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Important serpentine areas of Turkey and distribution patterns of serpentine endemics and nickel accumulators

Abstract

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Ultramafic rocks and derived soils (serpentines) are widespread in Turkey, making this one of the most significant countries in the world for serpentine soils and their associated floras. In northwestern Turkey considerable serpentine areas occur in Kütahya, Balıkesir and Bursa provinces, with smaller areas in Çanakkale province. In the Mediterranean region, serpentines extend from Muğla to Hatay provinces, and are scattered northeastwards from Kahramanmaraş to Erzincan provinces. Other notable smaller outcrops occur in Ankara province. Serpentine areas are rich places for plant diversity and local endemism. Many endemics in Turkey are restricted to serpentine soils; some of these are known from only one or two provinces, such as *Alyssum crenulatum* Boiss., *A. dubertretii* Gomb., *Bornmuellera kiyakii* Aytaç & Aksoy and *Centaurea aladaghensis* Wagenitz. The nickel-accumulating serpentine species in Turkey belong to the genera *Alyssum* L., *Bornmuellera* Hausskn., *Pseudosempervivum* (Boiss.) Grossh. (formerly in *Cochlearia* L.), *Thlaspi* L. s.l. and *Centaurea* L. The present authors have explored 55 serpentine sites; 60 Ni-accumulating and more than 40 serpentine-endemic species have been reported from Turkish serpentines. Ni accumulators and serpentine endemics are evaluated here according to their geographic distributions, altitudes, threat categories and Ni concentrations, and are presented in their grid squares and provinces.

Introduction

According to the Flora of Turkey, published between 1965-1988 and the second supplement in 2000, 9222 native, alien and cultivated species grow in Turkey (Davis 1965-1985; Davis & al. 1988). The number of infrageneric taxa is 11014. The endemic taxa is 3708 and the percentage endemism is 34.5 % (Güner & al. 2000). After the second supplement (volume 11) was published 470 taxa were added to the Turkish flora up to the end of 2007, most of which are new to science and endemic (Özhatay & al. 2006, 2009).

Serpentines in Turkey are widespread and abundant. During 1996-2003 the authors explored many notable serpentine sites in Turkey and continue exploring in these areas (Table 1, Fig.1).

In Turkey, the serpentine flora is rich in species and in local endemics. Besides, many of the Ni accumulators are serpentine-endemics. In temperate climates, including the Mediterranean region and Turkey, the families *Brassicaceae*, *Asteraceae* and the

Table 1. List of serpentine sites visited in Turkey with their province, altitude (m) and Grid square location.

Sites	Province	Altitude (m)	Grid square
1. Ezine	Çanakkale	50-80	B1
2. Sındırgı	Balıkesir	300-500	B2
3. Çal mt.	Manisa	500-1000	B1
4. Tavşanlı	Kütahya	900	B2
5. Tavşanlı-Harmancık	Kütahya	880	B2
6. Tunçbilek	Kütahya	900	B2
7. Kesiksöğüt	Kütahya	1350-1700	B2
8. Harmancık-Orhaneli	Bursa	700-1000	B2
9. Orhaneli-Bursa	Bursa	400	B2
10. Dursunbey-Tavşanlı	Balıkesir	1000	B2
11. Mihalıççık	Eskişehir	1300	B3
12. Kalecik	Ankara	850-900	A4
13. Elmadağ-Kırıkkale	Kırıkkale	730	B4
14. Beynam	Ankara	1350-1470	B4
15. Sandras mt.	Muğla	1100-1750	C2
16. Marmaris	Muğla	30	C2
17. Marmaris-Datça	Muğla	55-350	C2
18. Köyceğiz	Muğla	80	C2
19. Fethiye-Köyceğiz	Muğla	80-120	C2
20. Acıpayam-Göhlisar	Denizli	1000	C2
21. Dirmil pass	Burdur	1670	C2
22. Dirmil-Korkuteli	Antalya	1350	C2
23. Çıralı	Antalya	10-30	C3
24. Çamlık	Konya	1400	C3
25. Fındıkpınarı	İçel	1400	C5
26. Değirmendere	İçel	1100	C5
27. Arslanköy	İçel	1250	C5
28. Maden-Gümüş-Alihoca	Niğde	1500-1950	C5
29. Çamardı	Niğde	1150-1350	C5
30. Pozantı-Ulukışla	Niğde	900	C5
31. Karanfil mt.	Seyhan	1400	C5
32. Hamidiye-Karakuz	Seyhan	900-1400	C5
33. Gerdibi	Seyhan	900-1000	C5
34. Arsuz	Hatay	270-1450	C5
35. Zorkun	Osmaniye	800-1600	C6
36. Bahçe	Osmaniye	600-950	C6
37. Yarpuz	Osmaniye	1000	C6
38. Erzin	Osmaniye	500-750	C6
39. Yayladağ	Hatay	630-750	C6
40. Serinyol-Üçgedik	Hatay	450	C6
41. Güzelyayla-Belen	Hatay	800	C6
42. Dört Yol	Hatay	400	C6
43. İslahiye	Gaziantep	500	C6
44. Çiğli	Kahramanmaraş	800	C6
45. Göksun-Afşin-Çardak	Kahramanmaraş	1250-1480	B6
46. Pınarbaşı-Sarız	Kayseri	1600	B6
47. Maden	Elazığ	1150	B7
48. Hazar	Elazığ	950-1350	B7
49. Pülümür pass	Tunceli	1900	B7
50. Tunceli-Pülümür	Tunceli	1100-1250	B7
51. Keşiş mt.	Erzincan	2000-2250	B7
52. Kurutelek-Karataş	Erzincan	2150	B7
53. İliç-Kemaliye	Erzincan	1420	B7
54. Erzincan-Refahiye	Erzincan	1960-2020	B7
55. Refahiye-İmranlı	Erzincan	1850-2050	B7

