



## Serpentine Flora of Turkey

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### Abstract

This study was carried out to illustrate the importance of the edaphic and geological isolation for the floristic diversity and endemism. Some of the most important reasons for the floristic diversity of Turkey are the edaphic, geological and geomorphological diversity and different topographical structures. The fact that there is an extensive endemism on the land developed from the gypsum and serpentine rocks with extreme conditions is explained by the "geological isolation" and these regions are called "geologic island" or "edaphic island".

Turkey is very rich as regards to ophiolitic rock and endemism. Except for the eastern and south eastern part of the country the ultramaphic rocks are present all over Turkey. They are frequently observed in Kütahya, Balıkesir, Antalya, Muğla, Hatay and Adana regions in Amanos Mountains, in Eastern Taurus, north and northeast of Mersin and between Niğde and Adana, in Aladağ massive and thousands of kilometer square land from Adana to Erzincan. Also they are locally present between Ankara and Çanakkale regions.

In this study there were 223 taxa determined grow upon the ultramaphic serpentine rocks based on the species published in Flora of Turkey volumes I-XI and other sources and the observation made in the fields. Among these 223 taxa which prefer on the serpentine rocks 142 of them are endemic and 8 taxa are rare on the national and international scales. The distribution of the taxa according to families were found to be as follows; Asteraceae, 36 taxa; Lamiaceae, 21 taxa; Brassicaceae, 20 taxa; Liliaceae, 17 taxa; Caryophyllaceae, 16 taxa; Scrophulariaceae, 15 taxa; Poaceae, 13 taxa; Apiaceae, 11 taxa; Plumbaginaceae, 9 taxa; Fabaceae, 8 taxa; Boraginaceae, 7 taxa; Rubiaceae, 7 taxa; Crassulaceae, 6 taxa; Convolvulaceae, 6 taxa; Euphorbiaceae, 6 taxa and others 25 taxa. IUCN threatened categories of the endemic and rare taxa grown on serpentine rocks are 1 taxon EX; 20 taxa CR; 29 taxa EN; 27 taxa VU; 27 taxa LR(cd); 8 taxa LR(nt); 14 taxa LR(lc); 7 taxa DD. When we take the distribution of the serpentine rock in the country we see that the endemism is particularly located alongside the Anatolian Diagonal. One of the reasons for this endemism is found to be the geological isolation and most of the newly found taxa are distributed on the serpentine rocks and this shows the necessity of the further floristic studies of the region.

As a result of the investigation of the 223 taxa which were found to adapt to serpentine extreme conditions 97 of them were regarded as the *serpentinophyt* (which lives only on serpentine i.e an obligate) and remaining 126 of them were found to be *serpentinovag* (is capable to grow both on the serpentine and other edaphic condition i.e facultative). In order to verify these results it is necessary to investigate the genetic solutions, adaptation ways and life strategies of these taxa to these extreme conditions.

**Key words:** Flora, Endemism, Serpentine, Serpentinophyt, Serpentinovag, Turkey

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### Türkiye serpantin florası

### Özet

Bu çalışma, edafik ve jeolojik izolasyonun floristik çeşitlilik ve endemizm açısından öneminin ortaya konulması amacıyla gerçekleştirilmiştir. Türkiye'nin floristik çeşitliliğinin önemli nedenlerinden birkaçı edafik, jeolojik

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ve jeomorfolojik çeşitlilik ve farklı topoğrafik yapılarıdır. Ekstrem ekolojik şartlar içeren Jips, Serpantin gibi kayaçlardan gelişen topraklarda endemizmin yoğun olması “jeolojik izolasyon” ile açıklanmakta, bu bölgeler “jeolojik ada” ya da “edafik ada” olarak adlandırılmaktadır.

Türkiye’de ofiolitik kayaçlar endemizm bakımından oldukça zengindir. Ultramafik kayaçlar yurdumuzun doğu ve güneydoğu illeri hariç bir çok yerinde yayılmaktadır. Kütahya ve Balıkesir çevrelerinde, Antalya ve Muğla civarında, Hatay ve Adana civarında Amanos dağlarında, Doğu Toroslarda Mersin’in kuzeyi ve kuzeydoğusunda, Niğde ve Adana arasında Aladağ masifi içinde, Adana’dan-Erzincan’a kadar yüzlerce kilometrelik hat boyunca uzanır. Ayrıca Ankara ve Çanakkale çevrelerinde de lokal de olsa rastlanmaktadır.

Bu çalışmada Türkiye Florası I-XI ciltler ve daha sonra yayımlanan türler ve arazi gözlemlerine dayalı olarak yurdumuzda önemli bir yayılışa sahip ultramafik kayaçlardan serpantin üzerinde uzmanlaşan 223 takson tespit edilmiştir.

Serpantin kayaçlar üzerinde uzmanlaştığı tespit edilen 223 taksondan 142’si endemik, 8 takson ise ulusal ya da küresel ölçekte nadir taksonlardır. Taksonların familyalara göre dağılımı; Asteraceae, 36; Lamiaceae, 21; Brassicaceae, 20; Liliaceae, 17; Caryophyllaceae, 16; Scrophulariaceae, 15; Poaceae, 13; Apiaceae, 11; Plumbaginaceae, 9; Fabaceae, 8; Boraginaceae, 7; Rubiaceae, 7; Crassulaceae, 6; Convolvulaceae, 6; Euphorbiaceae, 6; diğerleri, 25 olarak saptanmıştır. Serpantin üzerinde gelişen endemik ve nadir taksonların bilinen IUCN tehlike kategorileri, 1 takson EX; 20 takson CR; 29 takson EN; 27 takson VU; 27 takson LR(cd); 8 takson LR(nt); 14 takson LR(lc); 7 takson DD’dir. Yurdumuzda serpantin kayaçların yayılış alanları dikkate alındığında özellikle “Anadolu Diyagonalı” üzerinde yoğunlaştığı, diyagonal üzerindeki endemizmin bir diğer nedeninin jeolojik izolasyon olduğu ortaya konulmuştur. Yeni tespit edilen taksonların büyük çoğunluğunun serpantin kayaçlar üzerinde yayılıyor olması, bu alanlarda detaylı floristik araştırmaların gereğini ortaya koymaktadır.

Serpantin sistemlere uyum sağladığı tespit edilen 223 taksonun yayılış alanları incelenmiş ve 97 taksonun Serpantinofit (zorunlu serpantin bitkisi=obligat) olarak adlandırılabilceği, geri kalan 126 taksonun ise serpantinovag (hem serpantin üzerinde hem de serpantin dışındaki farklı edafik koşullarda gelişebilen=fakültatif) olarak değerlendirilebileceği kanaatine varılmıştır. Bu taksonların habitata uyum için geliştirdikleri genetik çözümler ile yumsal açılımları ve yaşam stratejileri ile ilgili araştırmalarla bu sonuçlar kesinlik kazanabilecektir.

**Anahtar kelimeler:** Flora, Endemizm, Serpantin, Serpantinofit, Serpantiovag, Türkiye

## 1. Introduction

Turkey located between 36°- 42° northern longitudes and 26°-45° eastern latitudes is one of the floristically richest countries in the calmer belt with nearly 12,000 flowering plants (including the taxa related to sub species). The floristic diversity reflects phytogeographic, edaphic, climatic, habitat and topographic richness of the country.

The level of endemism is very high in Turkey which was the diversification center of many types and sections. This high endemism are mainly attributed to geological climatic and topographical heterogeneity. As a result of this, Anatolia is the gene center of many species in its close vicinity (Erik and Tarikahya, 2004).

Flora of Turkey first took the attention of the foreign scientists and so many scientists coming from various countries collected plants from Anatolia at various times . The collection and the herbariums where these collections are located established by these researches created an important data for the writing of ‘Flora of Turkey’. The first manifestation of these accumulated data was a five volume book written by E. Boissier entitled “Flora Orientalis” (Boissier, 1867-1888). The Flora of Turkey was published under the editorship of P.H. Davis with 9 volumes within a period of twenty years between 1965-1985. In order to add the new data found after the publication of the last volume the volume 10 was written by entirely Turkish scientists in 1988 and volume 11 was published as a supplement again by the group of Turkish workers (Güner et.al., 2000) (Erik and Tarikahya, 2004).

The major reasons for the biological diversity are the adaptation of the plants to the extreme edaphic conditions called the “*edaphic islands*“. The very intensive endemism on the soils developed from these rocks (gypsum, serpentine) was attributed to the “*geological endemism* “ and these regions are called “*geologic island* “ or “*edaphic island* “. Only could the plants which developed genetic solution to the extreme edaphic conditions be able to survive these lands (Reeves et.al 1999; Rajakaruna, 2004).

The ecological specivity in the use of habitat is very common in nature (Futuyma and Moreno 1988; Stevens 1989; Brown 1995; Gaston and Blackburn, 2000). The ecologic designs have played an important role in the loss or the appearance of the biological diversity throughout the revolution process. However the revolutionary origin of the adaptation to the habitat has not been fully clarified yet.

Serpentine rocks are known to be very rich regarding to endemism throughout the world (Brooks, 1987; Kruckeberg, 2002). For instance 1.5% of California is covered by serpentine rocks and only 176 (12%) of the 1410 plants living in California are serpentine endemic. If we think that only 669 taxa is related to serpentine, this number is quite high.

The ultramaphic (serpentine) rocks cover less than 1% of the world in patchwork manner. There are multi dimensional edaphic factors in the formation of serpentine rocks which includes physical, chemical and biotic elements (Brooks, 1987; Brady et.al., 2005).

The regions where the ophiolitic rocks are widely present have a very big importance for the endemism in Turkey. The ophiolitic rocks which are rich in minerals are classified as gabro-ultrabasic rocks. The serpentine rocks are formed by the change of peridotite and pyroxene as a result of hydration (Hoşgören, 2000). The soil with serpentine rocks (formed by the hydration of magnesium silicate) is difficult to dissociate and have a shallow and stony structure. Serpentine soils contain large amounts of Magnesium which is not suitable for the growth of plants. The serpentine soils are also rich in heavy metals such as Nickel, Chrome and Cobalt as well as Magnesium and Iron but poor in nutritious elements such as Calcium, Potassium and Phosphorous (Avcı, M., 2005).

These toxic elements in serpentine soils have a very negative effect upon the growth of plants. However some plants are observed to develop a good adaptation to it. The serpentine rocks are very rich as regards to endemic plants and this is called “geologic isolation”. The serpentine habitats are also called “geological islands”. Some of the plants with good genetic adaptation to extreme edaphic conditions are observed to have wide distribution on these lands (Kantarci, 1987; Kruckeberg et.al, 1999; Reeves et.al, 1999; Adigüzel and Reeves, 2002). Wallace, in his study entitled “*The Klamath Knot: Explorations of myth and evolution*” described the serpentine land as “although the look of the forests is not very good, the areas where these rocks are widely present are the refuge for their flora. The difficulty of physical and chemical endurance to the areas with ultramaphic rocks made the life adapt amazing changes (attributed to Wallace, 1983 by Rajakaruna 2004). (Avcı, M., 2005).

The most characteristic species of Mediterranean Region *Alyssum* is also known as Nickel hyperaccumulator. *Alyssum* has 48 taxa in Turkey and 27 of them are endemic to Turkey. *Silene cserei* Baumg. ssp. *aeoniopsis* (Bornm.) Chowdhuri, *Alyssum floribundum* Boiss. & Bal., *A. constellatum* Boiss., *A. murale* Waldst. & Kit., *A. dudleyi* N. Adigüzel & R. D. Reeves, *Thlaspi elegans* Boiss. and *Cochlearia sempervivum* Boiss. et. Bal. are some of the serpentine endemic plants which can accumulate very high amounts of Nickel in their structure. According to the studies carried out in the serpentine rich regions reveal that the amount of Nickel may reach up to 2% in plants such *Alyssum*, *Thlaspi* and *Cochlearia* (Kruckeberg et.al., 1999; Davis et.al., 2001; Reeves et.al., 2001; Avcı, M., 2005).

Low plant production, high endemism and the difference between the vegetation of the neighboring regions are the three main characteristics of the serpentine regions (Whittaker, 1954). The high heavy metal concentration (Chrome, Nickel, Cobalt and Manganese), low Ca/Mg ratio and lack of Nitrogen, Phosphorous and Potassium creates very unfavorable medium for the growth of other plants (Proctor and Woodell, 1975; Kruckeberg, 1984; Proctor, 1999; Robinson et. al., 1997). Serpentine soil is a ferromagnetic silicate and contains a high concentration of intakable Nickel and high amount of Chrome and Cobalt. Nickel has a very adverse effect upon the growth of the plants (Kruckeberg, 1984). The serpentine soils are usually dry is due to its low organic content and its weak physical structure (Brooks, 1987) and the plants which live on serpentine soils are adapted to the extremely unfavorable edaphic factors and very high concentration of heavy metals (Kruckeberg, 1984). The physical conditions of the serpentine soils are not suitable most of the plants and this results are very scarce but highly endemic vegetation in those areas (Baker et.al., 1992; Batianoff and Singh, 2001). The weak vegetation causes erosion and increases the temperature of the soil. In serpentine soil the levels of sand and clay are very low (Brady et. al., 2005). According to Kruckeberg (1954; 1984) the characteristic chemistry of serpentine soils has a deterministic effect on the appearance of serpentine endemism as with rich but small vegetation and low number of species. The plants which are grown on serpentine soils have to develop endurance against drought as well as the adverse chemical conditions (Proctor and Woodel, 1975; Brady et.al., 2005).

## 2. Materials and methods

The sample of the study is constituted by the Flora of Turkey and The East Aegean Islands vol. I-XI and new taxa reported after the publication of Flora of Turkey. The study is based upon the newly published taxa and site visit to Flora of Turkey. The taxa endemic to serpentine were determined by site surveys and observations. The taxa endemic or rare found are indicated. The distribution of the taxa growing on serpentine are given in tables and graphs according to families, phytogeographical regions and IUCN threatened categories. The taxa which take its epithet from serpentine were separately indicated. The taxa endemic to serpentine were separated into Serpentinophyt (obligate) and Serpentinovag (facultative) species according to the surveys. The area where the taxa are grown, its phytogeographical region, IUCN threatened category and whether they are serpentinophyt or serpentinovag are indicated.

## 3. Results

Ultramaphic rocks are widely present in many parts of the country except Eastern and South Eastern regions. They are located in Kütahya and Balıkesir, Antalya and Muğla, and Hatay and Adana regions, Amanos Mountains, eastern Taurus, North and South East of Mersin, between Niğde and Adana, in Aladağ massive and a hundreds of kilometers of line extending from Adana to Erzincan. They are also locally observed in Ankara and Çanakkale regions.

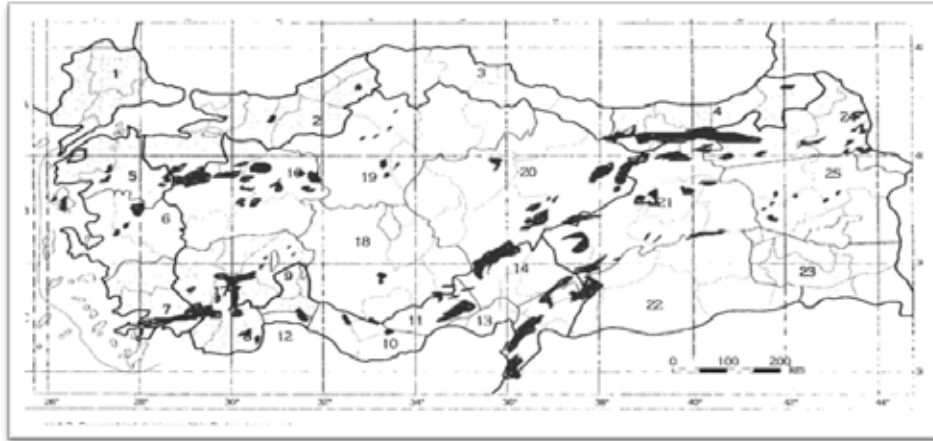


Figure 1. The distribution of the ultramaphic rocks in Turkey (R., D., Reeves, N., Adigüzel, 2004 changed version).

