selection method. These results are supported by those reported by Ceballos *et al,* (1991) and De leon *et al.* (1993), who also observed reduction in maydis leaf blight severity in advanced cycles of recurrent selection in maize populations. The average rate of MLB in the selected lines of cycle-3 was 0.5 while in cycle-4 it was 0.60. On the other hand MLB observed in the progenies of both the cycles was 0.5 (Table 1). In cycle-3 the expected response for MLB was -0.53, while the observed response was -0.65. Likewise in cycle-4 the expected response for MLB was -0.01 while the observed response was -0.13. In both cycles the responses were in desired direction. These results are also supported by those of Jinhyon and Russell (1969) who reported reduction in mean disease score for stalk rot from 3.7 to 1.7 with three cycles of S_1 line recurrent selection. Heritability for the said trait in cycle-3 and cycle-4 were 0.84 and 0.52 respectively (Table 2). The high heritability and negative value of expected responses in both cycles also predicted reduction in disease severity. The observed responses for MLB in progenies of selected S_1 lines of both the cycles were also reduced, thereby exhibiting the efficiency of selection. Disease progress for population, selected S_1 lines, progenies of selected S_1 lines and check in both the cycles, cycle-3 and cycle-4, are graphically presented in Figure.1 and 2 respectively, showing increasing infestation of MLB severity.

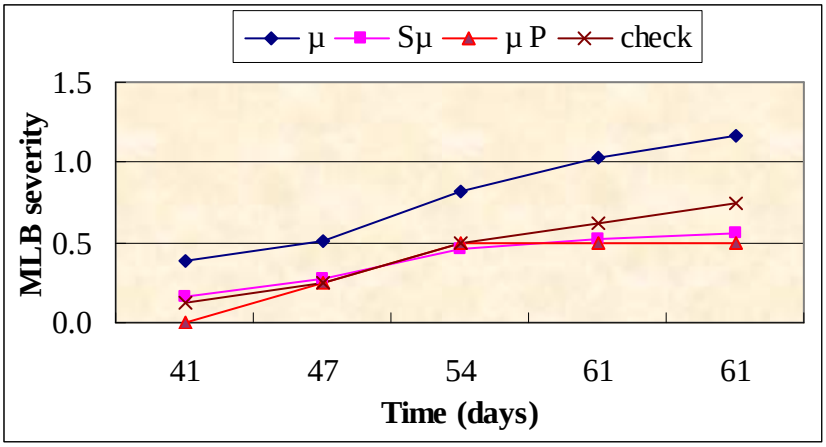

Figure 1. Response of population mean (μ), selected $S_{1's}$ mean (Sμ), progenies mean (μP) and check to MLB severity in cycle-3.

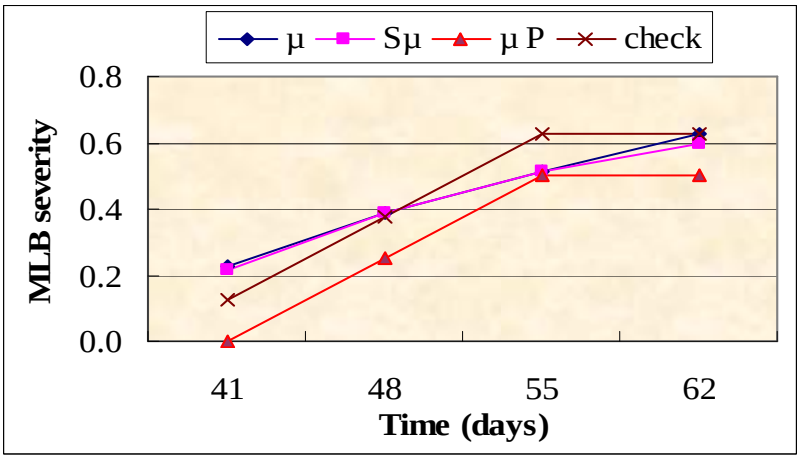

Figure 2. Response of population mean (μ), selected $S_{1's}$ mean (Sμ), progenies mean (μP) and check to MLB severity in cycle-4.