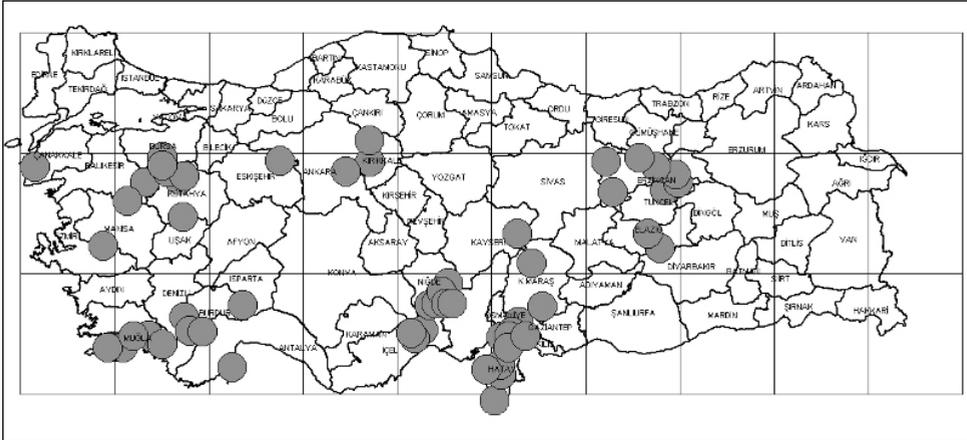


Fig. 1. Explored serpentine sites in Turkey.

Caryophyllaceae are well represented in the serpentine floras. The largest number of hyperaccumulators occur in the *Brassicaceae*. *Alyssum* is the most characteristic genus in this family. Other Ni accumulators include many species of *Thlaspi* s.l. (There have been recent changes of taxonomic status in *Thlaspi*. In this study, taxa in the Flora of Turkey were followed), for *Thlaspi* as well as for *Bornmuellera*, *Pseudosempervivum* (*Cochlearia*) and *Centaurea* species (*Asteraceae*) (Al-Shehbaz & al. 2007; Reeves & al. 2001, 2008, 2009).

Results and Discussion

According to geographical region of Turkey explored serpentine sites, Ni accumulators and some local serpentine endemics:

. — Marmara region

Two serpentine sites, Ezine in Çanakkale province and Sındırgı in Balıkesir province, were visited. Ezine is a small site where *Alyssum pinifolium* (Nyár.) T.R. Dudley was collected. This species is known only from Çanakkale province. In Flora of Turkey, only 2 gatherings in the 19th century are recorded. There are now 2 further collections from the 20th Century. *A. pinifolium* is endemic to Turkey and a serpentine endemic, known since 1979 as a Ni accumulator.

. — Aegean region

The Aegean region is one of the most important regions for serpentine areas. We visited 11 serpentine sites in this region. In Kütahya province, there are some interesting sites: just outside Tavşanlı town, between Tavşanlı-Harmancık, Tunçbilek (open-cast coal mining area, plant fossils are abundant in this overburden) and Kesiksöğüt in Murat mountain. Ni accumulators in these sites are *Alyssum corsicum* Duby (serpentine endemic,