Serpentine habitats are among the most important centers of endemism. According to the published data about the flora of Turkey, check- lists (Özhatay N, Kültür fi & Aksoy N 1994; Ozhatay, N., Ş. Kültür & N. Aksoy 1999; Ozhatay, N. & Ş. Kültür 2006; Ozhatay, N. , Ş. Kültür & S. Aslan 2009; Ozhatay FN, Kültür Ş & Gürdal MB 2011), field surveys and habitat information of the newly found taxa, there are 223 taxa which were directly related to serpentine, adapted to it extreme conditions or in other words became specific to these habitats. Among these taxa 142 of them are endemic and 8 taxa are highly rare in national or global scale.

#### FILICALES

*Cheilanthes marantae* (L.) Domin

Rock crevices (often serpentine), 30-2700 m. Serpentinovag.

1. *Asplenium cuneifolium* Viv.  
A3: Sakarya: Hendek, Czecczot. B2 Kütahya: Murat Da. , 2000 m, D. 36821A! C2 Muğla: Sandras Da., 2200 m, On serpentine rocks, 2000-2200 m. Serpentinophyt.

#### BRASSICACEAE

2. *Isatis pinnatifida* Davis  
Limestone sea cliffs, rocky serpentine hills and macchie, 50-300 m. E. Medit. Element, Endemic, LR (cd), Serpentinovag.
3. *Biscutella didyma* L.  
Rocky slopes, often limestone or serpentine, from s.l.-400 m. Serpentinovag.
4. *Alyssum masmenaeum* Boiss.,  
Serpentine, with *Pinus nigra*, 1200-2200 m. Endemic, LR(lc). Serpentinovag.
5. *Alyssum discolor* Dudley & Hub.-Mor  
Serpentine, limestone and sandstone, s.l.-300 m, E. Medit. element, endemic, VU. Serpentinovag.
6. *Alyssum caricum* Dudley & Hub.-Mor.  
[Turkey C2 Muğla] Muğla to Fethiye, Kalkgeröll linkes Ufer des Namlam Çay, 42 km südöstlich Muğla, 100 m, 20 vi 1954, Huber-Morath 12824 (holo. Hb. Hub.-Mor. iso. A! E!) Caria. C2 Muğla: 8 miles S of Muğla, 600 m Serpentine scree and scrub, 40-300 m, E. Medit. Element, endemic, EN. Serpentinophyt.
7. *Alyssum lesbiacum* (Cand.) Rech  
[Lesbos] Maleae Olympiaeque, Candargy. Is. : Lesvos: Ajassos to Magali Limni, 200-300 m, Rech. 5507! Serpentine, 200-300 m, E. Medit. Element, endemic, DD. Serpentinophyt.
8. *Erysimum echinellum* Hand.-Mazz.  
[Turkey B7 Elazığ] zwischen Serpentinfelsen auf dem niedrigen Gipfel des Hasarbaba Dagh am Goldschik (Quellsee des Tigris), 2400-2450 m, 29 vii 1910. Handel-Mazzetti 2608. On serpentine

rock, Ir.-Tur. Element, endemic, EN. Serpentinophyt.

9. *Aethionema speciosum* Boiss. & Huet in Boiss.  
Turkey C2 Muğla: Sandras Dağ. W. of the summit, 1970 m, slightly sloping stony flat (snowbed) near a small creek close to timberline, serpentine, lat. 37°04'N, long. 28°50'E, 7 vii 1984, P. Hartvig, Ö. Seçmen & A. Strid 23339 (holo. C, iso. E! EGE, G). Stony flats (snowbeds) nr tree-line, on serpentine, 1970 m, E. Medit. Element, endemic. Serpentinophyt.
10. *Thlaspi carriense* A. Carlström.  
Turkey [C2] Muğla: 1 km E. of Marmaris. In pine forest on serpentine, 19 iv 1983, Carlström 9293 (holo. LD). Clearings in *Pinus brutia* forest on serpentine, to 100 m, E. Medit. element, endemic, EN. Serpentinophyt.
11. *Alyssum pogonocarpum* A. Carlström.  
[Islands] Rodhos: 5 km E.N.E. of Agios Isidores, c. 200 m, 3 v 1982, Carlström 5347b (holo. LD). Open places on serpentine, c. 200 m., E. Medit. element., endemic to Rodhos., DD. Serpentinophyt.
12. *Barbarea minor* var. *anfractuosa* Hartvig & Strid.  
Turkey C2 Muğla: Sandras Dağ, W. side of the summit area, 2100-2200 m, lat. 37° 04'N, long. 28° 50'E, 7 vii 1984, P. Hartvig, Ö. Seçmen & A. Strid 23347 (holo. C. iso. E! EGE, G). Snowbed meadows and rocky slopes on serpentine, 2100-2200 m, E. Medit. Element, endemic variety, EN. Serpentinophyt.
13. *Erysimum vuralii* Yıld.  
Turkey, C2 Muğla: Koyceğiz, Hamitkoy-Ekincik arası, Paratype: Turkey, C2 Muğla: Koyceğiz, Hamitkoy, Domuzdireği tepesi, 17.iii.1991, A. Güner 8198, H. Duman & H. Şağban (HUB, Hb. Yıldırımılı); *ibid.*, 15.iv.1991, A. Güner 8652, M. Vural, H. Duman, A. A. Dönmez & B. Mutlu (GAZI); Fethiye, Dalaman, between kısıc dere and Dalaman çayı. Kızılcam ormanı, başkalaşımli taşlı yerler, 75 m, yangın alanı, 20-50 m, serpentine rocks, 100 m, endemic, new takson for science, CR. Serpentinophyt.

14. *Erysimum serpenticum* Polatschek.  
Turkey, C1 Muğla: 28 km W Marmaris, 150 m, vulkanisches Gestein. endemic, new takson for science, CR. Serpentinophyt.
15. *Hesperis anatolica* A. Duran.  
Turkey, C5 Adana: Pozanti, betw. Hamidiye and Karakuz (Camlibel), 4 km, serpentine pebbly slopes, open Pinus forest, scrub, 1400 m, 37°32.30'N, 34°00.38'E, serpentine pebbly slopes, open Pinus forest, scrub, 1400 m, endemic, new takson for science, CR. Serpentinophyt.
16. *Thlaspi leblebicii* Gemici & Görk.  
[Turkey C2 Muğla] Köyceğiz, summit of Sandras Dağı, rocky peridotite slopes, 2000-2100 m, 7 vi 1992, Y. Gemici 6656 & al. (holo. EGE!). Rocky peridotite (serpentine) slopes, 2000-2100 m, E. Medit. (mt.) element, endemic, EN. Serpentinophyt.
17. *Alyssum mughlaei* Orcan.  
(Turkey) C2 Muğla: Marmaris-Muğla, 10 km to Marmaris, 52 km to Muğla roadside, serpentine, 100 m, endemic, new takson for science, CR. Serpentinophyt.
18. *Hesperis kuerschneri* Parolly et Kit Tan.  
(Turkey) C2 Denizli: Fethiye-Çameli, N Fethiye, unterhalb des (below) Tuzla Beli 300 m, Serpentinhang (serpentine slope), endemic, new takson for science, CR. Serpentinophyt.
19. *Physoptychis purpurascens* Çelik et Akpulat.  
serpentine, chalky steppe and slopes, endemic, new takson for science, CR. Serpentinovag.
20. *Hesperis ozcelikii* sp. nova A. Duran.  
C3 Isparta: in Sütçüler 17th km from Ayvalıpınar to kesme Landslipped places, open forest, roadsides and serpentine, pebbly slopes with *Pinus nigra* 1025m, E.M. element, endemic. Serpentinophyt.
21. *Bornmuellera kiyakii* Aytac, & Aksoy.  
C4 Konya: Derebucak; Camlik kasabası, Kızıldağ, 1400-1600 m, clearing  
Open *Pinus nigra* forest on serpentine rocks, Ir.-Tur. element, endemic, LR(cd). Serpentinophyt.  
CARYOPHYLLACEAE
22. *Arenaria rhodia* var. *macropetala* McNeill  
Turkey [C2] Muğla: distr. Fethiye, between Kizil Dere and Dalaman Çay, 100 m, serpentine scree, annual, 1 iv 1956, Davis & Polunin, D. 25543 (holo. E! iso. K!) Rocks and screes, 30-300 m, E. Medit. element, Endemic, EN. Serpentinophyt.
23. *Minuartia garckeana* (Aschers. & Sint. ex Boiss.)  
Serpentine and micaceous gravel, 600 1800 m, Rare, DD. Serpentinovag.
24. *Cerastium ligusticum* Viv.  
On serpentine & perhaps elsewhere, rare, VU. Serpentinovag.
25. *Gypsophila graminifolia* Bark,  
Turkey B9 Van, distr. Başkale, ispiriz Dağ, 2700 m, serpentine screes, 31 vii 1954, Davis & Polunin, D. 23675 (holo. E! iso. K). Serpentine screes, 2700 m. Ir.-Tur. Element, endemic, CR. Serpentinophyt.
26. *Gypsophila sphaerocephala* var. *cappadocica* Boiss. ,  
Dry slopes, limestone and serpentine rocks, 800-1900 m, Ir.-Tur. element, endemic, LR(lc). Serpentinovag.
27. *Silene surculosa* Hub.-Mor.  
Turkey [B7] Tunceli, Pülümür-Mutu, Serpentschutt 8 km ob Mutu, 1760 m, 26 vi 1951, Huber-Morath 11170 (holo. Hb. Hub.-Mor.). B7 Tunceli: above Pülümür, 1850 m, D. 29289! Serpentine rock, 1760-1850 m., Ir.-Tur. Element, endemic, EX. Serpentinophyt.
28. *Arenaria ledebouriana* var. *grandiflora* Hartvig & Strid.  
Rocky limestone, schistose and serpentine slopes, 1950-2450 m, E. Medit. Element, endemic variety, LR(nt). Serpentinovag.
29. *Minuartia verna* subsp. *brevipetala* Hartvig & Strid.  
Turkey C2 Muğla: Sandras Dağ, W. of the summit, 1970 m, slightly sloping stony flat (snowbed) near a small creek close to timberline, serpentine, lat. 37°04'N, long. 28°50'E, 7 vii 1984, P. Hartvig, Ö. Seçmen & A. Strid 23336 (holo. C, iso. B, E! EGE, G). Moist gravelly or stony flats (snowbeds) on serpentine, c. 2000 m, E. Medit. Element, endemic subspecies, EN. Serpentinophyt.
30. *Bolanthus stenopetalus* Hartvig & Strid.  
Turkey C2 Muğla: Sandras Dağ, W. side of the summit area, 2100-2200 m, lat. 37°04'N, long. 28°50'E, 7 vii 1984, P. Hartvig, Ö. Seçmen & A. Strid 23375 (holo. C, iso. B, E!~EGE, G). Snowbed meadows and rocky slopes, 2100-2200 m, E. Medit. Element, endemic, EN. Serpentinophyt.
31. *Silene araratica* subsp. *davisii* (Chowdh.) Ghazanfar.  
Crevice of limestone, conglomerate and serpentine rocks, 1620-2700 m, Ir.-Tur. element, endemic, EN. Serpentinovag.
32. *Silene brevicalyx* Hartvig & Strid.  
Turkey C2 Muğla: Sandras Dağ, S.W. side along road between the village of Ağla and the fire watehtower, 1250 m, open *Pinus nigra* forest, lat. 37°04'N, long. 28C49'E, 6 vii 1984, P. Hartvig, Ö. Seçmen & A. Strid 23274 (holo. C, iso. E!). Open *Pinus nigra* forest, on serpentine, 1250 m., E. Medit. Element, endemic, EN. Serpentinophyt.
33. *Silene cserei* Baumg. ssp. *aeoniopsis* (Bornm.) Chowdhuri  
[ Turkey A4 Ankara, Kalecik in valle Keci Deresi, 700-800 m, 7 vii 1929, Bornmüller 13884 (K!). Serpentine steps. Endemic, VU. Serpentinophyt.
34. *Silene salamandra* Pamp.  
Serpentine rocks and sandy stream beds, 200-350 m., E. Medit. element, endemic to Rodhos, DD. Serpentinovag.
35. *Silene ruscifolia* (Hub.-Mor. & Reese) Hub.-Mor.  
On serpentine, 1300m Serpentinovag.
36. *Silene cariensis* subsp. *muglae* Vural & Donmez.  
(Turkey) C2 Muğla: Koyceğiz, Sultaniye, Kersele stream, 15-30 m, in stream bed, metamorphic, Paratype: (Turkey) C2 Muğla: Koyceğiz, between Hamitkoy, Domuzdire. i hill and Kersele bay, 80-130 m, macchia, serpentine Paratypes, 80-130 m, macchia, serpentin, endemic, new takson for science, LR(cd). Serpentinophyt.
37. *Silene koycegizensis* Donmez & Vural.  
(Turkey) C2 Muğla: Koyceğiz, Candır village, Horozlar district, 20 m, fallow field, Paratypes: (Turkey) C2 Muğla: Koyceğiz, between Hamitkoy and Kersele bay, C2 Muğla: Marmaris National Park, Nimara Island, macchia, 100 m, Paratypes,