2.4. Morphological characteristics

Data showed highly significant variations ($P<0.01$) for plant and ear height among the S_1 lines in both the cycles (Table 2). Abedon and Tracy (1998) reported significant differences for plant and ear height while using full sib recurrent selection in maize. The average plant height of the population in cycle-3 was 131 cm while in cycle-4 it was 129 (Table 1). Mean plant height attained by the selected S_1 lines in cycle-3 was 134 cm while in cycle-4 it was 130 cm. In both the cycles the progenies attained plant height of 159 cm and 170 cm, respectively in cycle-3 and cycle-4 (Table

1). In cycle-3, the expected response for plant height was 1.65 while the observed response was 28. In cycle-4 the expected response for plant height was 1.15 while the observed response was 41 (Table 2). It was found that the observed responses in both the cycles were far greater than the expected responses for plant height which are in close conformity with those reported earlier by Devey and Russell (1983) who also observed significant increase in plant height after conducting seven cycles of S_1 recurrent selection in maize. Heritability for the said trait in cycle-3 and cycle-4 were 0.62 and 0.79 respectively, (Table 2). Mihaljevic *et al.* (2005) obtained high heritability values (0.90) for plant height. The greater the heritability of a particular trait, the lesser will be the environmental effect.

As for as the ear height of population is concerned, in cycle-3 it was 57 cm while in cycle-4 it was 60 cm. Mean ear height observed in the selected S_1 lines in cycle-3 was 56 cm while in cycle-4 it was 61 cm. In both the cycles the progenies attained the ear height of 67 cm and 83 cm respectively (Table 1). The expected response for ear height was -0.43 while the observed response was 10 in cycle-3 whereas in cycle-4 the expected response for ear height was 0.44 while the observed response was 23. Heritability for ear height in cycle-3 and cycle-4 estimated were 0.63 and 0.47, respectively (Table 2). The observed responses in both the cycles for plant (28 cm, 41 cm) and ear height (10 cm, 23 cm) in the progenies of the selected S_1 lines were increased significantly after two cycles of S_1 line recurrent selection. However, Weyhrich *et al.* (1998) reported significant decrease (6.52 cm) in ear height using S_1 recurrent selection. The increased in plant and ear height in the progenies could be attributed to the expression of heterosis after recombining the selected S_1 lines.

2.5. Ear characteristics

Data concerning ear length and kernel rows ear^{-1} showed highly significant differences ($P<0.01$) for ear length and kernel rows ear^{-1} among the S_1 lines in both the cycles (Table 2). The mean ear length recorded for population in cycle-3 was 11 cm while in cycle-4 it was 13 cm. Ear length observed in the selected S_1 lines in cycle-3 was 13 cm while in cycle-4 it was 15 cm. For the progenies in both the cycles ear length recorded was 17 cm (Table 1). In cycle-3 the expected response for ear length was 0.78 while the observed response was 5 whereas in cycle-4, the expected and observed responses for ear length were 1.17 and 3, respectively. Heritability for the said trait in cycle-3 and cycle-4 were 0.58 and 0.55, respectively (Table 2).

Average kernel rows ear^{-1} in cycle-3 was 14 while in cycle-4 it was 13. In the selected S_1 lines of both the cycles the kernel rows ear^{-1} were 14. Similarly in the progenies of both the cycles, kernel rows ear^{-1} were 16 and 14, respectively (Table 1). The expected response for kernel rows ear^{-1} was -0.29 while the observed response of 2 in cycle-3 while in cycle-4 the expected and observed responses for kernel rows ear^{-1} were 0.07 and1, respectively. Heritability for the said trait in cycle-3 and cycle-4 were 0.63 and 0.62, respectively (Table 2). Theoretically, a greater number of rows ear^{-1} should result in higher yield. However, short rows in a short ear may not contribute to the total yield as much as long rows in a long ear, (Rahman *et al*., 2005). As an increase of (0.78 and 1.17 cm) and (-0.29 and 0.07 kernel rows ear^{-1}) was predicted from the expected responses in both the cycles for ear length and kernel rows ear^{-1}, respectively, hence the observed responses in both the cycles for ear length (5 and 3 cm), and kernel rows ear^{-1} (2 and 1) confirmed improvement in both the traits after two cycles of S_1 line recurrent selection.

