Distribution maps and New IUCN threat categories for the genus of *Arabis*, *Pseudoturritis* and *Turritis* (Brassicaceae) in Turkey

Türkiye'deki *Arabis*, *Pseudoturritis* ve *Turritis* Cinsleri (Brassicaceae) için Dağılım Haritaları ve Yeni IUCN Tehlike Kategorileri

Research Article

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ABSTRACT

In this study, distribution maps and IUCN threat categories for the 27 taxa of *Arabis* L., *Pseudoturritis* Al-Shehbaz and *Turritis* L. (Brassicaceae) in Turkey are given, based on taxonomic and distribution studies that it was lasted over the 20 years by Mutlu. In conclusion, new IUCN categories of these taxa were proposed as follows; five taxa are Criticaly Endangered (CR), eight are Endangered (EN), three are Vulnerable (VU) and eleven are Least Concerned (LC).

Key Words
Arabis, Brassicaceae, IUCN, distribution map.

ÖZET

Bu çalışmada Türkiye'deki *Arabis*, *Pseudoturritis* ve *Turritis* cinslerine (Brassicaceae) ait 27 taksonun dağılım haritaları ve IUCN tehlike kategorileri Mutlu tarafından yapılan 20 yıllık taksonomik ve dağılım çalışmaları temel alınarak verilmiştir. Sonuç olarak yeni IUCN ketegorileri şu şekilde önerilmiştir; 5 takson Kritik (CR), 8'i Tehlikede (EN), 3'ü Duyarlı (VU), 11'i Düşük riskli (LC).

Anahtar Kelimeler
Arabis, Brassicaceae, IUCN, dağılım haritası.

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INTRODUCTION

Biodiversity is commonly described as the variety of life on Earth. The number of species, the enormous diversity of genes in these species, the different ecosystems are all part of a biodiversity. Varieties of life are affected by climate change, pollution, construction, recreational activities and grazing etc. To prevent damage to biodiversity, first of all threat categories of species must be determined. Therefore in this study, we have three aims; (i) to summarize current knowledge on the distribution of genus *Arabis*, *Pseudoturritis* and *Turritis* in the Flora of Turkey; (ii) to present IUCN criteria to indicate priorities for conservation; and (iii) to highlight the principal avoidable threats to their survival.

The genus *Arabis* L., which is the main subject of this study, is one of six large genera of Brassicaceae distributed in all temperate regions of the Northern hemisphere except Mexico and Northern Africa [1]. The genus *Arabis*, comprises approximately 70 species restricted to the northern hemisphere that closely related to *Draba*, the largest genus in the Brassicaceae with more than 370 species [2]. Koch at al. indicated that this number might change because detailed analyses of the Central Asian and Russian taxa are largely missing [1].

Species number of the genus *Arabis* was given 18 in the Flora of Turkey [3-4]. Five new species in Turkey have been described from that date until today. They are *A. lycia* Parolly & P.Hein, *A. alanyensis* H.Duman, *A. davisii* H.Duman & A.Duran, *A. erikii* Mutlu and *A.kaynakiae* Daşkın [5-9]. In addition *A. mollis* Steven was added as a new record [10], *A. graelsiiformis* Hedge is accepted as a subspecies of *A. mollis* Steven [11] and *Arabis laxa* L. was transferred a new monotypic genus as *Pseudoturritis* Al-Shehbaz [12] that this genus is distributed in Europe [12-13], Turkey, Caucasus, and adjacent Russia [14], Algeria, Israel, Lebanon, and Syria [15].

Turritis was established in 1753 by Linnaeus, but most authors [e.g. 12, 16-19] unite it with *Arabis*. However, some authors and recent molecular studies indicated that this genus is seperated from *Arabis* and belongs to *tribus Camelinae* [20-22]. The genus includes two species, and one of them *T. glabra* is widely distributedmin Eurasia and North America [17]. The second species, *T. laxa* (Smith) Hayek, is confined to the eastern Mediterranean (Iraq, Israel, Lebanon, Syria, Turkey), Caucasus, Yugoslavia, and Greece [13-14, 19, 23].

The difficulties of identifying *Arabis* s.l. taxa and the consequent lack of detailed knowledge on their distribution and status have resulted in them being largely ignored by the statutory conservation agencies until recently. This study will be completed on lack of the knowledge.