- 80-130 m, *macchia*, *serpentine*, *endemic*, *new taxon for science*, CR. Serpentinophyt.  
LINACEAE
38. *Linum arboreum* L.  
*Macchie on rocky serpentine slopes, or on limestone cliffs, 200-700 m*, E. Medit. element, *nadir*, VU Serpentinovag.
39. *Linum boissieri* Aschers. & Sint. ex Boiss.  
*Limestone and serpentine screes, 1700-2200 m*, E. Medit. Element, *endemic*, EN. Serpentinovag.
40. *Linum virgultorum* Boiss. & Heldr.  
*Rocky serpentine and calcareous slopes, and in Pinus brutia forest, 50-400 m*, E. Medit. element. Serpentinovag.  
FABACEAE
41. *Astragalus zahlbruckneri* Hand.-Mazz.  
*On serpentine, etc., 1060-2450 m*, Ir.-Tur. Element, *endemic*, VU. Serpentinovag.
42. *Trifolium mesogitanum* Boiss.  
*Serpentine slopes, s.L-600 m*, E. Medit. Element. Serpentinovag.
43. *Trifolium rhizomatosum* O. Schwarz.  
[Turkey C2 Muğla] *Sandras Dağ Anatoliae austro-occidentalis, solo serpentina, c. 1500 m, On serpentine, c. 1500 m, endemic*. Serpentinophyt.
44. *Cyissopsis dorycniifolia* Jaub. & Spach.  
*Stony ground on chalk or serpentine, often in macchie, 50-1700 m*, E. Medit. Element, *endemic*, LR(nt). Serpentinovag.
45. *Genista sandrasica* Hartvig & Strid.  
*Turkey C2 Muğla: Sandras Dağ, S.W. side, along road between the village of Ağla and the fire watchtower, 1750 m, open Pinus nigra forest, lat. 37°04'N, long. 28°49'E, 6 vii 1984, P. Hartvig, Ö. Seçmen & A. Strid 23292 (holo. C, iso. B, E!EGE, G).S.W. Anatolia; local. C2 Muğla: Sandras D a , 1700 m, D. 13491 ! ibid, Contandr. et al. !Open Pinus nigra forest, on serpentine, 1700-1750 m*, E. Medit. Element, *endemic*, EN. Serpentinophyt.
46. *Hedysarum antitauricum* Hub.-Mor. & Yurdakulol.  
*Turkey C5 Adana: Distr. Karaisali, Karsanti am Südfuss des Antitaurus, Şamadan Beli, Quercus/Pinus pallasiana — Gehölz auf Serpentin, 1200 m, 30 v1973, Yurdakulol 91 (holo. Hb. Hub.-Mor., iso. ANK). S. Anatolia. C5 Adana: d. Karaisali, Karsanti, Şamadan Beli, 1100 m, Yurdakulol 54Mixed Quercus/Pinus forest on serpentine, 1100-1200 m*, E. Medit. element, *endemic*, EN. Serpentinophyt.
47. *Chamaecytisus gueneri* H.Duman, Başer & Malyer.  
[Turkey] C2 Muğla; *Köyceğiz, Sandras Dağ, between Ağla and Eskere, 1700 m, 25 vii 1992, open Pinus nigra forest, serpentine slopes, A. Güner 10760-A.A. Dönmez & H. Şağban, (holo. HUB!, iso. GAZI!, E!). SW. Anatolia, rare. C2 Muğla: Köyceğiz, Sandras Dağ, above Ağla, H. Duman 5716, K.H.C. Başer & A. Altıntaş!.: Muğla: Sandras Dağ, SW. side, along road between the village of Ağla and the fire watchtower, P. Hartvig 23277, Ö. Seçmen & A. Strid Open Pinus nigra forest, serpentine slopes, 1450-1700 m*, E. Medit. element, *endemic*, CR. Serpentinophyt.
48. *Astragalus serpentinicola* H.Duman & Ekim.  
*Turkey C2 Burdur: Yeşilova, S. of Salda lake, clearings in Pinus nigra and Quercus forest, on serpentine, 1170-1200 m, 11 vii 1993, H. Duman 5078 & F.A. Karavelioğullan, (holo. GAZI!; iso. ANK!, B!, ISTE!); ibid. 12 vii 1993, H. Duman 5090 & F.A. Karavelioğullan (para. GAZI!). S. Anatolia. C2 Burdur: Yeşilova, S. of Salda lake, F.A. Karavelioğullan 2073! Denizli: Acipayam, Olukbaşı (Abbas) village, Geyran Y., 1400-1650 m, Z. Aytaç 7635 & F.A. Karavelioğullan!Pinus nigra and Quercus sp. forest, on serpentine. 1150-1650 m*, E. Medit. element, *endemic*, VU. Serpentinophyt.  
APIACEAE
49. *Eryngium thoriifolium* Boiss.  
[S.W. Anatolia] *in montibus Lyciae, aest. 1843, Pinard. S.W. Anatolia. Lycia: Nif Da, 5 vi 1881, Luschan. CI Muğla: between Datça and Marmaris, 6 km from Emecik, D. 35449! C2 Muğla: Sandras Da, above Ağla, 1520 m, D. 13591! C3 Antalya: d. Kemer, Tekirova, c. 1950 m, Heilbronn & Başarman. Rocky serpentine slopes, often in open Pinus forest, 50-1950 m*, E. Medit. Element, *endemic* (A serpentine endemic, without near allies), LR(cd). Serpentinophyt.
50. *Scandix australis* subsp. *grandiflora* (L.) Thell.  
*Granite, serpentine or limestone slopes, steppe, fields and roadsides, 30-1300 m*. Serpentinovag.
51. *Bupleurum anatolicum* Hub.-Mor. & Reese.  
*Open Pinus brutia forest, at least partly on serpentine, 70-1100 m*, E. Medit. element, *endemic*, LR(nt). Serpentinovag.
52. *Microsciadium minutum* (d'Urv.) Briq.  
*Rocky limestone and serpentine slopes and screes, 10-1200 m*, E. Medit. element, *endemic*, VU. Serpentinovag.
53. *Ferulago sandrasica* Peşmen & Quézel.  
*Turkey C2 Muğla: Sandras Dağ, rocaifies, 2000 m, J. Contandriopoulos, A. Pamukçuoğlu, P. Quézel (holo. E! iso. MARS).Rocky serpentine slopes, 2000 m*, E. Medit. Element, *endemic*, EN. Serpentinophyt.
54. *Ferulago mughlae* Peşmen.  
*Macchie and forest, usually on serpentine, 20-880 m*, E. Medit. Element, *endemic* (A distinctive endemic species.), LR(cd). Serpentinovag.
55. *Peucedanum arenarium* subsp. *neumeyeri* (Vis.) Stoj. & Stef.  
*CI/2 Muğla: 20 km from Emecik, Datça to Marmaris, 100 m, Dudley, D. 35452! 25-30 km from Hisarönü, Marmaris to Datça, 250 m, Dudley, D. 35420! Yugoslavia, Albania, Bulgaria, subsp. urbanii (Freyn & Sint. ex Wolff) Chamberlain, comb. et stat. nov. Syn: P. urbanii Freyn & Sint. ex Wolff in Feddes Rep. 20: 68 (1924). Steep slopes. Type: [Turkey B1 Balikesir] Troas; in monte Ida (Kaz Da.), circa fontes Scamandri, 29 vii 1883, Sintenis 494 (iso. BM! E! K! LD!). B1 Çanakkale/Balikesir: Kaz Da., 1500 m, 1968, Quézel et al.Serpentine cliffs. 100-250 m*, *endemic*, VU. Serpentinophyt.
56. *Eryngium pseudothoriifolium* Contandr. & Quézel.  
*On marly soil, c.100 m*, E. Medit. element, *endemic* (*E. thoriifolium* being a serpentine endemic.), VU. Serpentinovag.
57. *Eryngium trisectum* A. Worz & H.Duman.  
*(Turkey) Mittl. Taurus. Konya: Kızıl Da. zw. Beyflehir und Akseki, Zufahrt zu Gipfel, 37°21'17.5"N, 31°4'1.9"E, gerollreicher Abhang, Serpentin [=Turkey, Central Taurus, Konya: Kızıl Da.*

- between Beyflehir and Akseki, access road to the summit, stony slope, serpentine, access road to the summit, stony slope, serpentine, endemic, new takson for science, CR. Serpentinophyt.
58. *Eryngium davisii* Kit Tan & Yildiz.  
Calcareous and serpentine steppe, 950-2100 m., E. Medit element, endemic, LR(cd). Serpentinovag.
59. *Ekimia bornmuelleri* (Hub.-Mor. & Reese) H.Duman & M. F. Watson.  
[Turkey C2 Burdur] Pisidien, Dirmil-Tefenni, 34 km nach Dirmil, 26 km vor Tefenni, Trift, Rand eines Weizenackers, 1000 m. 9 vi 1938, Reese. Renz & Huber-Morath 5668 (holo. G-Herb. Hub.-Mor.).  
SW. Anatolia. C2 Burdur: d. Yeşilova, S. of Salda lake, 1150 m, H. Duman 5071 & F.A. Karavelioğulları; ibid., N. Özhatay, E. Özhatay & H. Duman (İSTE 72127!); Tefenni-Çavdır, 15 km from Tefenni, 1100 m, H. Duman 5944-M. Ekici & A. Duran; Denizli: Acipayam, around Gölhisar road junction, 1000 m, 37°16.5'N, 29°33.8'E, A. Güner 12778 & al A On serpentine, *Quercus scrub*, stony slopes, 1000-1250 m., E. Medit element., endemic, VU. Serpentinophyt.
- ASTERACEAE
60. *Helichrysum stoechas* (L.) Moench.  
Macchie on limestone, *Pinus brutia* forest on serpentine, chalky cliff-tops, s.L-700 m. Serpentinovag.
61. *Helichrysum orientale* (L.) DC.  
Limestone cliffs, macchie and *Pinus brutia* woods on serpentine, 30-700 m, Aegean. Medit. Element. Serpentinovag.
62. *Senecio sandrasicus* P.H.Davis.  
[Turkey C2] Prov. Muğla, dist. Köyceğiz (Caria). Sandras Dağ above Ağla, 1300 m, 22 vii 1947, Davis & Bilger [Karamanoğlu], D. 13561 (holo. E! iso. K!). S.W. Anatolia. C2 Muğla: Sandras Da. , 1600 m, 1968, Quézel et. al. :Marmaris, 30 m, D. 25382 Rocky slopes on serpentine, nr S.I.-1600 m, E. Medit. Element, endemic, LR(cd). Serpentinophyt.
63. *Anthemis cretica* L. subsp. *leucanthemoides* (Boiss.).  
Cliffs, rocky serpentine slopes and pine woods, 200-1600 m. Serpentinovag.
64. *Achillea sipikorensis* Hausskn. & Bornm.  
Steppe, gypsum and serpentine hills, 1450-1800 m, Ir.-Tur. Element, endemic, LR(cd). Serpentinovag.
65. *Cousinia sivasica* Hub.-Mor.  
Serpentine hills, limestone slopes, steppe, 950-1700 m, endemic, VU. Serpentinovag.
66. *Ptilostemon chamaepeuce* (L.) Less.  
Limestone cliffs, rarely on serpentine soil, s.l-850 m. Serpentinovag.
67. *Serratula kurdica* Post.  
[N.W. Syria] in monte Kurd Dagh Syriae borealis, vi 1891, Shepard 58(BEI!). S. Anatolia (Amanus & Kurd Da.). C6 Adana: d. Osmaniye, Yağlipinar S. Of Yarpuz, 1150-1350 m, Hub.-Mor. 15853! Hatay: Amanus Da., W. of Achagi Zarkoun (Aşağı Zerkum), 1400-1700 m, vi 1932, Delbès! Meşelik mevkii, burunsuzun tepesi, Arsuz to Amanus Da., c. 800 m, Akman 212! *Pinus brutia* woods, on gabbro & serpentine, 800-1700 m., E. Medit. Element. Serpentinophyt.
68. *Centaurea ensiformis* P.H.Davis.  
Turkey C2 Muğla: Dist. Köyceğiz (Caria), Sandras Da. above Ağla, nr Gökçe Ova, 1700 m, on serpentine in open *Pinus nigra* subsp. *pallasiana* forest, 23 vii 1947, Davis & Bilger [Karamanoğlu], D. 13510 (holo. E! iso. GOET! K). *Pinus nigra* forest, c. 1700 m, E. Medit. (mt.), endemic, VU. Serpentinophyt.
69. *Echinops pungens* var. *pungens* Trautv.  
Rocky limestone, serpentine and igneous slopes in steppe, fallow fields, roadsides, 1100- 2700 m., Ir.-Tur. Element. Serpentinovag.
70. *Echinops pungens* var. *polyacanthus* (Iljin) Hedge.  
Rocky limestone, serpentine and igneous slopes in steppe, fallow fields, roadsides, 1100-2700 m., Ir.-Tur. Element, nadir, DD. Serpentinovag.
71. *Echinops pungens* var. *adenocladus* Hedge.  
Rocky limestone, serpentine and igneous slopes in steppe, fallow fields, roadsides, 1100- 2700 m., Ir.-Tur. element., Endemic, LR(nt). Serpentinovag.
72. *Echinops pungens* var. *transcaucasicus* (Iljin) Hedge.  
Rocky limestone, serpentine and igneous slopes in steppe, fallow fields, roadsides, 1100- 2700 m., Ir.-Tur. Element, nadir, VU. Serpentinovag.
73. *Scorzonera suberosa* subsp. *suberosa* C.Koch.  
Loamy banks, steppe, hillsides on gypsum and serpentine, 1000-2500 m., Ir.-Tur. Element, endemic. Serpentinovag.
74. *Scorzonera argyria* Boiss.  
endemic, DD. Serpentinovag.
75. *Scorzonera cinerea* Boiss.  
Rocky calcareous or serpentine slopes, 1200-2800 m., Ir.-Tur. element. Serpentinovag.
76. *Scorzonera acantholimon* Hand.-Mazz.  
Rocky slopes on calcareous soil or serpentine, 1500-2400 m., Ir.-Tur. element, endemic, LR(lc). Serpentinovag.
77. *Scorzonera kotschyi* Boiss.  
Among *Quercus scrub*, on limestone and serpentine, nr s.L-1250 m., Ir.-Tur. element. Serpentinovag.
78. *Crepis foetida* subsp. *Commutata* (Spreng.) Babcock.  
*Quercus* and *Pinus* woods, serpentine, igneous or limestone slopes, steppe, fieldsides, s.L-1200 m. Serpentinovag.
79. *Scorzonera pisdica* Hub.-Mor.  
Turkey C2 Burdur: Distr. Tefenni, *Quercus coccifera*—Bestand 3 km. nördlich von Dirmil (Altinyayla), 1200-1270 m, 27 vi 1948, A. Huber-Morath 8485 & H. Reese (holo. Hb. Hub.-Mor). S.W. Anatolia. C2 Burdur: 6 km S. of Dirmil, 1600-1650 m, Hub.-Mor. 8486 & Reese *Quercus scrub*, serpentine slopes, 1200-1650 m., E. Medit. element., endemic, VU. Serpentinophyt.
80. *Scorzonera sandrasica* Hartvig & Strid.  
Turkey C2 Muğla: Sandras Dağ, W. of the summit, 1970 m, slightly sloping stony flat (snowbed) near a small creek close to timberline, serpentine, lat. 37°04'N, long. 28°50'E, 7 vii 1984, P. Hartvig, Ö. Seçmen & A. Strid 23342 (holo. C.iso. E! EGE). Moist gravelly or stony flats (snowbeds) on serpentine, c. 2000 m, E. Medit. Element, endemic, VU. Serpentinophyt.
81. *Tragopogon oligolepis* Hartvig & Strid.