widespread in western Anatolia), *A. dudleyi* N. Adıgüzel & R.D. Reeves, *A. floribundum* Boiss. & Balansa, *A. murale* Waldst. & Kit. subsp. *murale* var. *murale*, *A. sibiricum* Willd. and *Thlaspi jaubertii* Hedge. These *Alyssum* species are found in Tunçbilek as mixed populations. Serpentine sites visited between Harmancık-Orhaneli and Orhaneli-Bursa are in Bursa province where we found *A. sibiricum* quite abundant and healthy individuals. *Centaurea sericea* Wagenitz from Dursunbey (type locality) is a serpentine endemic, Ni accumulator. Kesiksöğüt site in Murat mountain has *A. davisianum* T.R. Dudley, endemic, known only from Kesiksöğüt, also *A. sibiricum* and *A. virgatum* Nyár. Çal mountain in Manisa province is another serpentine site where were found *A. sibiricum*, *A. murale* subsp. *murale* var. *murale* and *Thlaspi jaubertii*. Near Marmaris and between Marmaris-Datça, *Alyssum corsicum*, *Centaurea dichroa* Boiss. & Heldr. and *Thlaspi carriense* A. Carlström are found. *A. discolor* T.R. Dudley & Hub.-Mor. occurs here also: some herbarium specimens indicate a collection from limestone, but we have found it only on serpentine, and all specimens we have analysed have been Ni-accumulating; it is possibly serpentine endemic.

. — Mediterranean region

Important serpentine areas occur in the Mediterranean region. This region has many notable endemism centers, and 28 serpentine sites were visited in this region.

In the south-west of Turkey, Sandras mountain is one of the most important areas for serpentine endemic plants in Muğla province. There are many rare and interesting species from here: about 20 serpentine endemic plants are localized in Sandras Mt. *Alyssum caricum* T.R. Dudley, endemic to this region (two localities only), *A. caricum* is Ni accumulator and a serpentine endemic. Other notable endemics from Sandras mountain are *Alyssum discolor*, *A. huber-morathii* T.R. Dudley, *A. masmenaeum* Boiss., *A. corsicum* and *Thlaspi carriense*, known at present from only three locations. *T. carriense* was described from Marmaris, and has also been recorded from the area of Lake Köyceğiz. The present authors have collected it from Sandras Mt. at 1550 m as well. All these *Alyssum* and *Thlaspi* species show high Ni levels. *Centaurea ensiformis* P.H. Davis is a serpentine endemic with very high Ni concentration, known only from Sandras Mt at 1700 m growing in open *Pinus nigra* forest.

Çıralı is located in Antalya province, where serpentine reaches the coast. *Alyssum pterocarpum* T.R. Dudley is a local serpentine endemic and Ni accumulator.

Another serpentine place rich in endemics is the Dirmil Pass in Burdur province. *Alyssum cypricum* Nyár. is a serpentine endemic here, known from only two localities in Turkey, in addition to its occurrences in Cyprus.

Another remarkable serpentine site in southern Anatolia is Çamlık where one can find several hyperaccumulating plants in Brassicaceae. These are *Alyssum murale* subsp. *murale* var. *murale*, *Alyssum peltarioides* Boiss. subsp. *peltarioides*, *Bornmuellera kiyakii* known only from Çamlık, *Pseudosempervivum sempervivum* (Boiss. & Bal.) Pobed., *Aethionema spicatum* Post and *Thlaspi elegans* Boiss. growing together in a very small area.

Further east, we found *Centaurea ptosimopappoides* Wagenitz south of Gerdibi, growing with *Thlaspi elegans*. *C. ptosimopappoides* is known only from Seyhan province, south side of Aladağ. Both species show high Ni concentration and are serpentine endemics. This area is also the type locality of the notable *Centaurea aladaghensis* which

shows a high Ni concentration and is a serpentine endemic. *Bornmuellera glabrescens* (Boiss. & Bal.) Cullen & T.R. Dudley and *Alyssum trapeziforme* Bornm. ex Nyár. are only known from Aladağ and both are Ni accumulators and serpentine endemics. Other species from these sites include *Alyssum callichroum* Boiss. & Balansa, *A. floribundum*, *Pseudosempervivum sempervivum*.

We visited 5 serpentine sites in Hatay and 4 in Osmaniye provinces and collected important Ni accumulators, local and serpentine endemic plants in these sites, which include the Amanos Mountains, one of the world's most notable ultramafic areas.