Table 2. Mean squares (MS), selection differential (S), expected (R_e) and observed (R_o) response and Heritability for different traits in two cycles of recurrent selection in maize composite population Azam, evaluated in 2006 and 2007.

Traits	**Cycle-3**					**Cycle-4**				
	MS	**S**	**R_e**	**R_o**	**h^2_{BS}**	**MS**	**S**	**R_e**	**R_o**	**h^2_{BS}**
Grain yield (kg ha^{-1})	1911093.8**	862	432	2144	0.50	1501733.1**	1119	715	2762	0.64
Maydis leaf blight	0.572**	-0.64	-0.53	-0.65	0.84	0.083**	-0.03	-0.01	-0.13	0.52
lant height (cm)	534.62**	2.66	1.65	28	0.62	534.62**	1.46	1.15	41	0.79
Ear height (cm)	314.64**	-0.68	-0.43	10	0.63	89.969**	0.92	0.44	23	0.47
Ear length (cm)	5.328**	1.35	0.78	5	0.58	4.028**	2.13	1.17	3	0.55
Kernel rows ear^{-1}	3.931**	-0.46	-0.29	2	0.63	4.266**	0.12	0.07	1	0.62
Days to pollen shedding	7.908**	-0.25	-0.21	-5	0.83	7.329**	-1.48	-1.23	-2	0.83
Days to Silking	10.719**	-0.12	-0.09	-4	0.72	8.325**	-1.68	-1.39	-1	0.82

** = Significant at 1% level of probability

2.6.Maturity characteristics

Data concerning days to pollen shedding and silking revealed highly significant variations ($P<0.01$) among S_1 lines in both the cycles (Table 2). Abedon and Tracy (1998) also observed significant differences for maturity traits using S_1 line recurrent selection. The selected S_1 lines of both the cycles took 52 and 53 days, respectively to start pollen shedding. Similarly in the progenies of both cycles days to pollen shedding were 47 and 52, respectively (Table

1). In cycle-3 the expected response for days to pollen shedding was -0.21 while the observed response was 5. In cycle-4 the expected response for days to pollen shedding was -1.23 while the observed response was -2. Similar estimates of heritability (0.83) for days to pollen shedding were observed in both the cycles indicating that this trait was less influenced by the environment.

The mean values recorded for days to silking in cycle-3 and cucle-4 were 52 and 55, respectively. Selected S_1 lines in both the cycles, cycle-3 and cycle-4, took 52 and 53 days, respectively for days to silking. In case of progenies cycle-3 and cycle-4 completed silking in 48 and 54 days, respectively (Table 1). In cycle-3 the expected response for days to silking was -0.09 while the observed response was -4. In cycle-4 the expected response for days to silking was -1.39 while the observed response was -1. Heritability estimates observed for days to silking in cycle-3 and cycle-4 were 0.72 and 0.82, respectively (Table 2). High heritability (0.85) for the same trait in testcross of BSK(HI)C8 was recorded by Mulamba *et al*. (1983). Based upon negative magnitudes of expected responses, decrease in days was expected for maturity traits in progenies of selected S_1 lines in the both cycles. As per expectation, decrease in days was observed for days to pollen shedding and silking in the progenies of the selected S_1 lines of cycle-3 and cycle-4. Using recurrent selection for resistance to *Exserohilum turcicum* in eight subtropical maize populations, Ceballos *et al*. (1991) reported a significant decrease in maturity traits.

3. Conclusions

These results suggest that S_1 line recurrent selection would be the most efficient method for improving MLB resistance and grain yield simultaneously in maize population Azam.

References

Abedon, B.G., and W.F. Tracy. 1998. Direct and indirect effects of full-sib recurrent selection for resistance to common rust (*Puccinia sorghi* schw.) in three sweet corn populations. Crop Sci. 38: 56-61.