MATERIAL AND METHODS

Data on the distribution of the taxa complied by B. Mutlu from herbaria (ADO, AEF, AKDENIZ, ANK, ATA, BULU, CUFH, E, EGE, G, GAZI, HUB, ISTE, ISTF, ISTO, K and VANF) and c.20 years of fieldwork investigating historic and new localities. The bulk of fieldwork by B. Mutlu was carried out between 1994 and 2014. Records of Donner [24] and Yıldırımlı [25] were evaluated after the field studies.

Grid square map were used for distribution of the species. The distribution maps of Turkish species were firtly prepared by Davis in Flora of Turkey [26]. Davis decided to use a grid system, based on two degrees of latitude and longitude, as the primary division for the citation of specimens. The rectangular shape of Turkey means that a grid is particularly convenient and can be readily memorised. This grid results in Turkey being divided into twenty-nine squares, as shown in Figure 1-25. Each location of the taxa was marked with circular or triangular point on the map.

We have applied the IUCN criteria for the threatened categories of species [27]. Threat categories and it's criteria are given in Table 1. Extent of occurrence and area of occupancy were calculated each point on the map that its area was approximately calculated 500 km^2. CorelDRAW (ver.12) is used for the each area calculation. Data on population sizes of the taxa were collected in the field.

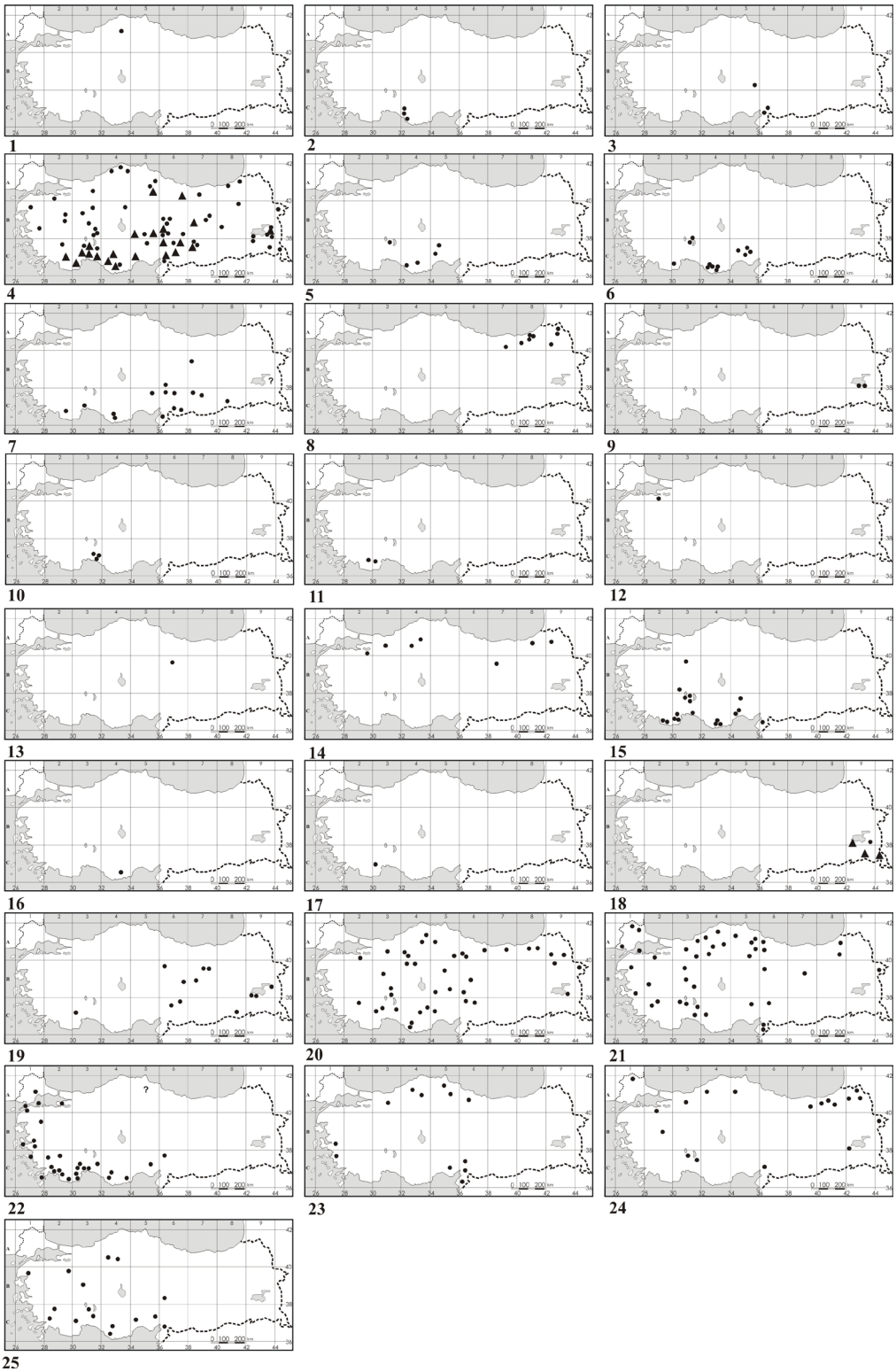

Figure 1-25. Distributional map of the species of *Arabis*, *Pseudoturritis* and *Turritis*: *A. abietina* Bornm (**fig.1**); *A. alanyensis* (**fig.2**); *A. allionii* (**fig.3**); *A. alpina* ssp. *alpina* (●) ve ssp. *brevifolia* (▲) (**fig.4**); *A. androsacea* (**fig.5**); *A. aubrietioides* (**fig.6**); *A. aucheri* (**fig.7**); *A. brachycarpa* (**fig.8**); *A. carduchorum* (**fig.9**); *A. davisii* (**fig.10**); *A. deflexa* (**fig.11**); *A. drabiformis* (**fig.12**); *A. erikii* (**fig.13**); *A. hirsuta* (**fig.14**); *A. ionocalyx* (**fig.15**); *A. kaynakiae* (**fig.16**); *A. lycia* (**fig.17**); *A. mollis* ssp. *mollis* (●), *A. mollis* ssp. *graellsiiformis* (▲) (**fig.18**); *A. montbretiana* (**fig.19**); *A. nova* (**fig.20**); *A. sagittata* (**fig.21**); *A. verna* (**fig. 22**); *P. turrita* (**fig.23**); *T. glabra* (**fig.24**); *T. laxa* (**fig.25**).

Table 1. Summary of distributions and population size data for *Arabis*, *Pseudoturritis* and *Turritis* in Turkey ranked in orded of IUCN threat criteria. CR, Critically Endangered; EN, Endangered; VU, Vulnerable; LC, Least Concern; LR(cd), Lower risk conservation dependent; LR(nt), Lower risk near threatened; LR(lc), Lower risk least concern.