Sites visited by us in Osmaniye and Hatay provinces were Bahçe, Zorkun, Yarpuz, Erzin (Osmaniye), Yayladağ, Serinyol-Üçgedik, Güzelyayla-Belen, Arsuz and Dörtyol (Hatay). In Zorkun yayla, at 1600 m, we collected from *P. nigra* forest both *Alyssum cassium* Boiss. known only in these provinces and *A. murale* subsp. *murale* var. *haradjianii* with high Ni concentrations. Other serpentine-endemic Ni-accumulators were *Thlaspi oxyceras* (Boiss.) Hedge and the very interesting *Centaurea ptosimopappa* Hayek which is found abundantly at the edge of the forest. Around Yayladağ near the Syrian border is the other interesting chosen site. *Alyssum crenulatum* is only known in this locality, endemic to Amanos and is also a Ni accumulating serpentine endemic. Serpentine endemic species *A. syriacum* Nyár. and *Pseudosempervivum amanum* (Contandr. & Quezel) Al-Shehbaz, Mutlu & Dönmez are known from Amanos mts. (type). The hyperaccumulation of Ni by *P. amanum* has been predicted, but is not yet proven. *Centaurea cassia* Boiss. and *Centaurea arifolia* Boiss. are two important Ni accumulators here. *C. cassia* is known only from Amanos mts., Syria and Lebanon, but is a rather isolated species. *C. arifolia* was collected by Boissier in 1846 and again by Dinsmore. This rare endemic species could not be found until our collection in 2001. *Alyssum dubertretii* is an endemic species known only from Belen. We found it at the edge of the *P. brutia* forest, above 1200 m, again *Alyssum dubertretii* is found in *P. nigra* forest. Species of special interest collected in Arsuz included *Alyssum cilicicum* Boiss. & Balansa (end.), *A. crenulatum*, *Centaurea ptosimopappa*, *Thlaspi eigii* subsp. *samuelssonii* (F.K. Mey.) Greuter & Burdet) only known from this type locality, in open *P. brutia* forest.

In the Mediterranean region, some serpentine sites around Kahramanmaraş were visited. *Alyssum eriophyllum* Boiss. & Hausskn. was collected from a nice serpentine site near Çiğli. It was quite abundant on waste places. *A. eriophyllum* with white-pan-nose indumentum covering the sterile shoot leaves is unique in the genus. The Ni accumulator and rare endemic *Centaurea cataonica* Boiss. & Hausskn. is known only from Kahramanmaraş province.

. — East Anatolia

We visited 9 serpentine sites in Elazığ, Tunceli and Erzincan provinces. In Maden and Hazar in Elazığ province, some interesting species were collected such as *Alyssum samariferum* Boiss. & Hausskn. which has a quite good population on the slopes and *Pseudosempervivum sempervivum* which is also abundant.

Pülümür pass on the road between Tunceli-Pülümür, at 1900 m, is covered with a very rich stepic flora and has a wonderful landscape. Ni accumulator plants collected from this site included *Alyssum samariferum*, *A. peltarioides* subsp. *virgatifforme* (Nyár.) T.R. Dudley (endemic), *Pseudosempervivum aucheri* (Boiss.) Pobed. Flora of Turkey records many species collected by P.H. Davis from this locality.

Keşiş mountain is another important site in Erzincan province; our Ni accumulator collections from this province included *Alyssum murale* subsp. *murale* var. *murale* and *Pseudosempervivum aucheri*. There are also interesting extensive and well known serpentine sites between Erzincan-Refahiye-İmranlı at elevations of 1850-2000 m; Ni accumulators collected from here included *A. peltarioides* subsp. *peltarioides* and subsp. *virgatiforme*, *A. samariferum*, *Pseudosempervivum aucheri* (with its type locality being in Erzincan). *Thlaspi oxyceras* is another important plant at these sites.

. — **In Central Anatolia** visited serpentine sites were Elmadağ-Kırıkkale, Kalecik and Beynam. *Silene aeoniopsis* Bornm. (*Silene cserei* subsp. *aeoniopsis* (Bornm.) Chowdh.) was collected in Kalecik which was the extensive serpentine site of Bornmueller's first discovery. This site has a treeless landscape with slopes and narrow ravines. The other site visited is near the highway between Elmadağ-Kırıkkale. *S. aeoniopsis* was found here, but is now under threat because of highway activity. This plant is endemic to serpentine but not a Ni accumulator; its leaves have very high Mg. The other extensive serpentine site in Central Anatolia is Beynam forest near Ankara, which was preserved in 1966 as a relic of *Pinus nigra* forest. *Alyssum sibiricum* and *A. murale* var. *murale* are found here with high Ni levels.

Between Pınarbaşı-Sarız is one of the interesting serpentine sites where *Pseudosempervivum sempervivum* is quite abundant.

According to the results of analyses of plants collected from above mentioned sites, Ni concentrations of Turkish Ni hyperaccumulators are given Figures 2-4.

Apart from all these Ni accumulators, there are many non-accumulating endemics growing in serpentine areas in Turkey. The Mediterranean region has the greatest number of these.