Agrios, G.N. 1997. Plant pathology. 4th Edition. Academic press, San Diego and London.

Bekele, E., and D.R. Sumner. 1983. Epidemiology of southern corn leaf blight in continuous corn culture. Plant Disease 67: 738-742.

Carangal, V.R., S.M. Ali, A.F. Koble, E.H. Rinke and J.C. Sentz. 1971. Comparison of S_1 with testcross evaluation for recurrent selection in maize. Crop Sci. 11:658-661.

Carson, M.L. 1998. Aggressiveness and presentation of isolates of *Cochliobolus herterostrophus* from North Carolina. Plant Disease. 9(82): 1043-1047.

Carson, M.L., C.W. Stuber, and M.L. Senior. 2004. Identification and mapping of quantitative trait loci conditioning resistance to southern leaf blight of maize caused by *Cochliobolus herterostrophus* race O. Phytopathol. 94: 862-867.

Ceballos, H., J.A. Deutsch, and H. Gutierrez. 1991. Recurrent selection for resistance to *E. turcicum* in eight sub-tropical maize populations. Crop Sci. 31: 964-971.

CIMMYT. 1985. Managing trials and reporting data for CIMMYT's International Maize Testing Program. CIMMYT, El Batan, Mexico.

De Leon, G. Granados, R.N. Wedderburn, and S. Pandey. 1993. Simultaneous improvement of downy mildew resistance and agronomic traits in tropical maize. Crop Sci. 33: 100-102.

Devey, M.E., and W.A. Russell. 1983. Evaluation of recurrent selection for stalk quality in a maize cultivar and effects of other agronomic traits. Iowa State J. Res. 58:207-219.

Gao, Z.S., H.W. Cai, and G.H. Liang. 2005. Field assay of seedling and adult plant resistance to southern leaf blight in maize. Plant Breeding. 124: 356-360.

Guzman, P.S. and K.R. Lamkey. 2000. Effective population size and genetic variability in the BS11 maize population. Crop Sci. 40(2): 338-346.

Hafiz, A. 1986. Plant diseases. Pak. Agric. Res. Council, Islamabad. 52 pp.

Hinze, L.L. and K.R. Lamkey. 2003. Absence of epistasis for grain yield in elite maize hybrids. Crop Sci. 43:46-56.

Ihsan, H., I.H. Khalil, H. Rahman and M. Iqbal. 2005. Genotypic variability for morphological and reproductive traits among exotic maize hybrids. Sarhad J. Agri. 21 (4): 599-602.

Jinhyon, S., and W.A. Russel. 1969. Evaluation of recurrent selection for stalk rot resistance in an open pollinated variety of maize. Iowa Stat J. Sci. 43: 229-237.

John, H.P. 1991. Hybrid genetic complement and corn plant DK570. Dekalb Genetics Corporation, IL, USA.

Khan, K. 1986. Study of different varieties of maize under traditional and modified management practices in Swat, NWFP. M.Sc. (Hons) Thesis, Deptt. Pl. Br. & Gen. NWFP Agri. Uni. Peshawar.

Khan, K., F. Karim, M. Iqbal, H. Sher and B. Ahmad. 2004. Response of maize varieties to environments in two agro-ecological zones of NWFP: Effects on morphological traits. Sarhad J. Agri. 20 (3): 395-399.

Lambert, R.J., and D.G. White. 1997. Disease reaction changes from tandom selection for multiple disease resistance in two maize synthetics. Crop Sci. 37: 66-69.

Lee, E.A., a. Ahmadzadeh and M. Tollenaar. 2005. Quantitative genetic analysis of the physiological processes underlying maize grain yield. Crop Sci. 45(3):981-987.

Levings, C.S., and J.N. Siedow. 1992. Molecular basis of disease susceptibility in the Texas cytoplasm of maize. Plant Mol. Biol. 19: 135-147.