- Turkey C2 Muğla: Sandras Dağ, W. of the summit, 1970 m, slightly sloping stony flat (snowbed) near a small creek close to timberline, serpentine, lat. 37°04'N, long. 28°50'E, 7 vii 1984, P. Hartvig, Ö. Seçmen & A. Strid 23341 (holo.C). S.W. Anatolia. C2 Muğla: Sandras Da. nr Gökçe ova, 1700 m, D. 13495! Sandras Da., 1525 m, D. 13616! Moist gravelly or stony flats (snowbeds) on serpentine, with sufficiently deep mineral soil, 1500-2000 m., E. Medit. Element, endemic to Sandras Da, EN. Serpentinophyt.
82. *Pilosella sandrasica* Hartvig & Strid.  
Turkey C2 Muğla: Sandras Dağ, S.W. foothills, c. 4 km S.W. of the village of Ağla, 500 m, opening in *Pinus brutia* forest, serpentine, lat. 37°03'N, long. 28°47'E, 6 vii 1984, P. Hartvig, Ö. Seçmen & A. Strid 23256 (holo. C, iso. E! EGE, G!) Clearing in *Pinus brutia* forest, on serpentine, 500 m, E. Medit. (mt.) element, endemic, EN. Serpentinophyt.
83. *Senecio leucanthemifolius* Poir.  
Rocky slopes, dry river beds, dry pastures, coastal sands and salt marshes, olive groves, ruderal places, on serpentine, 0-400 m. Serpentinovag.
84. *Anthemis karacae* Güner.  
Turkey C2 Muğla: Köyceğiz, Ekincik Köyü, *Pinus brutia* forest, on serpentine, OYO m, 17 iv 1991, A. Güner 8764a-M. Vural, H. Duman, A.A. Dönmez & B. Mutlu (holo. AIBU!; iso. GAZI!, E!) *Pinus brutia* forest, metamorphic rock, 0-40 m., E. Medit. element, endemic. Serpentinophyt.
85. *Cirsium dirmilense* R.M. Burton.  
Open *Pinus nigra* and/or *Cedrus libani* forests, mountain steppe, calcareous or serpentine slopes, 1250-1850 m, E. Medit. (mt.) element, endemic, EN. Serpentinovag.
86. *Tragopogon sinuatus* Avé-Lall.  
Rocky and sandy places by sea, cultivated or fallow fields, vineyards, olive groves, on a variety of substrates (limestone, schist, serpentine), s.L-700 m. Serpentinovag.
87. *Achillea sivasica* Celik & Akpulat.  
Turkey, B6 Sivas: Ulaş, Distr. of Kovalı, Ziyarettepe, serpentine steppe, '46932 37°01'18"E, 1350-1400 m serpentine steppe, 1350-1400 m, endemic, new takson for science, CR. Serpentinophyt.
88. *Centaurea aksoyi* Hamzaoğlu & Budak.  
Turkey, B5 Yozgat: between Şefaati and Yerkoş, Karanlıkdere valley, Adatepe, '28934 34°40'23"E, 850 m a.s.l., serpentine rocks, 6.vii.2006, Hamzaoğlu & Budak 850 m a.s.l., serpentine rocks, endemic, new takson for science, CR. Serpentinophyt.
89. *Centaurea yaltirikii* N. Aksoy, H. Duman & A. Efe.  
Turkey, A3 Düzce: Golyaka, Elmacık Dağı, upper side of Eft eni Lake, the road of Guzledere waterfall, slopes of basalt rocks in maquis area, 568 m a.s.l., Paratype: Turkey, A3 Düzce: Elmacık Dağı, Konaş Ardı, Melikderesi, serpentine rocks, 1085 m a.s.l., under and beside *Pinus sylvestris* forest paratype, serpentine rocks, 1085 m a.s.l., under and beside *Pinus sylvestris* forest, endemic, new takson for science, CR. Serpentinophyt.
90. *Centaurea serpentinica* A. Duran & B. Doğan.  
Turkey, C5 Kayseri: Yahyalı, between Kapuzbaşı and Aladağ, 15 km, 1080 m a.s.l., endemic, new takson for science, CR. Serpentinophyt.
91. *Jurinea tortumensis* A. Duran & B. Doğan.  
Turkey, A8 Erzurum: Tortum to Erzurum, 7 km, serpentine stony place, 1880 m a.s.l., 40°15.08'N, 41°31.59'E Serpentine stony place, 1880 m, endemic, new takson for science, CR. Serpentinophyt.
92. *Caucasalia kizildaghensis* E. Uzunhisarcıklı, E. Doğan et H. Duman (caucasalia new genus for Turkish flora), (Turkey) C3 Konya: Derebucak, Camlık, Kızıl Dağ, 1600-1700 m, serpentine rocky slopes, open area of a *Pinus nigra* forest, endemic, new takson for science, CR. Serpentinophyt.
93. *Scorzonera coriacea* A. Duran & Aksoy.  
TURKEY. C3 Konya: Derebucak, Camlık district, Kızıl Dağ, serpentine stony places, 1400 m, 37°21.869'N 31°40.501'E, 12.VI.2009 open *Pinus nigra* forest and on the serpentine stony slopes, 1400m, endemic. Serpentinophyt.
94. *Centaurea anthemifolia* Hub.-Mor.  
C5 Konya: Ereğli, Aydos Dağı, Deli-mahmutlu village, rocky serpentine slopes, 1600 m rocky serpentine slopes, 1600m. Serpentinophyt.
95. *Psephellus coruhensis* A. Duran & M. Öztürk sp. nova  
Turkey. A8 Artvin: between Yusufeli-Sarıgöl, 2th km, 630 m, 31.v.2003, stony slopes, 40°50.820'N, 41°32.339'E, eroded serpentine stony slopes, endemic. Serpentinophyt.  
CAMPANULACEAE
96. *Campanula strigillosa* Boiss.  
On limestone and serpentine rocks, c. 1350-1800 m, E. Medit. (mt.) element, endemic, LR(cd). Serpentinovag.
97. *Campanula oligosperma* Damboldt.  
Turkey B7J Tunceli, d. Pülümür, Pülümür-Mutu, Serpentschutt am Pass, 8 km ob Pülümür, 1760 m, Huber-Morath 11074 (holo. Hb. Hub.-Mor. iso. E!). E. Anatolia; local. B7 Erzincan/Tunceli: on Pülümür pass, 1950 m, Holtz et al. 00.768! Alpine pastures, serpentine screes, 1760-1950 m., Ir.-Tur. Element, endemic, LR(cd). Serpentinophyt.  
ERICACEAE
98. *Erica manipuliflora* Salisb.  
Open places, macchie, under *Pinus brutia*, limestone, serpentine and schistose rocks, s.L-1530 m, E. Medit. element. Serpentinovag.
99. *Arbutus andrachne* L.  
Macchie *Pinus brutia* forest, on igneous, serpentine and limestone substrata, s.L-800 m. Serpentinovag.  
LENTIBULARIACEAE
100. *Pinguicula crystallina* Sm. in Sibth. & Sm..  
In spray zone of permanent springs, rivulets and waterfalls, rocky mossy places in *Pinus brutia* and *P. nigra* belts, on serpentine and limestone, 1050-1700 m, E. Medit. element. Serpentinovag.  
PRIMULACEAE
101. *Androsace armeniaca* var. *macrantha* (Boiss. & Huet) Martelli.  
Limestone and igneous rocks and screes, serpentine and schistose rocky slopes, alpine pastures, 900-2600 m., Ir.-Tur. element., endemic, LR(lc). Serpentinovag.



102. *Cyclamen trochopteranthum* O.Schwarz.  
Stony ground underbushes, *Pinus brutia* forest, on limestone or serpentine, 350-1100 m., E. Medit. element., endemic, LR(lc). Serpentinovag.
103. *Lysimachia linum-stellatum* L.  
Open *Quercus aegilops* scrub, on serpentine and rocky limestone slopes, clay soil, s.l.-1200 m, Medit. element. Serpentinovag.  
CONVOLVULACEAE
104. *Convolvulus aucheri* Choisy.  
Stony limestone slopes, *Pinus* forest, on gabbro and serpentine, 50-1700 m., E. Medit. element. Serpentinovag.
105. *Convolvulus oleifolius* Desr.  
Macchie, limestone and serpentine cliffs, s.l.-250 m, Medit. element. Serpentinovag.
106. *Convolvulus compactus* Boiss.  
Open *Pinus nigra* woodland, *Quercus coccifera* macchie, steppe, screes, chalky and serpentine slopes, eroded hills, grazed fields, 200-2135 m, This species grows in both Medit. and Ir.-Tur. Territory. Serpentinovag.
107. *Convolvulus libanoticus* Boiss.  
Mountain pastures on limestone and serpentine, 1600-2670 m, E. Medit. Element. Serpentinovag.
108. *Convolvulus carduchorum* Davis.  
[Turkey B9] Bitlis-Tatvan, 1700 m, disturbed steppe, 30 vi 1954, Davis & O.Polunin, D. 23382 (holo. E! iso. K!). E. Anatolia. B/C6 Malatya: Malatya to Kahta, Hand.-Mazz. 2226 (type of *C. anatolicus*)\ B7 Tunceli: d. Pülümür, pass between Pülümür and Mutu, 1780 m, Hub.-Mor. 15657 (type of *C. glabrescens*)! B7 Elaziğ: Hasanbaba Da, 2100 m, Hand.-Mazz. 2572 (type of *C. orophilus*)\ B7/8 Elaziğ/Muş: Elaziğ to Muş, 4 vii 1963, M.Zohary\ C7 Adiyaman: between Kumik and Bekikara (Malatya to Kahta), 1900 m, Hand.-Mazz. 2226 (as *C. cataonicus*)\ Alpine pastures, *Astragalus* steppe, disturbed steppe, on serpentine, 1700-2100 m., Ir.-Tur. Element, endemic. Serpentinophyt.
109. *Convolvulus pseudoscammonia* C.Koch.  
[Turkey A8 Erzurum] im Gaue Sber auf Porphy und Kalk, 1067-1219 m, C.Koch (B, destroyed). Mainly N.E. Anatolia. A6 Sivas: 32 km from Suşehri to Zara, 1300 m, Stn. & Hend. 5763! A7 Gümüşane: Ardas (Torul) to Beşkilise, Sint. 1889:1335 (syntype of *C. cappadocicus*) ! A8 Çoruh: Çoruh river between Tzria (Siryia) and Ordshoch, Woronow 271! Erzurum: 8 km N.E. of Tortum, 1450 m, Hub.-Mor. 15654. A9 Çoruh: Ardanuç, 500-600 m, D. 30166! B7 Erzincan: Eğin (Kemaliye), Sint. 1890:2864 (isolecotype of *C. Stony slopes, serpentine screes, eroded shaly clay hills, 450-1450 m, Ir.-Tur. element, endemic. Serpentinophyt.*  
BORAGINACEAE
110. *Rochelia disperma* var. *microcalycina* (Bornm.) Edmondson.  
Sandy fields, alpine grassland on schist and serpentine, 1550-2100 m, Ir.-Tur. Element, Endemic, LR(lc). Serpentinovag.
111. *Asperugo procumbens* L.  
Limestone and serpentine slopes, among rocks, fields and field margins, 80-2200 m, Euro-Sib. element. Serpentinovag.
112. *Paracaryum ancyritanum* Boiss.  
Steppe, slate, serpentine, chalk and mudstone slopes, fallow fields, stony disturbed ground, 500-1500 m, Ir.-Tur. element, endemic, LR(lc). Serpentinovag.
113. *Onosma sericeum* Willd.  
*Quercus* scrub, serpentine, limestone slopes and screes, etc., 400 -2290 m., Ir.-Tur. Element. Serpentinovag.
114. *Onosma cappadocicum* Siehe ex H.Riedl.  
Turkey C5 Adana: Masmutli Dag (Ala Da.), 1800 m, vii 1907, Siehe [107] (holo. W! iso. E! GE!). Assigned to Niğde in original publication. S. Anatolia (Taurus). C5 Niğde: Bereketli Maden (Çamardı), 1800 m, Siehe s.n. Adana: Karsanti, Akinek, 1550 m, Yurdakulol 45! Hızar pass, 1800 m, Yurdakulol (ANK 10026). Serpentine rocks, clearings in *Pinus nigra* forest, 1550-1800 m., E. Medit. (mt.) element, endemic, LR(cd). Serpentinophyt.
115. *Onosma mite* Boiss. & Heldr.  
[Turkey C3 Antalya] in pinetis apricis ad radices montis Taktalu (Tahtali Da.) Lyciae supra portum Tcherali, [13 v 1845,] Heldreich [1088] (holo. G). S.W. Anatolia. C2 Antalya: Katran Da. to Kaş, Kasaba Ovasi, Bozakman & Fitz 1970:320! C3 Antalya: Adrasan Körfezi between Çirali and Finike, Hub.-Mor. 9745; Kayran, N.E. of Antalya, Bozakman & Fitz 1970:175! Serpentine rocks, *Pinus brutia* forest, nr s.l.-1900 m, E. Medit. element. Serpentinophyt.
116. *Anchusa strigosa* Labili.  
On serpentine, limestone banks, waste places, 150-1300 m. Serpentinovag.  
SCROPHULARIACEAE
117. *Verbascum serratifolium* (Hub.-Mor.) Hub.-Mor.  
[Turkey B3] Eskişehir: Eskişehir - Kütahya, Wegrund 25 km südwestlich Eskişehir, 950 m, 13 vi 1954, Huber-Morath 12297 (holo. Hb. Hub.-Mor.!). C. Anatolia. B3 Eskişehir: 41 km from Eskişehir to Sarıcakaya, 320 m, Buttler 13348! Kütahya: 64 km S.W. from Eskişehir to Kütahya, 900 m, Hub.-Mor. 12298! B4 Ankara: Elma Da., Hisar Köy, Kiliç 153! *Pinus* forest, phrygana, roadsides, dry slopes, serpentine rocks, 300-950 m., *Pinus* forest, phrygana, roadsides, dry slopes, serpentine rocks, 300-950 m., endemic, LR(cd). Serpentinophyt.
118. *Verbascum serpenticola* Hub.-Mor.  
[Turkey C2] Burdur: Serpentschutt auf dem Pass 6 km südlich ob Dirmil (Altınyayla), 1600 m, 28 vi 1948, Renz & Huber-Morath, Hub.-Mor. 8249 (holo. Hb. Hub.-Mor.!) iso. Hb. Basier Bot. Ges.!). Serpentine scree, 1600 m, E. Medit. (mt.) element., endemic, CR. Serpentinophyt.
119. *Verbascum adenophorum* Boiss.  
[Turkey C2 Muğla/Denizli] in Caria, aestate 1843, Pinard (holo. G!). S.W. Anatolia. C2 Muğla: Sandras Da, S.W. side above Ağla, Fitz & Spitz. 758! Burdur: pass 6 km S. above Dirmil (Altınyayla), 1600 m, Hub.-Mor. 8032! Serpentine rubble, c. 1600 m., E. Medit. Element, endemic, LR(cd). Serpentinophyt.
120. *Verbascum heterobarbatum* Hub.-Mor.  
[Turkey B4] Ankara: d. Çankaya, Wegrund 9 km südlich Gölbaşı, 870 m, 1 vi 1956, Huber-Morath 14075 (holo. Hb. Hub.-Mor.!). C. Anatolia. A4