	Taxa	Total Population	EOO (km^2)	AOO (km^2)	Mature indivudial and reduction (%)	Mature indivudial and reduction (%)	Endemism	Red List Categories [5, 7-9, 28, 31]	Proposed Red List Categories
1	*A. abietina*	1	<50	<5	<2.500	(<30)	End.	VU	CR B1ab(i,v); B2ab(i,v)
2	*A. alanyensis*	3	<1.500	<10	<2.500	(<30)	End.	EN	EN B1ab(i,v)
3	*A. allionii*	3	<4.500	<10	>2.000	(<30)		-	EN B1ab(i,v)
4	*A. alpina ssp. alpina*	52	<450.000	<15.000	>10.000	(0)		-	LC
5	*A. alpina ssp. brevifolia*	20	<121.000	<1.000	>5.000	(0)		-	LC
6	*A. androsacea*	6	<26.000	<100	<10.000	(<30)	End.	LR(cd)	VU C1
7	*A. aubrietioides*	12	<30.000	<2.000	>10.000	(<30)	End.	LR(lc)	VU B2ab(i,v)
8	*A. aucheri*	17	<83.000	<5.000	>10.000	(0)		-	LC
9	*A. brachycarpa*	8	<16.000	<100	>2.500	(<30)		-	EN B1ab(i,v); C2a(i)
10	*A. carduchorum*	2	<1.100	<10	<2.500	(<30)	End.	LR(nt)	EN B1ab(i,v)
11	*A. davisii*	3	<950	<10	>1.500	(<30)	End.	VU	VUB2bcjC2a(i)
12	*A. deflexa*	4	<1.400	<10	<450	(<30)	End.	EN B1a; C2a(i)	EN B1ab(i,v); B2ab(i,v)
13	*A. drabiformis*	1	<67	<2	<1.000	(<30)	End.	VU	CR B2ab(i,v)
14	*A. erikii*	1	<10	<1	<100	(<30)	End.	-	CR B1ab(i,v); B2ab(i,v); C1
15	*A. hirsuta*	11	<46.500	<5.000	>10.000	(0)		-	LC
16	*A. ionocalyx*	17	<56.500	<4.000	>10.000	(0)		-	LC
17	*A. kaynakiae*	1	<100	<10	-	-	End.	CR B1; B2ab(iii)	CR B1ab(i,v); B2ab(i,v)
18	*A. lycia*	1	<10	<2	<100	(<50)	End.	CR	CR B1ab(i,v); B2ab(i,v); C1
19	*A. mollis ssp. graellsiiformis*	3	<7.100	<10	<1000	(<30)	End.	LR(nt)	ENC1
20	*A. mollis ssp. mollis*	1	<500	<10	<250	(<30)		-	EN B2ab(i,v); D
21	*A. montbretiana*	15	<101.100	<5.000	>10.000	(0)		-	LC
22	*A. nova*	43	<221.000	<10.000	>10.000	(0)		-	LC
23	*A. sagittata*	42	<320.000	<15.000	>10.000	(0)		-	LC
24	*A. verna*	32	<104.500	<1.000	>10.000	(0)		-	LC
1	*P. turrita*	11	<31.500	<1.000	<1.000	(0)		-	VU D1
1	*T. glabra*	19	<160.000	<5.000	>10.000	(0)		-	LC
2	*T. laxa*	16	<120.500	<5.000	>10.000	(0)		-	LC

Table 2. Distribution to the squares of *Arabis* species in Turkey (♣): new distribution to the square was given in this paper, (*) endemic species.