Some remarkable serpentine endemics known only from the type with their localities are as follows: From Sandras Mt., *Chamaecytisus gueneri* Duman, K.H.C. Başer & Malyer, *Polygonum karacae* Ziel. & Boratynski; *Salsola canescens* subsp. *serpentinicola* Freitag & E. Özhatay, *Thlaspi leblebici* Gemici & Görk are described as new to science recently and the other taxa localized in Sandras Mt. are *Aethionema speciosum* subsp. *compactum* Hartvig & Strid; *Barbarea minor* K.Koch var. *anfractuosa* Hartvig & Strid; *Bolanthus stenopetalus* Hartvig & Strid; *Ferulago sandrasica* Pesmen & Quézel; *Genista sandrasica* Hartvig & Strid; *Lamium sandrasicum* P.H.Davis; *Merendera figlilii* Varol; *Minuartia verna* subsp. *brevipetala* Hartvig & Strid; *Muscari sandrasicum* T.Karlén; *Pilosella sandrasica* Hartvig & Strid; *Prometheum serpentinicum* (Werdermann) 't Hart var. *giganteum* (Eggl) 't Hart; *Scorzonera sandrasica* Hartvig & Strid; *Senecio sandrasicus* P.H.Davis; *Silene brevicalyx* Hartvig & Strid; *Tragopogon oligolepis* Hartvig & Strid; *Viola sandrasea* Melch. subsp. *sandrasea*.

Astragalus dirmilensis Hub.-Mor. & Reese; *Cephalaria dirmilensis* Hub.-Mor.; *Dorycnium axilliflorum* Hub.-Mor.; *Ebenus pisidica* Hub.-Mor. & Reese; *Euphorbia pisidica* Hub.-Mor. & Khan; *Fritillaria serpenticola* (Rix) M. Tekşen & Aytaç; *Salvia nydegeri* Hub.-Mor.; *Scorzonera pisidica* Hub.-Mor.; *Verbascum latisepalum* Hub.-Mor.; *V. reeseanum* Hub.-Mor.; *V. serpenticola* Hub.-Mor.; *Viola dirmilensis* Blaxland are known only from the Dirmil pass in Burdur province.

Aladağlar is the type locality of the serpentine endemics *Galium sieheanum* Ehrend.; *Hedysarum antitauricum* Hub.-Mor. & Yurdakulol and *Viola sandrasea* subsp. *cilicica* Contandr. & Quézel.

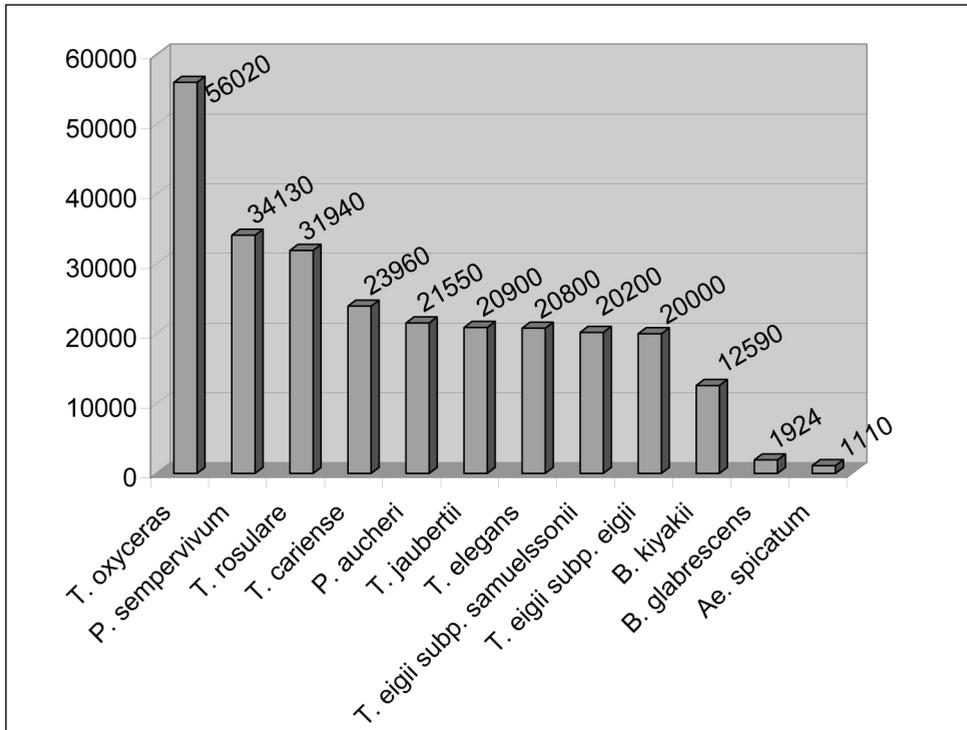


Fig. 2. Distribution of nickel accumulators in *Thlaspi*, *Bornmuellera*, *Pseudosempervivum* and *Aethionema*, according to maximum Ni concentrations.