- Ankara: Kalecik, nr Çukur Köy, Kiliç 1975:141 ! B4 Ankara:  
Beynam, D. 13005Roadsides, steppe, fallow fields, serpentine slopes, 870-1020 m., Ir.-Tur. Element, endemic, LR(cd), Serpentinophyt.
121. *Verbascum trichostylum* Hub.-Mor.  
[Turkey B7] Erzincan: d. Refahiye, Refahiye - Suşehri, Weizenfeldrand 19 km N.W. Refahiye, 1600 m, 7 vii 1955, Huber-Morath 13060 (holo. Hb. Hub.-Mor.). E. Anatolia. A7 Sivas/B7 Erzincan: 18-22 km N.W. of Refahiye, 1560 m, Hub.-Mor. 14754! B7 Erzincan: 52 km from Erzincan to Refahiye, 2000 m, Rech. 15188!Roadsides,wheat-fields, serpentine slopes, 1560-2000 m., Ir.-Tur. Element, endemic, EN. Serpentinophyt.
122. *Verbascum renzii* Hub.-Mor.  
Pinus forest,macchie, limestone rocks and scree, and on serpentine, s.L-1500 m., E. Medit. Element, endemic, LR(cd), Serpentinovag.
123. *Verbascum eriorrhodon* Boiss.  
Picea orientalis forest, serpentine slopes, roadsides, 300-1400 m, Euxine element, endemic, VU. Serpentinovag.
124. *Verbascum chazaliei* Boissieu.  
[Turkey C3 Antalya] Lycie, à Chiralu (Çirali), en montan à la Chimère, 1894, H. de Boissieu (holo. P). S.W. Anatolia. C3 Antalya: Tekirova bay, E. foot of Tahtali Da, s.l.-100 m, Hub.-Mor. 5934 Pinus brutia forest, macchie,serpentine rocks, s.L-300 m., E. Medit. Element, endemic, LR(cd). Serpentinophyt.
125. *Scrophularia pegaea* Hand.-Mazz.  
Limestone and serpentine rocks, alpine steppe, 1900-2200, Ir.-Tur. Element. Serpentinovag.
126. *Scrophularia lucida* L.  
Limestone and serpentine cliffs, rocky slopes and scree, dry riverbeds, l.0-2200 m, Medit. element. Serpentinovag.
127. *Chaenorhinum litorale* (Bernh.) Fritsch.  
Valleys, screes, sandy soil and on serpentine, 1000-1650 m, E. Medit. Element, endemic, LR(lc). Serpentinovag.
128. *Digitalis cariensis* Boiss. ex Jaub. & Spach.  
In coniferous forests(Cedrus, Abies cilicica, Pinus nigra), Quercus woods, rocky slopes (limestone and serpentine), rarely screes, 800-1700 m., E. Medit. Element, endemic, LR(lc). Serpentinovag.
129. *Veronica balansae* Stroh.  
[Turkey CS içel] circa pagum Ala Dagħ sex leucis ('7 Heues') ad septentrionem portus Mersina in Cilicia sito, 16 v 1855, Balansa 688 (holo. G, iso. G!JE! W!). Mainly S. Anatolia; rare. B5 Kayseri: Erciyas Da, Tekir Y , 2200 m, 30 vi 1902, Zederbaueri CS Adana: Kassan Oghlu (Hasanoğlu), nr Gorumse (Gürümze), c. 1400 m, Kotschy 1859: 59 p.p. (type of V. gorumsensis)!. C5/6 Adana: Sis (Kozan) to Hadjin (Hacin, = old Saimbeyli), 4 vii 1906, G. & B.Post! C6 Hatay: 8 km S. of Dörtöl, 100 m, Coode & Jones 519! Maraş: Çatak (13 km S. of Andirin), 900 m, Coode & Jones 1158B! C7 Urfa: Kainar (Kaynak?) nr Siverek, Sint. 1888:691 p.p.!Moist places in alpine pastures, abandoned alpine fields,serpentine gravel, deciduous foresti ?), 100-2200 m., E. Medit. element(?), endemic, LR(lc). Serpentinophyt.
130. *Verbascum basivelatum* Hub.-Mor.  
Turkey B3 Eskişehir: Türkmen Da, Porsuk barajı, auf Serpentinfelsen, zirka 900 m, 16 vi 1976, T. Ekim ANK 2071 (holo. Hb. Hub.-Mor, iso. ANK).Serpentine rocks, c. 900 m, Ir.-Tur. element., endemic, LR(cd). Serpentinophyt.
131. *Verbascum tuna-ekimii*.  
Turkey B7 Erzincan: between Erzincan and Kemaliye Calcerous and serpentine stony slopes and along roadsides 1150m, Ir.-Tur. Element, endemic, Recommended, EN. Serpentinovag. GLOBULARIACEAE
132. *Globularia trichosantha* Fisch. & Mey.  
Rocky and grassy slopes, forest clearings, on limestone, serpentine and volcanic rocks, steppe, 200-2470 m., ,endemic,EN. Serpentinovag. LAMIACEAE
133. *Teucrium sandrasicum* O. Schwarz.  
[Turkey C2 Muğla] dist. Fethiye, in pinetis apertis lapidosis inter monte Caldağ et Pirnasdağ ad jugum Kirkpınar solo serpentinico, c. 1200-1500 m, 15 viii 1938, Schwarz 416 (holo. JE). S.W. Anatolia. C2 Muğla: 43 km from Muğla to Fethiye, 70 m, Dudley (D.35142)! Köyceğiz to Fethiye, T. Baytop (İSTE 11138)! Kizübel, 1966, Peşmen & Aydar! Sandras Da. above Köyceğiz, 1100-1500 m, D. 13559!Open Pinus nigra forest and. macchie, on serpentine, 70-1800 m, E. Medit. Element, endemic, LR(cd). Serpentinophyt.
134. *Teucrium alyssifolium* Stapf.  
[Turkey C2 Muğla] Lycia, ad Chertek (Kertek), 8 vi 1882, Luschan (holo. WU!) S.W. Anatolia. C2 Muğla: Fethiye to ÇameU, Göztepe, 1600 m, Contandriopoulos & Quézel 73-41 (!).On serpentine rocks, c. 1600 m., E. Medit. Element, endemic, LR(cd). Serpentinophyt.
135. *Teucrium chamaedrys* subsp. *lydium* O. Schwarz.  
Pinus nigra forest, macchie, stony serpentine slopes, open slopes, 500-1700 m., E. Medit. Element. Serpentinovag.
136. *Scutellaria orientalis* subsp. *orientalis* Syn: *S. caucasicum* A. Ham.  
Rocky igneous (incl. serpentine) and shaley hillsides, 450-1500 m., Ir.-Tur. Element. Serpentinovag.
137. *Scutellaria orientalis* subsp. *bornmuelleri* (Hauskn. Ex. Bornm.) Edmonson.  
Lectotype (chosen here): N. Iraq, Riwandous (ad fines Persiae) in monte Händarin, 1200 m, 21 vi 1893, Bornmüller 1691 (BM! E!). S.E. Anatolia. B9 Van: Artos Da. above Gevaş, 2135 m, D. 22692! ibid., 1800-2000 m, Ehrend, et al. 787-92-1! Gurundaş, Şatak (Çatak) to Van, 1900 m, Nâbelek 1609! C9/10 Hakkari: Cilo Tepe, 3000 m, D. 24028 (a rather dwarf alpine form)! CIO Hakkari: 40 km from Yüksekova to Başkale,1650 m, A. Baytop (ISTE 41276)!Montane steppe, on serpentine rocks, 1600-3000 m, Ir.-Tur. Element. Serpentinophyt.
138. *Phlomis bourgaei* Boiss.  
Macchie, Quercus scrub, Pinus woods, calcareous and serpentine rocks, s.l.-1000 m, E. Medit. Element, endemic, LR(nt). Serpentinovag.
139. *Phlomis lycia* D. Don.  
[S.W. Turkey] in sylvis montanis, Lycia septentrionalis, Fellows. S.W. Anatolia, Islands. CI Aydin: Söke, 1962, Regel! Muğla: 5 km from Milas

- to Bodrum, 130 m, Hub.-Mor. 16539! C2 Muğla: 4 km above Muğla, 900 m, Hub.-Mor. 12289! Antalya: Fethiye to Kale, above Kalkan, 80 m, Simon 69-830! (Greece) Is: Kastellorizo, *Insula Strongili*, 70-100 m, Greuter 11710! C3 Antalya: Termessus, 600 m, D. 15448! Is: Kalimnos, Gathorne-Hardy 342! Tilos, 190 m, Gathorne-Hardy 136! Simi, 300 m, Rech. 8462. *Macchie, Quercus scrub, Pinus brutia forest, serpentine cliffs, s.l.-900 m, E. Medit. Element, endemic, LR(lc). Serpentinophyt.*
140. *Phlomis angustissima* Hub.-Mor.  
*Dry slopes, limestone and serpentine scree, 1100-2170 m, endemic, VU. Serpentinovag.*
141. *Lamium sandrasicum* P.H. Davis.  
[Turkey C2] Muğla: distr. Köyceğiz (Caria), Sandras Dağ, 2200 m, 23 vii 1947, P.H. Davis 13548 (holo. K! iso. E!). S.W. AnatoUa. C2 Muğla: Sandras Da., E. Özhatay (ISTE 19448! 20278!). *Serpentine gulliesnr snow line, c. 2200 m, E. Medit. (mt.) element., endemic, EN. Serpentinophyt.*
142. *Sideritis leptoclada* O. Schwarz & P.H. Davis.  
*Pinus brutia forest, serpentine rocks, conglomerate ledges and scree, s.l.-800 m, E. Medit. Element, endemic, LR(cd). Serpentinovag.*
143. *Stachys cretica* subsp. *lesbiaca* Rech. fil.  
*Rocky ruins on mountain slopes, on serpentine, trachyte etc., 220-400 m., E. Medit. Element, endemic, LR(nt). Serpentinovag.*
144. *Stachys iberica* Bieb.  
*Sloping limestone or serpentine rocks and scree, streams and riversides, steppes and igneous banks, 800-2400 m. Serpentinovag.*
145. *Stachys iberica* subsp. *stenostaehya* (Boiss.).  
*Igneous rocky slopes and serpentine scree, sometimes in field banks, 450-1900 m, Ir.-Tur. Element. Serpentinovag.*
146. *Stachys arvensis* (L.) L.  
*Fallow fields, on serpentine soil, open sward in Pinus brutia forest, s.l.-100 m. Serpentinovag.*
147. *Nepeta fissa* C.A. Meyer.  
*Volcanic and serpentine rocks, scree, slopes, steppe, dry or moist banks, (540-1100-1950 m, Ir.-Tur. Element Serpentinovag.*
148. *Origanum hypericifolium* O. Schwarz & P.H. Davis.  
*Calcareous and serpentine rocks and slopes, sometimes in Pinus nigra forest, 1300-2000 m, E. Medit. Element, endemic, LR(cd). Serpentinovag.*
149. *Acinos troodi* (Post) Leblebici.  
[Turkey C2 Muğla] Sandras Da. nr Gökçe ova, on serpentine, 1700m, 23 vii 1947, Davis 13499 (holo. E!).  
S.W. Anatolia. C2 Muğla: Sandras Da., 2200 m, D. 13553! Sandras Da., Beşparmak, 1900 m, N. & E. Özhatay s.n.! *Rocky slopes on serpentine, 1700-2200 m., E. Medit. (mt.) element, endemic. Serpentinophyt.*
150. *alvia blepharochlaena* Hedge & Hub.-Mor.  
*Limestone and serpentine slopes, 1000-1620 m, Ir.-Tur. element., endemic, LR(nt). Serpentinovag.*
151. *Salvia vermifolia* Hedge & Hub.-Mor.  
*Igneous and serpentine slopes, c. 1450 m, Ir.-Tur. Element, endemic, VU. Serpentinovag.*
152. *Stachys sivasica* Kit Tan & Yıldız.  
*Calcareous and serpentine rocks, 1400 -1500 m, Ir.-Tur. Element, endemic, EN. Serpentinovag.*
153. *Sideritis ozturkii* Z. Aytaç et A. Aksoy.  
B3 Konya: Derebucak, Kızıldağ, 3 km N of Çamlık town 1450-1700 m, *serpentine rocky place and clearings of Pinus nigra forest, endemic, EN. Serpentinophyt.*
- PLUMBAGINACEAE
154. *Goniolimon collinum* (Griseb.) Boiss.  
*Steppe, fallow fields, chalky and serpentine hills, stream beds, 100-750 m, E. Medit. element. Serpentinovag.*
155. *Acanthalimon spirizianum* var. *spirizianum*. Mobayen.  
*Rocky limestone and serpentine slopes, mountain steppe, 1180-2700 m, Ir.-Tur. element., endemic, LR(cd). Serpentinovag.*
156. *Acanthalimon spirizianum* var. *multiflorum* Bokhari.  
*Rocky limestone and serpentine slopes, mountain steppe, 1180-2700 m, Ir.-Tur. element., endemic, LR(cd). Serpentinovag.*
157. *Acanthalimon ulicinum* var. *ulicinum*. Ic: Jaub. & Spach.  
*Stony slopes, on limestone and serpentine, exposed mountain tops, scree, 1200-3000 m, E. Medit. element. Serpentinovag.*
158. *Acanthalimon ulicinum* var. *creticum* (Boiss.) Bokhari & Edmondson.  
*Stony slopes, on limestone and serpentine, exposed mountain tops, scree, 1200-3000 m, E. Medit. element. Serpentinovag.*
159. *Acanthalimon ulicinum* var. *purpurascens* (Bokhari) Bokhari & Edmondson.  
*Stony slopes, on limestone and serpentine, exposed mountain tops, scree, 1200-3000 m, E. Medit. element, endemic, LR(cd) Serpentinovag.*
160. *Acanthalimon ulicinum* subsp. *lycaonicum* (Boiss. & Heldr.) Bokhari & Edmondson.  
*Stony slopes, on limestone and serpentine, exposed mountain tops, scree, 1200-3000 m, Ir.-Tur. Element. Serpentinovag.*
161. *Acantholimon capitatum* subsp. *sivasicum* Dogan et Duman.  
(Turkey) B6 Sivas: Ulaş, between Kutlukaya and Boğazdere village 1400-1500 m, *serpentine, steppe., endemic, new takson for science, CR. Serpentinophyt.*
162. *Acantholimon koycegizicum* Doğan & Akaydin.  
Turkey C2 Muğla: Köyceğiz around Sultaniye, *serpentine slopes Serpentine mountain slopes 20m, Medit. element, endemic. Serpentinophyt.*
- THYMELAEACEAE
163. *Daphne sericea* Vahi.  
*On limestone, serpentine and shale, open Pinus brutia forest, Quercus coccifera-Arbutus macchie, s.l.-1500m, E. Medit. Element. Serpentinovag.*
164. *Thymelaea tartonraira* var. *linearifolia* K. Tan.  
*Uncultivated slopes, macchie on serpentine, 100-250 m. Serpentinovag.*
- ARISTOLOCHACEAE
165. *Aristolochia guichardii* Davis & Khan.,  
*Pinus brutia forest, serpentine hills, limestone slopes, and in shady Quercus coccifera macchie, s.l-610 m, E. Medit. Element, endemic, VU. Serpentinovag.*
- EUPHORBIACEAE
166. *Euphorbia acanthothamnus* Heldr. & Sart. ex Boiss.