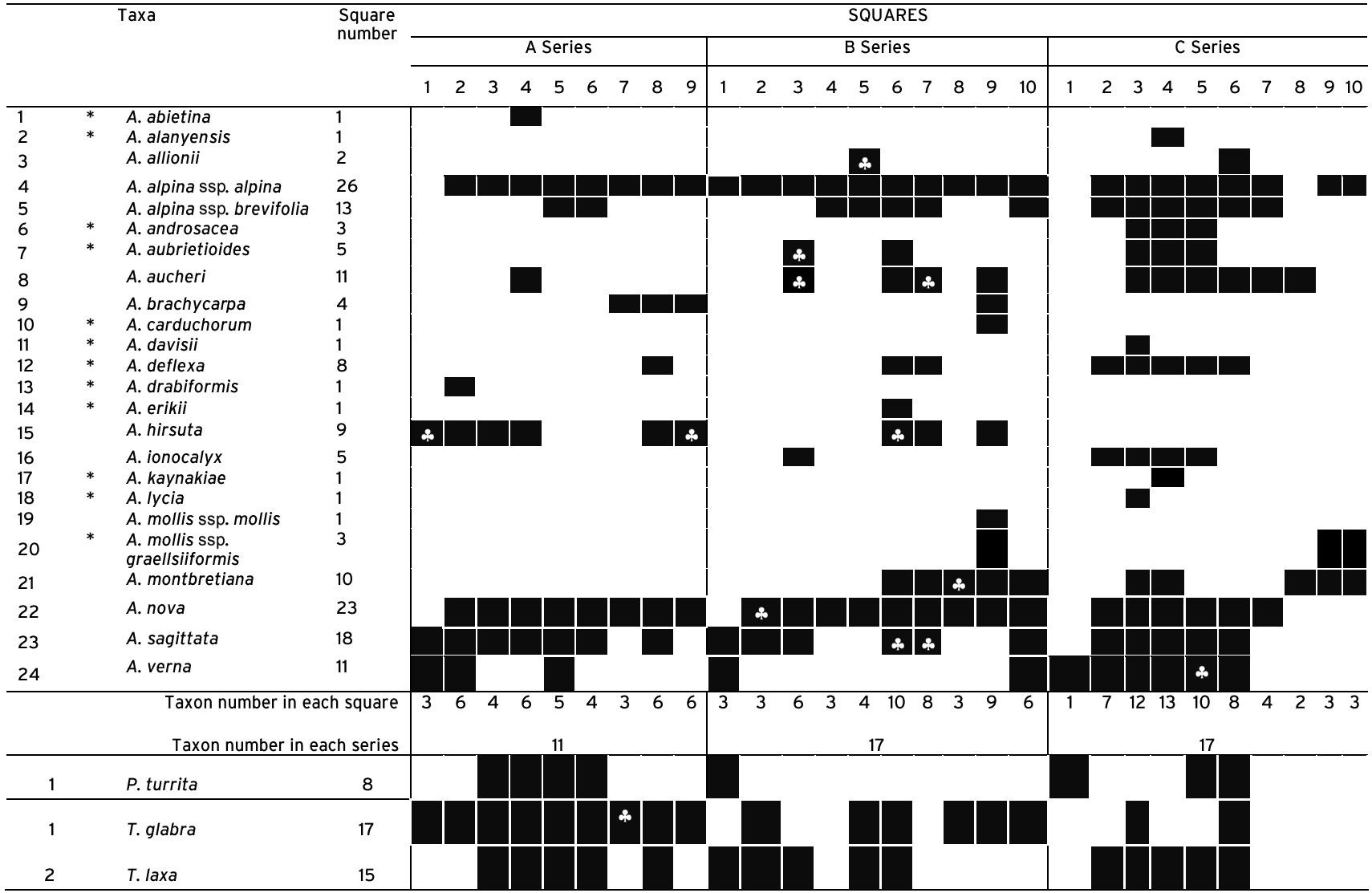

Table 3. Number of the taxa in the Red List categories.

IUCN category	Number of Taxa		
	Arabis	*Pseudoturritis*	Turritis
Extinct (EX)			
Extinct in the willd (EW)			
Critically Endangered (CR)	5		
Endangered (EN)	8		
Vulnerable (VU)	2	1	
Near Threatened (NT)			
Least Concern (LC)	9		2
Data Deficient (DD)			
Not Evaluated (NE)			

Some population estimates are from memory rather than being precise counts noted in the field. The main number of sites for each species was estimated from the records, though it is always difficult to be certain that plants found recently were in exactly the same place as historic records. For all these reasons the distribution, locality and population data were regarded as minima.

We have also included an assessment of the threat categories for the infraspecific taxa, because of the Convention on Biodiversity at Rio in 1992 requires that conservation be carried out at ecosystem, species and genetic levels [28]. According to nature of criteri in guidelines for IUCN red list categories and criteria threat categories are proposed for all taxon whether a taxon is threatened or not [27].

RESULTS AND DISCUSSION

The Turkish Vascular Plant Red Data Book published the firstly in 1989 [29], and then secondly in 2000 [30]. Unfortunately its gave no new World Conservation Union threat categories [27] for *Arabis*, *Turritis* and *Pseudoturritis* on grounds of lack of knowledge.

Results of this study, thirteen new square records belong to 9 species are determined (Table 2). New IUCN categories of twenty-seven taxa were proposed as follows, five taxa are CR, eight are EN, three are VU and eleven are LC (Table 3). These categories of taxa are given below under the taxon name.

A. abietina Bornm.
This species is endemic to Turkey. It's only distributed in **A** series and 1 squares. This species have extremely local and very scarce in one locality in Çankırı, Ilgaz Mountain (Figure 1). Extent of occurrence of this species is <50 km^2 which is calculated in the location by field studies. This location is covered by forest of the *Abies nordmanniana* (Steven) Spach subsp. *nordmanniana* that the species is found in the forest openness. Main species distribution area is used winter sport and it's used to grazing in the summer. Area of occupancy is calculated 5 km^2 and there are <2.500 individual in the population. According to criteria of geographic range size (criteria B) in IUCN cetegories [27], threat category of this species is proposed as **CR B1ab(i,v); B2ab(i,v).**