Mihaljevic, R.C., C.C. Schoon, H.F. Utz, and A.E. Melchinger. 2005. Correlation and QTL correspondence between line per se and testcross performance for agronomic traits in four populations of European maize. Crop Sci. 45: 114-112.

MINFAL. 2007. Agriculture Statistics of Pakistan. Ministry of Food, Agric. and Livestock, Econ. Wing, Islamabad.

Mulamba, N.N., A.R. Hallaeur, and O.S. Smith. 1983. Recurrent selection for grain yield in a maize population. Crop Sci. 23: 536-540.

Penny, L.H., and S.A. Eberhart. 1971. Twenty years of reciprocal recurrent selection with two synthetic varieties of maize (*Zea mays* L.). Crop Sci. 11: 900-903.

Rahman, H., F. Raziq, and S. Ahmad. 2005. Screening and evaluation of maize genotypes for southern leaf blight resistance and yield performance. Sarhad J. Agric. 2(21): 231-235.

Shah, S.S., H. Rahman, I.H. Khalil, and A. Rafi. 2006. Reaction of two maize synthetics to maydis leaf blight following recurrent selection for grain yield. Sarhad J. Agric. 2(22): 263-269.

Steel, R.G.D., and J.H. Torrie. 1984. Principles and Procedures of Statistics: A Biometrical Approach, 2nd Ed., McGraw Hill Book Co., New York.

Sumner, D. R., and R. H. Littrell. 1973. Influence of tillage, planting date, inoculum survival, and mixed populations on epidemiology of southern corn leaf blight. Phytopathol. 64: 168-173.

Tollenaar, M., A. Ahmadzadeh and E.A. Lee. 2004. Physiological basis of heterosis for grain yield in maize. Crop Sci. 44:2086-2094.

Vales, M.I., R.A. Valar, P. Revilla, and A. Ordas. 2001. Recurrent selection for grain yield in two Spanish maize synthetic populations. Crop Sci. 41: 15-19.

Wei, J.K., K.M. Lui, J.P. Luo, Y.O. Lee, and Standelman. 1988. Pathological and physiological identification of race 'C' of *Bipolaris maydis* in China. Phytopathol. 75: 550-554.

Welsh. J. R. 1981. Fundamentals of plant breeding. John Wiley and Sons. Inc. pp 134-135.

Weyhrich, R.A., K.R. Lamkey, and A. R. Hallauer. 1998. Effective Population Size and Response to S_1-Progeny Selection in the BS11 Maize Population. Crop Sci. 38:1149–1158.