- Dry rocky limestone slopes, serpentine slopes under *Pinus brutia*, 30-300 m, E. Medit. Element. Serpentinovag.
167. *Euphorbia apios* L.  
Metamorphic rocks, serpentine, limestone, clay in *Quercus* and *Pinus brutia* forest, *Corylus* & *Crataegus* scrub, macchie, field margins, 150-1200 m, E. Medit. Element. Serpentinovag.
168. *Euphorbia austroanatolica* Hub.-Mor. & M.S. Khan.  
*Pinus brutia* forest on serpentine, macchie, limestone cliffs, 50-1600 m, E. Medit. element., endemic, LR(cd). Serpentinovag.
169. *Euphorbia aleppica* L.  
Dry stony slopes, serpentine hills, steppe, streamsides, fields and roadsides, 150-1350 m. Serpentinovag.
170. *Euphorbia herniariifolia* var. *herniariifolia*.  
Rock crevices (limestone, serpentine, quartzite etc.), rocky slopes and screes, often in conifer belt, stony steppe, 50-3050 m. Serpentinovag.
171. *Euphorbia herniariifolia* var. *glaberrima* Hal.  
Rock crevices (limestone, serpentine, quartzite etc.), rocky slopes and screes, often in conifer belt, stony steppe, 50-3050 m. Serpentinovag.  
RUBIACEAE
172. *Asperula tenuifolia* Boiss.  
Dry rock ledges on limestone or serpentine, 700-2200 m., E. Medit. (mt.) element., endemic, LR(lc). Serpentinovag.
173. *Galium sieheanum* Ehrend.  
[Turkey C5 Adana] Gerölle des MasmütU dagh, 2300 m, *Antitaurusim* Norden von Bozanti (Pozanti), Vilayet Konia, vi 1906, Siehe 347(holo. W! iso. E!). S. Anatolia; rare. C5 Adana: Karsanti, Akinek Da., 1760 m, Yurdakulol 86-12! Alpine scree, on serpentine (always?), 1760-2300 m., Endemic to Ala Daglari, VU. Serpentinophyt.
174. *Galium tmoleum* Boiss.  
[Turkey C2 Denizli] ad rivulos alpinos montis Tmoli ad Bozdag, vii 1842, Boissier (holo. G!). S.W. Anatolia. C2 Muğla: Nif Da., 5 vii 1881, Luschan (type of *G. pulchellum*)! Köyceğiz, Sandras Da. nr Gökçe ova, D. 13507a! ibid., D. 13507! C3 İsparta: Dedegöl Da., 2300 m, D. 16025! Open alpine habitats (sometimes on serpentine), c. 1500-2300 m., endemic, VU. Serpentinophyt.
175. *Galium dieckii* Bornm.,  
[Turkey C5 Niğde] *Taurus Ciliciae in rupibus vulcanicis (dioriticis) haud procul a portis Ciliciae, supra Tschift-Han (Çiftehān), 1400 m, vi 1906, Dieck (holo. B!). C. & S. Anatolia. C5 Niğde: Ovacik, nr Tyana (Kemerhisar), c. 1400 m, Siehe! 4 km W. from Çiftehān to Ulukişla, c. 1000 m, Ehrend. 62-1/67-27! 25 km from Ulukişla to Pozanti, 1130 m, Hub.-Mor. 16435! Serpentine rocks, 1000-1400 m., endemic, LR(cd). Serpentinophyt.*
176. *Galium setuliferum* Ehrend. & Schönb.,  
Turkey C6 Adana: Amanus, mt. Düldül, 1500-2000 m, Haradjian 3906 (holo. W!). S. Anatolia (Amanus). C6 Adana: Amanus, Düldül Da., 1500-2000 m, Haradj. 3842 Serpentine rocks, 1500-2000 m, endemic, DD. Serpentinophyt
177. *Galium galiopsis* (Hand.-Mazz.) Ehren.  
[Turkey B7 Elaziğ] Gesteinfluren auf Serpentin des HosarbabaDagham Göldschik (Quellsee des westUchen Tigris), 1800-2450 m, 29 vii 1910, Handel-Mazzetti 2578 (holo. W!). E. Anatolia. B7 Elaziğ: above S.W. slope of Hazar G., c. 5 km E. of Sivrice, Ehrend, et al. 787-68-Serpentine scree, 1200-2450 m., Ir.-Tur. Element, Serpentinicolous endemic, EN. Serpentinophyt.
178. *Galium floribundum* subsp. *airoides* Hub.-Mor. ex Ehrend. & Schönb.,  
Turkey C3 Antalya: bay of Tekirova at E. foot of Tahtali Da, on serpentine, 0-50 m, 25 v 1950, Huber-Morath 10079 (holo. Hb. Hub.-Mor.). S.W. Anatolia. C2 Muğla: N.W. of Marmaris, 20-50 m, Runem. & Bentzer 29409! C3 Antalya: Perge, W. of theatre, Sorger 66-9-4! İsparta: Dedegöl Da. between Daribükü and Selköse, D. 15967! Steppe hills, gravel, s.L-50 m., E. Medit element, endemic, LR(nt). Serpentinophyt.  
ARACEAE
179. *Arum elongatum* subsp. *detruncatum* (C.A. Meyer ex Schott) H. Riedl in Rech.  
Limestone and serpentine rocks and slopes, steppe, *Juniperus* scrub, 400-1800 m. Serpentinovag.  
LILIACEAE
180. *Allium cupani* subsp. *hirtovaginatatum* (Kunth) Stearn.  
*Pinus nigra* forest, among *Quercus*, phrygana, alpine and grey steppe, rocky places on limestone, serpentin and schist, fallow fields, s.L-2200 m. Serpentinovag.
181. *Allium callidictyon* C.A. Meyer ex Kunth.  
*Quercus* scrub, alpine steppe, rocky slopes on limestone and serpentine, cornfields, 400-2800m. Serpentinovag.
182. *Muscari macrocarpum* Sweet.  
Rocky macchie and on serpentine and limestone slopes near the sea, 10-800 m, E. Medit. Element, nadir, VU. Serpentinovag.
183. *Muscari tenuiflorum* Tausch.  
*Pinus nigra* and *P. brutia* forest, *Juniper* scrub, *Artemisia* steppe, pastures, rocky slopes, on limestone, serpentine, gypsum and volcanic soils, nr s.L-2400 m. Serpentinovag.
184. *Muscari armeniacum* Leichtlin ex Baker.  
Limestone slopes, rock outcrops, sometimes on serpentine or schist, often in *Juniperus* scrub, *Pinus brutia* forest with *Quercus*, *Pinus sylvestris* woods, *Sarcopoterium spinosum* phrygana, pastures, sand dunes, s.L-2 750 m. Serpentinovag.
185. *Muscari inconstictum* Rech.  
[Transjordan] Arabia Petraea, Petra, Felsen, 1000 m, Davis 10371(holo. S!). S. Anatolia. C6 Hatay: iskenderun to Haleb (Aleppo), nr Kyryk Han at foot of Amanus, c. 180 m, Hand.-Mazz. 24! Phrygana on serpentine, c. 180 m., Ir.-Tur. Element, rare, VU. Serpentinophyt.
186. *Muscari bourgaei* Baker.  
Mountain pastures, stony slopes, on calcareous and igneous substrata, 1500-3000 m., Medit. (mt.) element, endemic, LR(lc). Serpentinovag.
187. *Fritillaria forbesii* Baker.  
[Turkey C2 Muğla] *Lyeia* in dumetisrupestribus ad Macri (Fethiye), [s.l.-1000 m, 1842], E. Forbes 626 (holo. K!). S.W. Anatolia. C2 Muğla: Marmaris to Emecik, 350 m, D. 25375!

- Fethiye, 100 m, D. 25408 *Pinus brutia* forest, macchie on serpentine, s.l.-1000 m, E. Medit. Element, endemic, EN. Serpentinophyt.
188. *Fritillaria carica* subsp. *serpenticola* Rix. Turkey C2 Antalya: between Karaçulha and Altinyayla, in bare Brown scree, 1700 m, 5 iv 1980, O. S'nderhousen 680 (holo. E!). Serpentine screes with *Pinus* and *Juniperus*, c. 1 700 m, E. Medit. element., endemic, EN. Serpentinophyt.
189. *Colchicum lagotum* K.Perss (Turkey) B8 Erzurum: Çat to Bingöl, 73 km from Erzurum, 7 km before Cirisli Geçidi Steep unstable serpentine slopes, 1900 m, endemic, new takson for science, CR. Serpentinophyt.
190. *Merendera figlalii* Varol. (Turkey) C2 Muğla: Sandras Dağ, around Kartal Gölü 1900-2100 m serpentine rocks, open stony places endemic, new takson for science, CR. Serpentinophyt.
191. *Allium karacae* M.Koyuncu. Turkey. C4 Konya: between Hadim-Taşkent, open forest and steppe, 1450 m, 22 vii 1993, H. Karaca, T. Ekim, M. Koyuncu & A. Güner (holo. AEF 182001). S. Anatolia. C3 Antalya: Akseki, Geyran Yaylası, 1250 m, H. Duman 5632-Z. Aytaç & A. Duran! C4 Konya: between Taşkent-Ermenek, 1650 m, Koyuncu & Coşkun (AEF 12642); Taşkent-Sanveliler, 4 km, 1650 m, Koyuncu & Güner (AEF 182461) Steppes, dry slopes, open places and serpentine sa; 1250-1650, E. Medit. element, endemic, LR(cd). Serpentinophyt.
192. *Allium koyuncui* H.Duman & N.Özhatay. Turkey. C4 Konya: Bozkır, between Korualan-Akdam Yaylası, 18 km, serpentine; high mountain steppes, 2000-2100 m, 19 vii 1996, H. Duman 6202-A. Duran & M. Dadandı (holo. GAZI; iso. ISTE, AEF, K). High mountain steppe, serpentine rocky places, 2000-2100 m, E. Medit. element (mt.), endemic. Serpentinophyt.
193. *Fritillaria sibthorpiana* subsp. *enginiana* Byfield & N.Özhatay. *Pinus brutia* and *Platanus orientalis* woodland and wood margins on limestone, serpentine and shales, 50-1450, E. Medit element, endemic, EN. Serpentinovag.
194. *Fritillaria byfieldii* N.Özhatay & Rix. Stony slopes, loose and mobile limestone screes. 1700-1900 m, E. Medit element, endemic. Serpentinovag.
195. *Colchicum lingulatum* subsp. *rigescens* K.M.Perss. Turkey C2 Muğla: 25 km from Marmaris to Datça, bare brown stony soil (serpentine) among *Pinus*, 140 m, 21 iv 1991, fid. in cult. 31 viii 1992, K. Persson 515 (holo. GB!; iso. K!). SW. Anatolia. C2 Muğla: Datça peninsula, Runemark & Wendelbo bulb coll. no. 191; Marmaris to Datça, 200 m, T. Baytop, Mathew & Brickell (ISTE 31367) ! ; 48 km from Datça to Marmaris, 50 m, T. Baytop & Leep (ISTE 36234)! Open stony places among *Pinus* and *Erica*; on ultramafic ground; 50-200 m., E. Medit. element, endemic subspecies. Serpentinophyt.
196. *Muscari sandrasicum* Karlén. Turkey [C2] Muğla: Sandras Dağ, W. side of the summit area, 2100-2200 m, snowbed meadows and rocky slopes, serpentine, 7 vii 1984, Strid et al. 23379 (holo. C, iso. EGE, LD). S.W. Anatolia. C2 Muğla: S.W. side of Sandras Da. between Ağla village and fire watchtower, 1750 m, 6 vii 1984, Hartvig et al. s.n. (bulbs cult. LD as KE 351) Snowbed meadows and rocky slopes on serpentine, 1750-2200 m, E. Medit. element, endemic. Serpentinophyt.
- CYPERACEAE
197. *Scirpoides holoschoenus* (L.) Sojak. Marshes, wet meadows, streamsides, river valleys and flats, volcanic ash by crater lake, serpentine or siliceous rock, coastal dune slacks, edge of saline canals, s.l.-3050 m. Serpentinovag.
198. *Schoenus nigricans* L. Peaty places, serpentine rock by streams, damp flushes, open stony slopes, saline marshes, thermal springs, open limestone heath, meadows, maritime sand, s.l.-2000 m. Serpentinovag.
- POACEAE
199. *Brachypodium kotschy* Boiss. [Turkey C5 Niğde] in arenosis dioritica Tauri Cilicici ad Bulgar Mağara, 2440 m, Kotschy 233 sub *B. ramoso* var. (holo. G!). S. Anatolia. C4 Konya: Bozkır to Haydar Da., 2000 m, Çetik et al. 60! C5 Adana: Karsanti to Pos ormani, Hızar Bölgesi, Hızar Y. civari, 1300 m, Yurdakulol 1409! Taurus mts., Kotschy 536! On diorite and serpentine, 1300-2440 m., Ir.-Tur. Element, endemic, VU. Serpentinophyt.
200. *Secale montanum* Guss. In massive stands on non-arable steppe, on limestone, volcanic slopes, serpentine, in *Quercus cerris* forest, as weed with *Triticum turgidum* on arable land, spilling over to roadsides, 800-3050 m. Serpentinovag.
201. *Secale ciliatoglume* (Boiss.) Grossh. [Iran] in monte Zagros Kurdistaniae Persicae, Haussknecht (holo. G). E. Anatolia. B7 Tunceli: 17 km S. of Tunceli, 1100 m, 8 viii 1972, Spencer 0407! Elaziğ: Hazar G, c. 5 km E. of Sivrice, 1200 m, Ehrend, et al. 787-68-3! B9 Bitlis: Nemrut Da, A. Baytop (ISTE 31086)! Süphan Da, 2500 m, D 24716! C8 Mardin: Mardin, Sint. 1888:1192! Bakakri (Bakirkiri), Sint. 1888:1326 (as *S. montanum*) Mountain slopes, growing with *Aegilops* and *Triticum*, on serpentine, 1100-2700 m., Ir.-Tur. Element, rare, VU. Serpentinophyt.
202. *Polypogon maritimus* Willd. subsp. *maritimus*. Sand dunes, serpentine cliffs, s.l.-400 m., Euro-Sib. Element. Serpentinovag.
203. *Festuca ziganensis* Markgr.-Dannenb. [Turkey] A8 Gümüşane : Bayburt, Kop Dağ, Quellmoor südlich des Strassenpasses mit Sefw/ß-Büschen, feuchter Mergel, 2300 m, 15 vii 1958, I. & F. Markgraf s.n. (holo. Z!). N. Anatolia. A4 Kastamonu: Kara Su, N. of İlgaz Da, 1050m, Simon! A8 Gümüşane: Kop Da, E. slope, Çankule roadmen's house, Butler 14303 Streams, fens, sometimes on serpentine, 1050-2300 m., endemic, VU. Serpentinophyt.
204. *Briza minor* L. Edge of *Quercus* forest, marshy grassland, springs on serpentine debris, etc., nr s.l.-30 m. Serpentinovag.
205. *Sesleria alba* Sm. in Sibth. & Sm. Stony slopes and screes above tree-line, on limestone or serpentine, at edge of or in open *Pinus brutia*, *P. nigra*, *P. sylvestris*, *Cedrus libani*, *Abies*,

- Juniperus* or *Carpinus-Fagus* forest, 50-3125 m. Serpentinovag.
206. *Melica ciliata* L. subsp. *ciliata*.  
*Pinus nigra* forest, rocky slopes, gorges, steppe, fallow fields, dry river beds, on limestone, serpentine, gypsum, lava, etc., 400-2800 m. Serpentinovag.
207. *Piptatherum miliaceum* subsp. *thomasi* (Duby) Freitag.  
Cliffs, on serpentine, *Pinus brutia* woods, macchie, shady banks, edge of fields, rocky knolls nr sea, s.L-900 m. Serpentinovag.
208. *Piptatherum coeruleascens* (Desf.) P. Beauv.  
Steep ridges, rocky limestone slopes, conglomerate (serpentine) rocks in river and on cliffs, open *Quercus* and *Pinus brutia* forest, waste places with rubble, nr s.l.-1420 m. Serpentinovag.
209. *Piptatherum holciforme* var. *holciforme*.  
Mixed or open *Pinus* forest, granitic rock, serpentine, limestone slopes and screes, by lakes, river valleys and gorges, s.L-3200 m. Serpentinovag.
210. *Eragrostis minor* Host.  
On serpentine, limestone cliffs with thermal pools, gravelly screes, valleys and dried up river beds, wet places, by lake shores, salt pans, under *Populus*, at edge of and in cultivated fields, ditches, roadsides. Serpentinovag.
211. *Bromus regnii* H. Scholz.  
*Liquidambar orientalis* forest, serpentine, c. 100 m, open ground on serpentine, phrygana on serpentine, serpentine, limestone, new record for Turkish Flora. Serpentinovag.  
CRASSULACEAE
212. *Sedum caricum* A. Carlström.  
On limestone, granite and serpentine, s.L-1000 m, E. Medit. Element, endemic. Serpentinovag.
213. *Prometheum serpentinicum* (Werdermann) 't Hart var. *giganteum* (Eggl.) 't Hart.  
Turkey C2 Muğla: between Muğla and Marmaris, in a narrow ravine, serpentine, ann. 1984, A. Carlström s.n. (holo Z; iso ISTE!). SW. Anatolia. C2 Muğla, 3 km N. of Marmaris, E. of the road to Muğla, 150 m, 't Hart, HRT 30205!; Marmaris, Balan Dağı. c. 100 m, H. Şağban 1860 & H. Dumani On serpentine, 100-150 m, endemic. Serpentinophyt.
214. *Rosularia sempervivum* subsp. *amanensis* Eggl.  
[Turkey C6 Hatay:] monts Amanus, 1520 m, vii 1906, Haradjian 536 (holo.G, iso. K). S. Anatolia. C6 Hatay: Erzin, Amanos Dağ, Ufacık Y., 1700 m, Akman 201 ! Monts Amanus, 1200-1800 m, Haradjian 4637!; Adana: 28 km S. of Osmaniye, above Zorkun, 1700 m, K.Alpmar & H. vt Hart (ISTE 60971 !). Serpentine rocks, 1500-1800 m., E. Medit. element, endemic, EN. Serpentinophyt.
215. *Sedum ursi* 't Hart.  
endemic, LR(lc). Serpentinovag.
216. *Sedum eriocarpum* subsp. *caricum* (Carlström) 't Hart.  
On serpentine, also on limestone, endemic, EN. Serpentinovag.
217. *Rosularia serpentinica* (Werdermann) Muirhead [Turkey C2 Muğla] distr. Köyceğiz, Sandras Da., in *rupibus serpentinicis cacuminis Çiçekli Buba*, c. 3000 m, 18 vii 1938, Schwarz 557. S.W. Anatolia. C2 Muğla: Sandras Da. , 2200 m, D. 135571 Antalya: Ak Da. , 2000 m, Sorger 68-26-80 Serpentine rocks, 2000-3000 m. Serpentinophyt.  
GENTIANACEAE
218. *Centaurium serpentinicola* A. Carlström.  
Turkey [CI] Muğla: Datça peninsula, 8 km N.W. of Orhaniye, c. 100 m, 18 V 1983, Carlström 10671 (holo. LD). S.W. Anatolia. CI Muğla: Kuruca adasi, 8 km E.S.E. of Emecik, Carlström 10961. C2 Muğla: 43 km from Muğla to Fethiye, 70 m, D. 35147! Open places on serpentine, c. 70-100 m, E. Medit. Element, endemic, VU. Serpentinophyt.  
OROBANCHACEAE
219. *Orobanche rechingeri* Gilli.  
On *Alyssum* sect. *Odontarrhena* (incl. *A. masmenaeum* Boiss.), in open *Pinus nigra* forest and on rocky limestone slopes, serpentine rock and snowbed meadows, 1500-2200 m. Serpentinovag.  
SINOPTERIDACEAE
220. *Cheilanthes maderensis* Lowe.  
Spores ripe 4-7. Dry rocky places, serpentine outcrops, old walls, s.L-100 m. Serpentinovag.  
POLYGONACEAE
221. *Polygonum karacaei* Ziel. & Boratynski.  
Turkey C2 Muğla: Massif of Sandras Dağı, summit area of Çiçekli Büyük Kızıldağ, 1900-1950 m, 20 vi 1989, Boratynski & Zielinski 6900 (B, iso. KOR!). S.W. Anatolia. C2 Muğla: Köyceğiz, Sandras Dağı, Serçe pass, 1650 m, N. & E. Özhatay (ISTO 20669!); Burçova, 1800 m, N. & E. Özhatay (ISTO 20639!); Burdur: Korkuteli, SE. of Altınyayla, Dirmil Pass, 1600 m, N. & E. Özhatay, M. Johnson (ISTE 67376! Open forests, serpentine rocks, 1650-1950 m, endemic, LR(cd). Serpentinophyt.  
PINACEAE
222. *Pinus nigra* subsp. *pallasiana* Lamb. (Holmboe)  
Deep weathered serpentine rocks. Serpentinovag.