C. doddsii Post; *C. foliosa* Boiss. & Kotschy; *Galium setuliferum* Ehrend. & Schönb.-Tem.; *Herniaria amoena* Çelebioğlu & Favarger; *Rosularia sempervivum* subsp. *amanensis* Egli are known only from Amanos mts.

Local serpentine endemics *Cerastium dominici* Kit Tan & R.R. Mill (Marmaris); *Anthemis karacae* Güner (Köyceğiz); *Colchicum lingulatum* subsp. *rigescens* K.M.Perss. (Marmaris-Datça); *Astragalus serpentinicola* H.Duman & Ekim, *Verbascum dudleyanum* (Hub.-Mor.) Hub.-Mor. and *V. flabellifolium* (Hub.-Mor.) Hub.-Mor. (around Salda lake); *V. coronopifolium* Kuntze (Kesitsöğüt); *Verbascum basivelatum* Hub.-Mor. (Türkmen Mt.); *Isatis huber-morathii* P. H. Davis (Pınarbaşı); *Galium galiopsis* (Hand.-Mazz.) Ehrend. (Hazar) and *Gypsophila graminifolia* Barkoudah (İspiriz Mt.) are known only from type.

Alyssum mughlaei Orcan (Marmaris); *Merendera figlalii* Varol (Sandras Mt.) *Hesperis kuerschneri* Parolly & Kit Tan (between Fethiye and Çameli); *Acantholimon köycegizicum* Doğan & Akaydın and *Silene koycegizensis* Dönmez & Vural (Köyceğiz); and known from Kızıldağ, Çamlık *Centaurea kizildaghensis* E.Uzunhisarcıklı, E.Doğan et H. Duman, *Eryngium trisectum* A. Wörz & H. Duman, *Noccaea camlikensis* Aytaç, Nordt et Parolly and *Rindera dumani* Aytaç & R.R. Mill; are described as new to science after volume 11 (Güner & al. 2000).

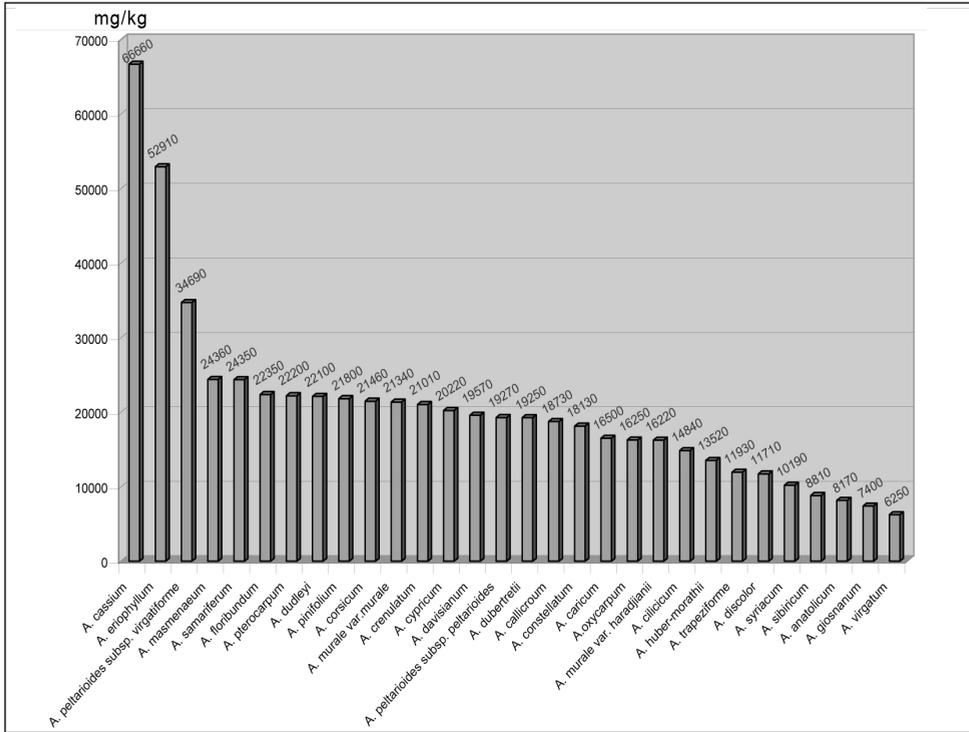


Fig. 3. Distribution of nickel accumulators in *Alyssum*, according to maximum Ni concentrations.