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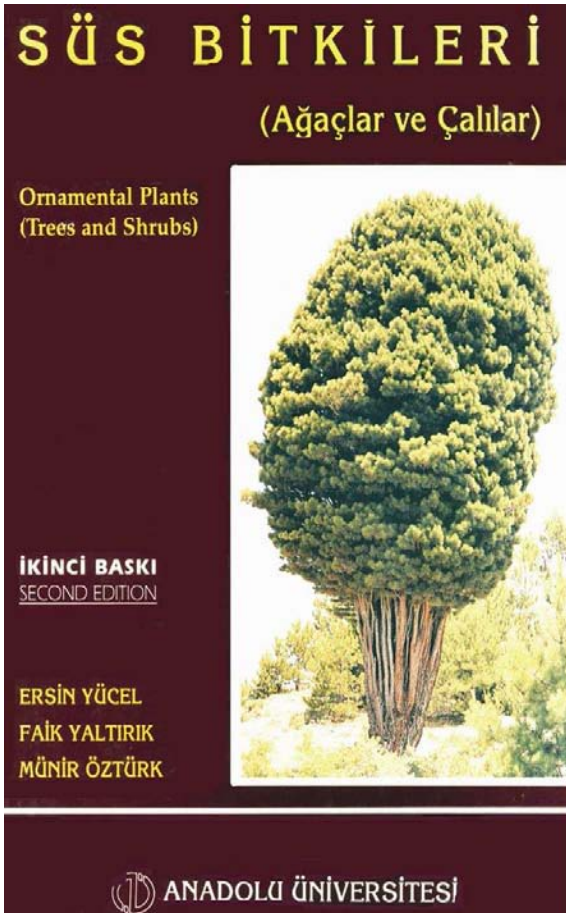
DOĞAL YAYILIŞI VE
EKOLOJİK ÖZELLİKLERİ
ERSİN YÜCEL
ANADOLU ÜNİVERSİTESİ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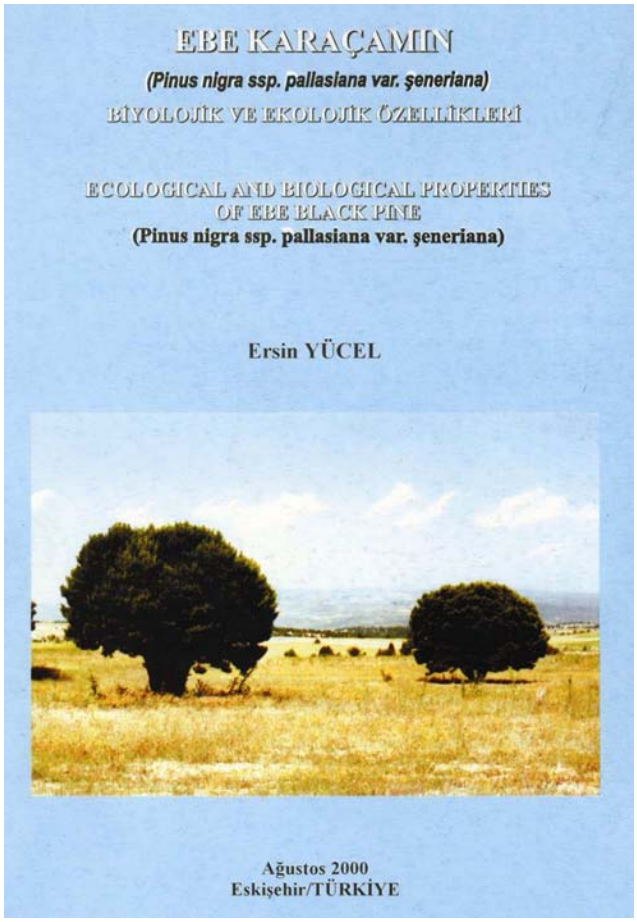
EBE KARAÇAMIN
(Pinus nigra ssp. pallasiana var. şeneriana)
BİYOLOJİK VE EKOLOJİK ÖZELLİKLERİ
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Ersin YÜCEL
Ağustos 2000
Eskişehir/TÜRKİYE


ÇİÇEKLER
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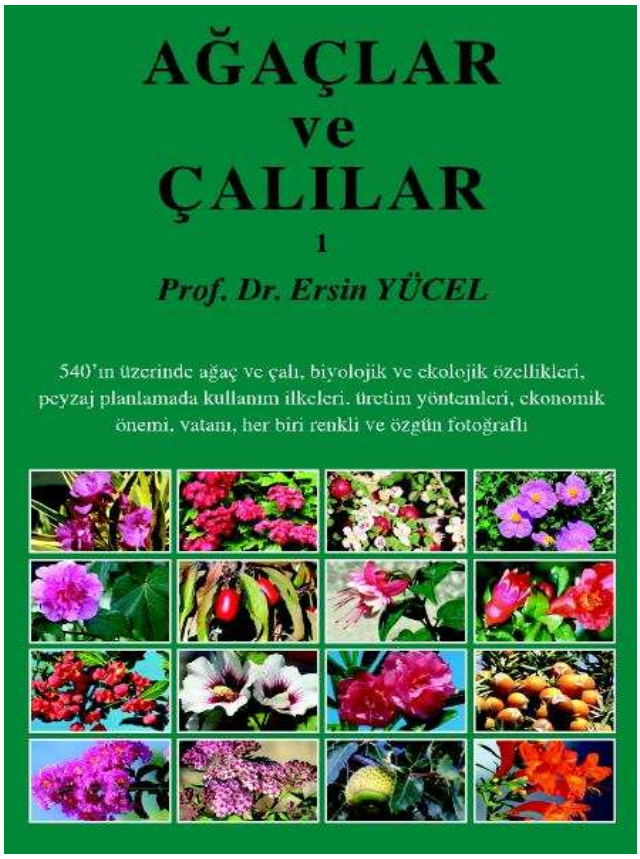