When we examine the taxa which are specific to serpentine soils according to their families the first place is occupied by Asteraceae with 36 taxa. It was followed by Lamiaceae with 21 taxa, Brassicaceae with 20 taxa, Liliaceae with 17 taxa, Caryophyllaceae with 16 taxa; Scrophulariaceae with 15 taxa; Poaceae with 13 taxa; Apiaceae with 11 taxa; Plumbaginaceae with 9 taxa; Fabaceae with 8 taxa; Boraginaceae and Rubiaceae with 7 taxa, and Crassulaceae, Convolvulaceae and Euphorbiaceae with 6 taxa. Other families have 25 taxa in total.

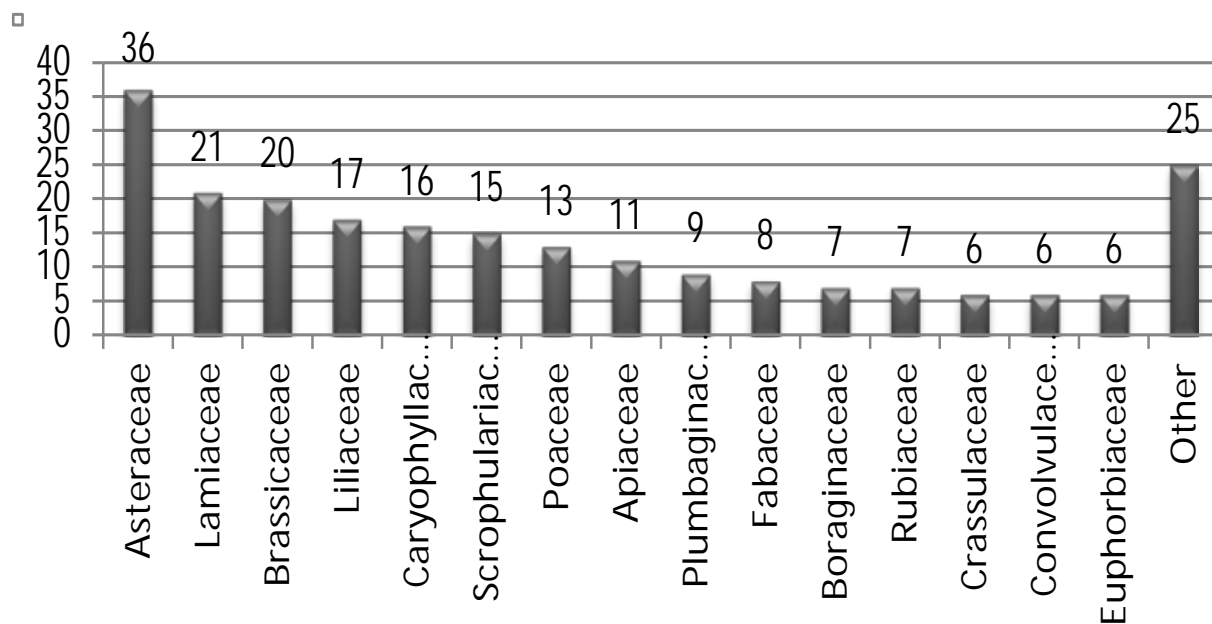


Figure 2. The distribution of the serpentine specialist taxa according to their family.

When we classify the serpentine species there are 142 endemic and 8 rare taxa observed in national or global scale. According to IUCN threatened categories among these rare taxa 2 of them attached to be in DD and 6 of them in VU categories. The distribution of the endemic taxa according to IUCN threatened categories are as follows EX, 1; CR, 20; EN, 29; VU, 21; LR(cd), 27; LR(nt), 8; LR(lc), 14; DD, 2 (Ekim et al. 2000)

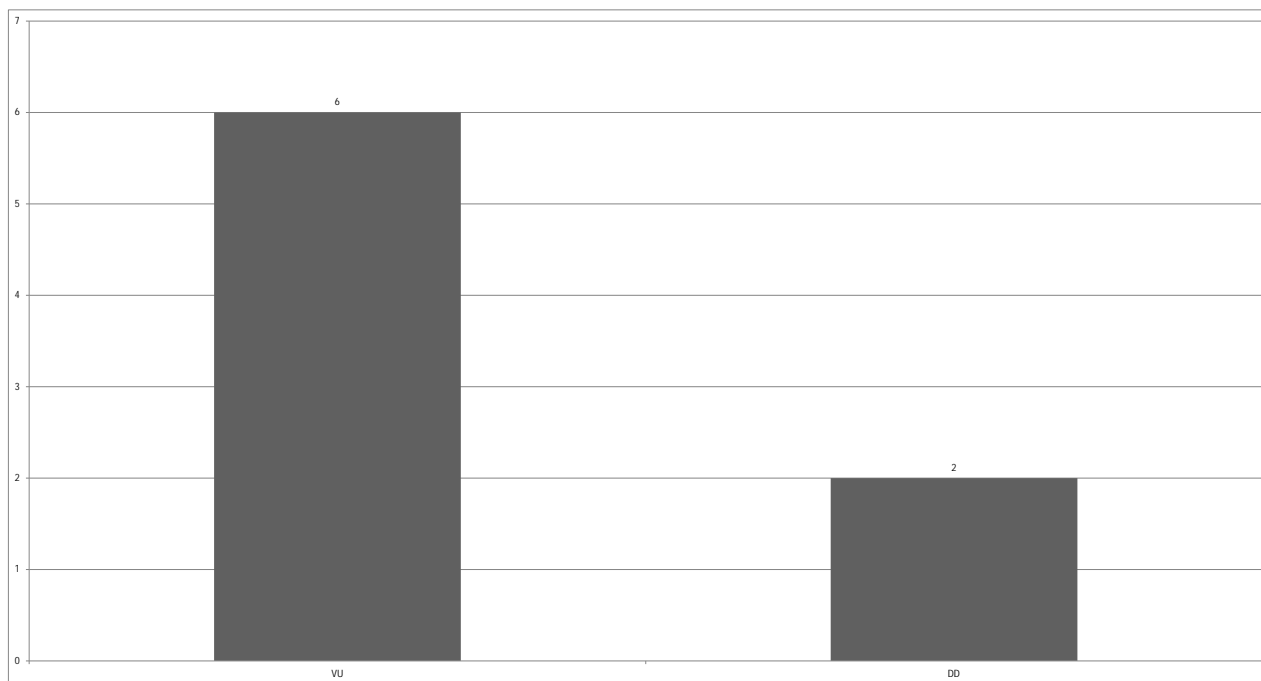


Figure 3. : The distribution of the serpentine specialist nationally or globally rare taxa according to IUCN threatened categories.

The distribution of 223 taxa specific to serpentine soil according to phytogeographical areas are as follows: 91 taxa in East Mediterranean element, 5 taxa Mediterranean element and 42 taxa in Irano-Turanian phytogeographical region. The number of taxa in Euro-Siberian and Euxin element is 3. The reason for the high density of taxa in Mediterranean and Irano-Turanian regions is related to the geological processes and the intensification of these metamorphic rocks in this phytogeographic region.

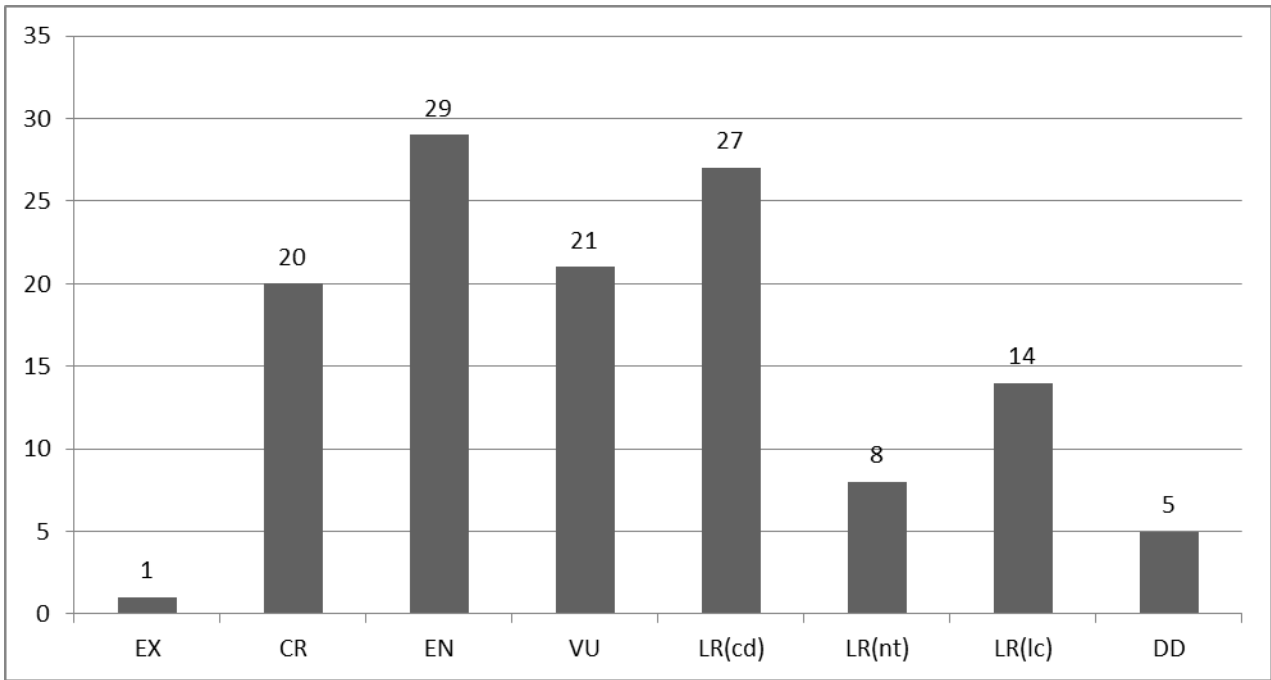


Figure 4. The distribution of serpentine specialist endemic taxa according to IUCN threatened categories

There were 8 taxa found in Flora of Turkey which take its epithet form serpentine. These are :

**CRASSULACEAE**

*Rosularia serpentina* (Werdermann) Muirhead  
Serpentine rocks, 2000-3000 m.

**SCROPHULARIACEAE**

*Verbascum serpenticola* Hub.-Mor.  
Serpentine scree, 1600 m

**L I L I A C E A E**

*Fritillaria carica* subsp. *serpenticola* Rix  
Serpentine screes with *Pinus* and *Juniperus*, c. 1700 m

**GENTIANACEAE**

*Centaureum serpenticola* A.Carlström  
Open places on serpentine, c. 70-100 m

**FABACEAE**

*Astragalus serpenticola* H.Duman & Ekim  
*Pinus nigra* and *Quercus sp.* forest, on serpentine.  
1150-1650 m

**CRASSULACEAE**

*Prometheum serpenticum* (Werdermann) 't Hart var.  
*giganteum* (Eggl) 't Hart  
On serpentine, 100-150 m

**ASTERACEAE**

*Centaurea serpentina* A.Duran & B.Doğan

**BRASSICACEAE**

*Erysimum serpenticum* Polatschek

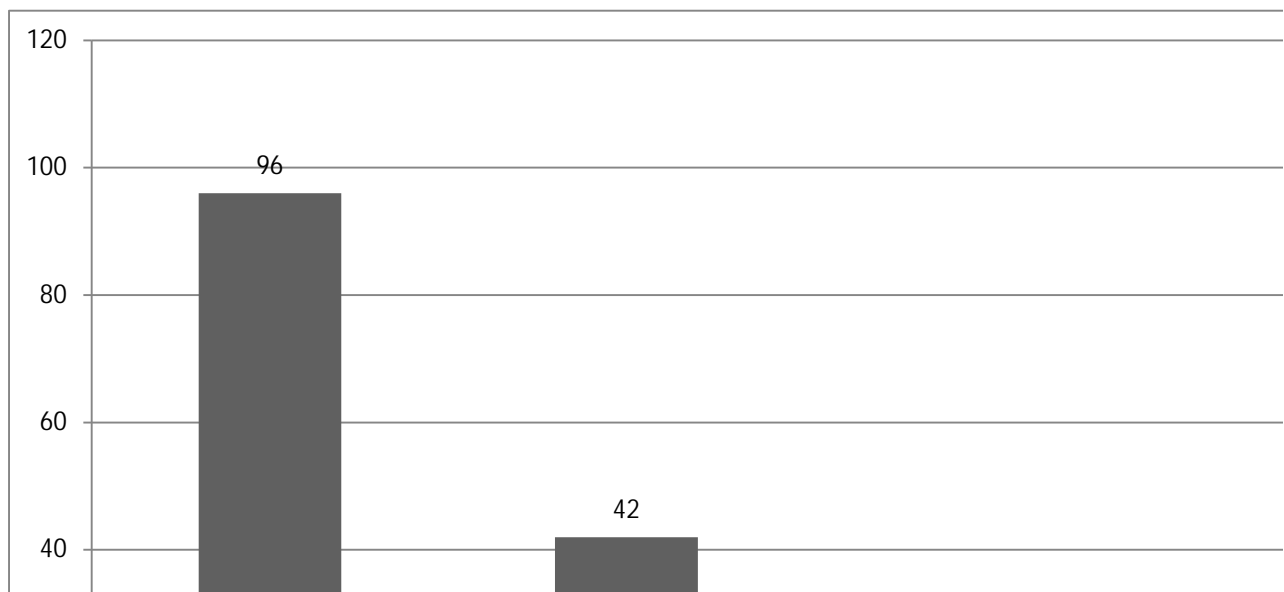


Figure 5. The distribution of serpentine specialist taxa according to phytogeographical regions



#### 4. Conclusions

The Flora of Turkey has been published in 9 volumes between 1965-1988. The newly found taxa were added as two supplementary volumes. In spite of this almost a new taxon is reported every week. Although the floristic studies in Turkey are far from completed the studies should be directed to the edaphic diversity which is the most important region for the biological diversity. The floristic studies related to the parent rock are partially started.