The number of serpentine endemics known only from the type and their localities are: Sandras Mt. 21; Dirmil pass 12; Amanos 11; Aladağ (Niğde) 6; Çamlık 5; Marmaris, Köyceğiz and Salda lake 3 each; Kesiksöğüt 2; Dursunbey, Marmaris-Datça, Kahramanmaraş, Türkmen mt., Pınarbaşı, Hazar and İspiriz Mt. 1 each.

The greatest number of taxa are found in the Mediterranean region with 104. In other regions number of taxa are: Aegean 12, East Anatolia 11, Central Anatolia 6 and Marmara 3. The richest squares in terms of the number of taxa are as follows: C2 square is 55 taxa, C5 and C6 squares are 20 taxa.

The threat categories

Many of the endemic species and Ni hyperaccumulators have very local distribution and are known only from a single or 2-3 localities; some are represented by weak populations or are under serious threat. These taxa in the “Red Data Book of Turkish Plants” were placed in CR, EN, VU and DD categories according to IUCN criteria (Ekim & al. 2000). Threat categories of the narrow endemic species have been revised with recent data according to the IUCN (2001). The threat categories of Ni accumulators and non-accumulating serpentine endemics growing in serpentine areas were given according to IUCN-2001 cri-

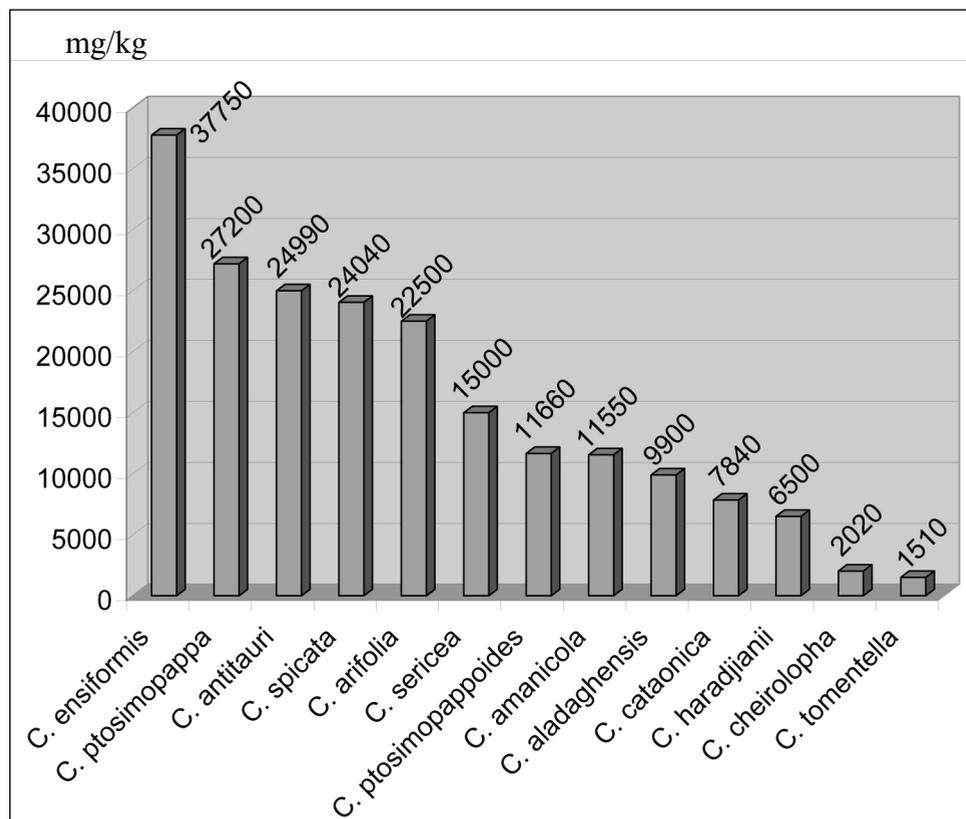


Fig. 4. Distribution of nickel accumulators in *Centaurea*, according to maximum Ni concentrations.

teria (Table 2). The number of taxa placed in these categories are: 22 CR, 39 EN, 23 VU and 4 DD. *Alyssum caricum*, *A. crenulatum*, *A. dubertretii*, *Centaurea dichroa* and *Thlaspi cariense* are placed under Globally Threatened Endemic Ni accumulators species.

Conclusion

Many important serpentine areas of Turkey were visited by us and these explorations have provide much knowledge about Turkish serpentines, such as distribution of Turkish Ni accumulators, especially in *Alyssum*, *Bornmuellera*, *Pseudosempervivum (Cochlearia)*, *Thlaspi* s.l., *Centaurea*; new Ni hyperaccumulators, taxa, records and serpentine endemics and recording again of rare and endemic plants.