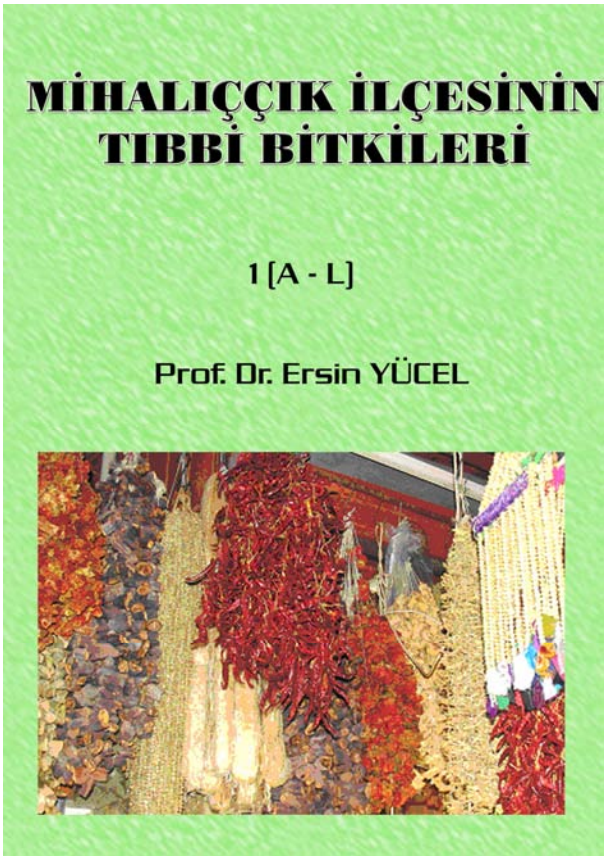

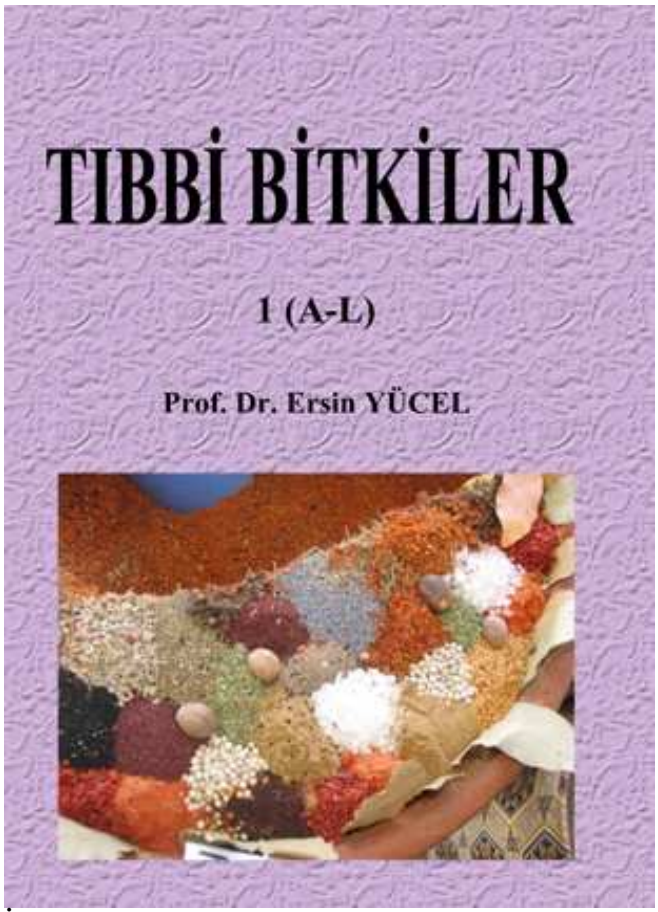

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