The ecology of the serpentine system is of special importance due to the high endemism and the morphological structures of serpentine specialist species and their adaptation to extreme conditions (Brady et. al., 2005). The research carried out on the difference between the vegetation and the endemism of the high and low regions of the large serpentine regions in eastern Australia showed the number of endemic species in higher region are twice the endemic species observed in lower regions (Batianoff and Singh, 2001). Serpentine habitats are the most important endemic regions in the world. The serpentine regions in Turkey extends from the western parts of the country to Muğla and Hatay regions of the Mediterranean part, in Bilecik, Bursa and Kütahya regions in the junction point of Marmara and Aegean parts and the large areas between Ankara and Erzincan (Reeves and Adıgüzel, 2004).

Although the inventory of the plants which grow on serpentine has not been completed yet it is assumed that there would be at least 100 species endemic to serpentine due to the fact that The Flora of Turkey contains more than 9000 species with an endemism ratio of %25 (Reeves and ark., 2001). The studies carried out in serpentine regions the western part of Turkey (Çanakkale, Balıkesir, Ankara, Antalya and Muğla, İçel, Niğde and Seyhan, Kütahya regions) revealed 8 new nickel accumulator species (*Alyssum murale* Waldst. et. Kit. subsp. *murale* var. *haragjianii* (Rech.) Dudley, *A. sibiricum* Willd., *A. aff. Cassium* Boiss. (probably a new taxon), *A. dudleyi* N. Adıgüzel & R. D. Reeves, *Aethionema spicatum* Post, *Thlaspi perfoliatum* L. , *Th. cariense* A. Carlström and *Centaurea ptosimopappoides* Wagenitz ).

There are 223 taxa which develop adaptability to the extreme conditions on serpentine rocks which are one of the ultramaphic rocks widely distributed in Turkey. 142 of these taxa are endemic and 8 of them are rare in national or global dimensions.

When we examine the distribution of serpentine rocks they are seen to be concentrated on the Anatolian Diagonal and it there was another reason for the higher endemism on it.

Although the Flora of Turkey is seen to be extensive with 11 volumes the fact that there are nearly 50 taxa found every year and most of these taxa are seen to be located on serpentine rocks makes the further floristic studies an absolute necessity (Figure 6.).

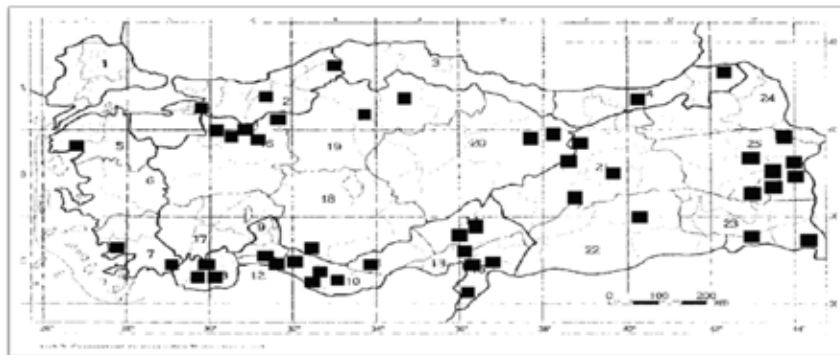


Figure 6. : The distribution of the taxa discovered in Turkey after 2000 (Avcı, M., 2005 abridged ).

When we investigate the regions where 223 taxa which adapted to the extreme serpentine systems, 97 of them are regarded as *serpentinophyt* (obligative serpentine plant i.e obligate) and remaining 126 ones are regarded as *serpentinovag* (grown on both serpentine and non-serpentine habitat i.e facultative). The data needs further verification by further studies regarding the genetic solutions and life strategies which the plants developed to adapt these extreme conditions.

The serpentine system which constitutes an important part of Flora of Turkey is the extreme habitats for the growth of plants. Some of the taxa which adapted to these extreme conditions which are also known as “*geological islands*” or the “*edaphic islands*” show limited distribution within these areas. The reason that most of these taxa have high IUCN threatened categories (EX, 1; CR, 20; EN, 29; VU, 27 and etc.) is attributed to the extreme conditions. It is necessary that the serpentine systems which are the most important endemic fields of the world are to be regarded as the high priority protection areas.

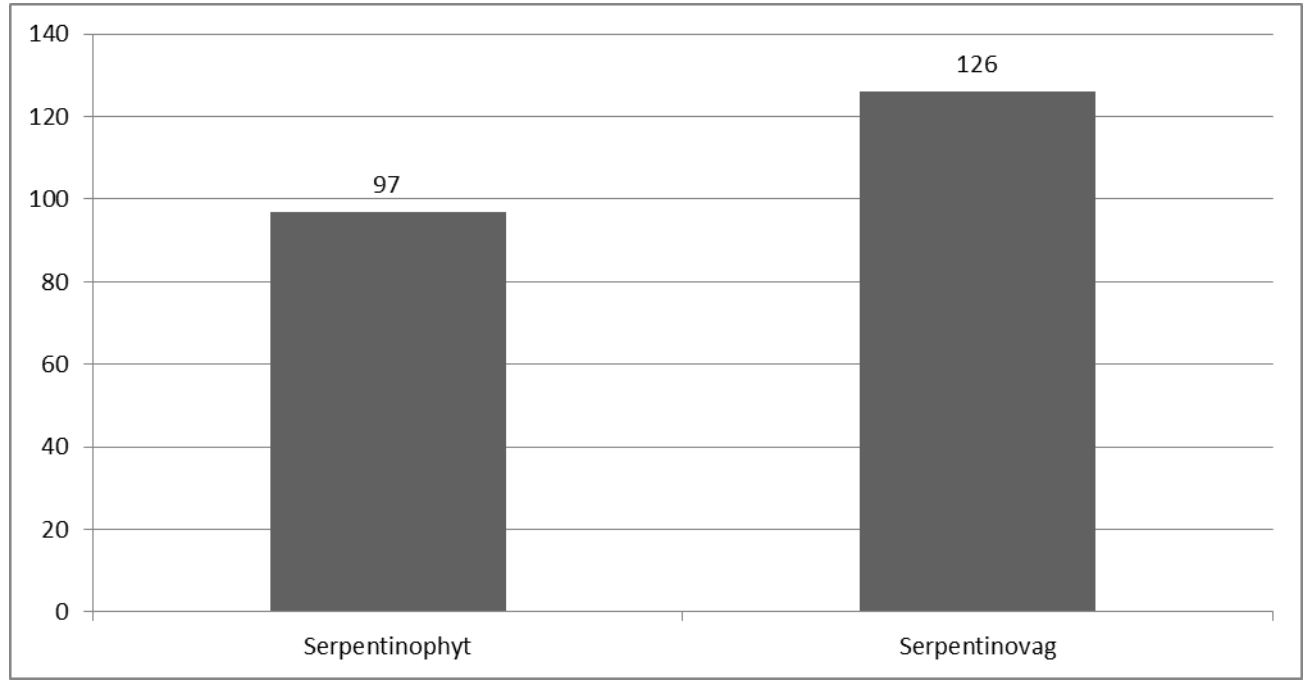


Figure 7. : The distribution of serpentinophyte and serpentinovags which developed resistance to serpentine conditions.

## References

- Adıgüzel, N., Reeves, RD. 2002. "A new nickel-accumulating species of *Alyssum* (Cruciferae) from western Turkey", *Edinburgh Journal of Botany* 59: 215-219.
- Atalay, I., Efe, R. 2012. Ecological attributes and distribution of Anatolian black pine [*Pinus nigra* Arnold. subsp. *pallasiana* Lamb. Holmboe ] in Turkey. *J. Environ. Biol.* 33, 509-519 (2012)
- Avcı, M. 2005. Diversity and endemism in Turkey's vegetation. *İstanbul Üniversitesi Edebiyat Fakültesi Coğrafya Bölümü Coğrafya Dergisi* 13: 27-55.
- Aytaç, Z., Aksoy, A. A new *Sideritis* species (Labiatae) from Turkey. - *Fl. Medit.* IO: 181- 184. 2000. - ISSN 1120-4052.
- Aytaç, Z., 2000. A new species of *Bornmuellera* Hausskn. (Brassicaceae) from south Anatolia, Turkey. *Botanical Journal of the Linnean Society* (2000), 134: 485–490.
- Baker, AJM., J. Proctor, and Reeves, RD. (Eds.). 1992. *The Vegetation of Ultramafic (Serpentine) Soils*. Proceedings of the First International Conference on Serpentine Ecology. Intercept, Andover, Hampshire, UK. 509 pp.
- Batianoff GN, Singh S. 2001. Central Queensland serpentine landforms, plant ecology and endemism. *S. Afr. J. Sci.* 97: 495–500
- Brady, KU., AR. Kruckeberg, HD., Bradshaw Jr. 2005. Evolutionary ecology of plant adaptation to serpentine soils. *Annu. Rev. Ecol. Evol. Syst.* 36: 243–266
- Brooks, RR. 1987. *Serpentine and its vegetation: a multidisciplinary approach*. Dioscorides Press, Portland.
- Brown, JH. 1995. *Macroecology*. Univ. of Chicago Press, Chicago.
- Davis PH.: *Flora of Turkey and the East Aegean islands*. 1-9. Edinburgh: Edinburgh Univ. Press. UK (1965-1985)
- Davis, PH., Tan, K., 1988. *Mill R.R. Flora of Turkey and the East Aegean islands*. 10. Edinburgh: Edinburgh Univ. Press. UK.
- Davis MA, Boyd RS, Cane JH. 2001. Host-switching does not circumvent the Ni-based defense of the Ni hyperaccumulator *Strep-tanthus polygaloides* (Brassicaceae). *S. Afr. J. Sci.* 97: 554–5
- Duran, A., 2009. *Hesperis ozcelikii* (Brassicaceae), a new species from Turkey. *Ann. Bot. Fennici* 46: 577-584.
- Duran, A., Ozturk, M., Doğan, B. 2009. A New Species of the Genus *Psephellus* (Asteraceae) From North-East Anatolia, Turkey. *Ozean Journal of Applied Sciences* 2(1), 2009.
- Duran, A., Dogan, B., Hamzaoglu, E., Aksoy, A. 2011. *Scorzonera coriacea* A. Duran & Aksoy (Asteraceae, Cichorieae), a new species from South Anatolia, Turkey. *Conservatoire Et Jardin Botaniques De Genève, Candellea* 66(2): 353-359 (2011).
- Doğan, M., Akaydin, G. 2003. Two new species in *Acanthalimon* sect. *Staticopsis* (Plumbaginaceae) from Turkey. *Ann. Bot. Fennici* 40: 53-58.
- Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z., Adıgüzel, N. 2000. *Türkiye Bitkileri Kırmızı Kitabı (Pteridophyta and Spermatophyta)*, Türkiye Tabiatını Koruma Derneği ve Yüzüncü Yıl Üniversitesi yayını, Ankara

- Erik, S., Tarikahya, B. 2004. "Türkiye Florası Üzerine", *Kebikeç* 17:139-163.
- Futuyma, DJ., G. Moreno. 1988. The evolution of ecological specialization. *Annu. Rev. Ecol. Syst.* 19: 207–233.
- Gaston, KJ., Blackburn, TM. 2000. *Pattern and process in macroecology*. Blackwell, Oxford.
- Güner, A., N. Özhatay, Ekim T., Baser KHC. 2000. *Flora of Turkey and the East Aegean islands* . 11. Edinburgh: Edinburgh Univ. Press.
- Hoşgören, MY. 2000. *Jeomorfolojinin Ana Çizgileri I*, Rebel yayıncılık, İstanbul.
- Kantarıcı, D., 1987. *Toprak İlimi*, İstanbul Üniversitesi Orman Fakültesi yayını, İstanbul
- Karavelioğulları, F. A., Duran, A., Hamzaoğlu, E. 2004. *Verbascum tuna-ekimii* (Scrophulariaceae), a new species from Turkey. *Ann. Bot. Fennici* 41: 227-231.
- Krückeberg, AR. 1954. The ecology of serpentine soils: A symposium. III. Plant species in relation to serpentine soils. *Ecology* 35: 267–
- Krückeberg, AR. 1984. *California serpentines: flora, vegetation, geology, soils, and management problems*. Univ. of California Press, Berkeley, CA.
- Krückeberg, AR., Adıgüzel, N., Reeves, RD. 1999. Glimpses of the flora and ecology of Turkish (Anatolian Species), *The Karaca Arboretum Magazine* 5 (2): 67-86
- Krückeberg, AR. 2002. *Geology and plant life: the effects of landforms and rock types on plants*. University of Washington Press, Seattle, WA.
- Özhatay N, Kültür Ş., Aksoy, N. 1994. Check-List of additional taxa to the supplement Flora of Turkey. *Turk J Bot.* 18: 497-514.
- Ozhatay, N., Kültür, Ş. Aksoy, N. 1999. Check-list of additional taxa to the Supplement Flora of Turkey II. *Turk. J. Bot.* 23: 151- 170.
- Ozhatay, N., Kültür, Ş. 2006. Check-list of additional taxa to the Supplement Flora of Turkey III. *Turk. J. Bot.* 30: 281-316.
- Ozhatay, N., Kültür, Ş. Aslan, S. 2009. Check-list of additional taxa to the Supplement Flora of Turkey IV. *Turk. J. Bot.* 33: 191-
- Ozhatay, N., Kültür, Ş., Gürdal, MB. 2011. Check-list of additional taxa to the supplement Flora of Turkey V. *Turkish Journal of Botany* 35: 589-624.
- Parolly, G., Tan, K. 2006. A new species of *Hesperis* (Brassicaceae) from SW Anatolia, Turkey. – *Willdenowia* 36: 851-856. – ISSN 0511-9618; 2006 BGBM Berlin-Dahlem.
- Proctor, J., Woodell, SRJ. 1975. The ecology of serpentine soils. *Advances in Ecological Research* 9: 255–366.
- Proctor, J. 1999. Toxins, nutrient shortages and droughts: the serpentine challenge. *Trends Ecol. Evol.* 14: 334–35
- Rajakaruna, N. 2004. The edaphic factor in the origin of plant species. *Int. Geol. Rev.* 46: 471–478.
- Reeves, RD., Baker AJM, Borhidi A., Berazaín R. 1999. Nickel hyperaccumulation in the serpentine flora of Cuba. *Annals of Botany* 83: 29-38.
- Reeves RD., Krückeberg AR, Adıgüzel N., Krımer, U. 2001. Studies on the flora of serpentine and other metalliferous areas of western Turkey. *South African Journal of Sciences* 97: 513-517.
- Reeves RD., N., Adıgüzel, 2004. Rare plants and nickel accumulators from Turkish serpentine soils, with special reference to *Centaurea* species. *Turk. J. Bot.* 28: 147-153.
- Robinson, B., Brooks, R., Kirkman, J., Gregg, P., Alvarez, H. 1997. Edaphic influences on a New Zealand Ultramafic (serpentine) flora: a statistical approach. *Plant and Soil* 188:11-20.
- Stevens, G.C. 1989. The latitudinal gradient in geographical range: how so many species coexist in the tropics. *American naturalist* 133: 240-256
- Vural, M., Adıgüzel, N. 1996. Türkiye Florasıyla İlgili Notlar II= *Silene cserei* subsp. *aeoniopsis*, *Silene argaea* ve *Silene balansae* (Caryophyllaceae). *Ot Sistematik Botanik Dergisi*.3, 2, 93-98, 1996-ISSN 1300-2953.
- Wallace, DR. 1983. *The Klamath Knot: Explorations of Myth and Evolution*. San Francisco: Sierra Club Books. 149 pp.
- Whittaker, 1954. Whittaker, RH. 1954. The ecology of serpentine soils: A symposium. I. Introduction. *Ecology* 35: 258–59.
- Wörz, A., Duman, H. 2004. *Eryngium trisectum* (Apiaceae, Saniculoideae), a new species from Turkey. – *Willdenowia* 34: 421-425. – ISSN 0511-9618; 2004 BGBM Berlin-Dahlem.

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