Many Ni hyperaccumulators and endemic plant species growing on Turkish serpentines are very valuable and might be used in future for phytomining and for phytoremediation. Future research needs to ensure the conservation of these rare and endemic plants and their sustainable uses. Especially the ultramafic areas including local species are under serious

Table 2. The threat categories of Ni accumulators and of non-accumulating serpentine endemics.

CR	EN	VU	DD
<i>Alyssum davisianum</i>	<i>Aethionema speciosum</i> subsp. <i>compactum</i>	<i>Alyssum anatolicum</i>	<i>Alyssum syriacum</i>
<i>Anthemis karacae</i>	<i>Alyssum caricum</i>	<i>Alyssum cilicicum</i>	<i>Centaurea doddsii</i>
<i>Astragalus serpentinicola</i>	<i>Alyssum crenulatum</i>	<i>Alyssum discolor</i>	<i>Centaurea sericea</i>
<i>Bornmuellera kiyakii</i>	<i>Alyssum dubertretii</i>	<i>Alyssum dudleyi</i>	<i>Galium setuliferum</i>
<i>Centaurea aladaghensis</i>	<i>Alyssum trapeziforme</i>	<i>Alyssum murale</i> subsp. <i>murale</i>	
<i>Centaurea arifolia</i>	<i>Barbarea minor</i> var. <i>anfractuosa</i>	var. <i>haradjianii</i>	
<i>Centaurea ensiformis</i>	<i>Bolanthus stenopetalus</i>	<i>Alyssum pinifolium</i>	
<i>Centaurea foliosa</i>	<i>Bornmuellera glabrescens</i>	<i>Alyssum pterocarpum</i>	
<i>Centaurea kizildaghensis</i>	<i>Centaurea cataonica</i>	<i>Astragalus dirmilensis</i>	
<i>Centaurea ptosimopappoides</i>	<i>Centaurea dichroa</i>	<i>Astragalus serpentinicola</i>	
<i>Chamaecytisus gueneri</i>	<i>Cephalaria dirmilensis</i>	<i>Astragalus zahlbruckneri</i>	
<i>Colchicum lingulatum</i> subsp. <i>rigescens</i>	<i>Cerastium dominicii</i>	<i>Centaurea amanicola</i>	
<i>Ebenus pisdica</i>	<i>Euphorbia pisdica</i>	<i>Centaurea antitauri</i>	
<i>Gypsophila graminifolia</i>	<i>Ferulago sandrasica</i>	<i>Centaurea cassia</i>	
<i>Herniaria amoena</i>	<i>Fritillaria serpentinicola</i>	<i>Centaurea haradjianii</i>	
<i>Hesperis kuerschneri</i>	<i>Fritillaria forbesii</i>	<i>Centaurea ptosimopappa</i>	
<i>Merendera figlalii</i>	<i>Galium galiopsis</i>	<i>Centaureum serpentinicola</i>	
<i>Rindere dumanii</i>	<i>Genista sandrasica</i>	<i>Ekimia bornmuelleri</i>	
<i>Thlaspi rosulare</i>	<i>Hedysarum antitauricum</i>	<i>Galium sieheanum</i>	
<i>Verbascum dudleyanum</i>	<i>Isatis huber-morathii</i>	<i>Polygonum karacae</i>	
<i>Verbascum flabellifolium</i>	<i>Lamium sandrasicum</i>	<i>Salsola canescens</i> subsp. <i>serpentinicola</i>	
<i>Verbascum serpentinicola</i>	<i>Minuartia verna</i> subsp. <i>brevipetala</i>	<i>Scorzonera pisidica</i>	
	<i>Muscari mirum</i>	<i>Scorzonera sandrasica</i>	
	<i>Muscari sandrasicum</i>	<i>Thlaspi elegans</i>	
	<i>Noccaea camlikensis</i>		
	<i>Pilosella sandrasica</i>		
	<i>Pseudosempervivum amanum</i>		
	<i>Prometheum serpentinicum</i> var. <i>giganteum</i>		
	<i>Salvia nydeggeri</i>		
	<i>Silene brevicealyx</i>		
	<i>Silene aconiopsis</i>		
	<i>Thlaspi cariense</i>		
	<i>Thlaspi eigii</i> subsp. <i>eigii</i>		
	<i>Thlaspi eigii</i> subsp. <i>samulssonii</i>		
	<i>Thlaspi leblebici</i>		
	<i>Tragopogon oligolepis</i>		
	<i>Verbascum coronopifolium</i>		
	<i>Verbascum latiseptalum</i>		
	<i>Verbascum reeseanum</i>		

threat because of agriculture, urbanisation, mining activity, afforestation, touristic and road constructions. Before these changes of habitat proceed, further explorations should be carried out. Protection of centres of rare and endemic taxa is very important and urgent because of the rich plant diversity.

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