A. alanyensis H.Duman
This species is endemic to Turkey. It's only distributed in **C** series and 1 square. (Figure 2). Extent of occurrence of this species is <1.500 km^2. These areas used to grazing for goats in the summer. Area of occupancy is calculated <10 km^2 and there are <2.500 individual in the population. According to criteria of geographic range size (criteria B) in IUCN cetegories [27], threat category of this species is proposed as **EN B1ab(i,v).**

A. allionii DC.
This species distributed in 2 squares (1 square in **B** series and 1 square in C series). (Figure 3). Extent of occurrence of this species is <4.500 km^2. Area of occupancy is calculated <10 km^2 and there are >2.000 individual in the population. According

to criteria of geographic range size (criteria B) in IUCN cetegories [27], threat category of this species is proposed as **EN B1ab(i,v).**

A. alpina L.
There are two subspecies of this plant in Turkey.
subsp. ***alpina*** - This subspecies distributed in 26 squares (8 squares in **A** series, 10 squares in **B** series and 8 squares in **C** series). (Figure 4). Extent of occurrence of this species is <450.000 km^2. Area of occupancy is calculated <15.000 km^2 and there are >10.000 individual in the population. Because of its have widespread and abundant populations, threat category of this species is proposed as **LC**.
subsp. ***brevifolia*** (DC.) Greuter & Burdet - This subspecies distributed in 13 squares (2 squares in **A** series, 5 squares in **B** series and 6 squares in **C** series). (Figure 4). Extent of occurrence of this species is <121.000 km^2. Area of occupancy is calculated <1.000 km^2 and there are >5.000 individual in the population. Because of its have widespread and abundant populations, threat category of this species is proposed as **LC**.

A. androsacea Fenzl
This species is endemic to Turkey. It's only distributed in **C** series and 3 squares. (Figure 5). Extent of occurrence of this species is <26.000 km^2. Area of occupancy is calculated <100 km^2 and there are <10.000 individual in the population. According to criteria of small population size and decline (criteria C) in IUCN cetegories [27], threat category of this species is proposed as **VU C1.**

A. aubrietioides Boiss.
This species is endemic to Turkey. It's distributed in 5 squares (2 square in **B** series and 3 squares in **C** series). (Figure 6). Extent of occurrence of this species is <30.000 km^2. Area of occupancy is calculated <2.000 km^2 and there are >10.000 individual in the population. According to criteria of geographic range size (criteria B) in IUCN cetegories [27], threat category of this species is proposed as **VU B2ab(i,v).**

A. aucheri Boiss.
This species distributed in 11 squares (1 square in **A** series, 4 square in B series and 6 squares in **C** series). (Figure 7). Extent of occurrence of this species is <83.000 km^2 which is calculated in the location by field studies. Area of occupancy is calculated <5.000 km^2 and there are >10.000 individual in the population. Because of its have widespread and abundant populations, threat category of this species is proposed as **LC**.

Arabis brachycarpa Rupr.
This species distributed in 4 squares (3 squares in **A** series and 1 square in **B** series). (Figure 8). Extent of occurrence of this species is <16.000 km^2. Area of occupancy is calculated <100 km^2 and there are >2.500 individual in the population. According to criteria of geographic range size (criteria B), and small population size and decline (criteria C) in IUCN cetegories [27], threat category of this species is proposed as **EN B1ab(i,v); C2a(i).**

A. carduchorum Boiss.
This species is endemic to Turkey. It's only distributed in **B** series and 1 squares. (Figure 9). Extent of occurrence of this species is <1.100 km^2. Area of occupancy is calculated <10 km^2 and there are <2.500 individual in the population. According to criteria of geographic range size (criteria B) in IUCN cetegories [27], threat category of this species is proposed as **EN B1ab(i,v).**

A. davisii H. Duman & A. Duran
This species is endemic to Turkey [31]. It's only distributed in **C** series and 1 squares. (Figure 10). Extent of occurrence of this species is <950 km^2. Area of occupancy is calculated <10 km^2 and there are >1.500 individual in the population. According to criteria of geographic range size (criteria B), and small population size and decline (criteria C) in IUCN cetegories [27], threat category of this species is proposed as **VU B2bc; C2a(i).**

A. deflexa Boiss.
This species is endemic to Turkey [31]. It's distributed in 8 squares (1 square in **A** series, 2 squares in **B** series and 5 squares in **C** series). (Figure 11). Extent of occurrence of this species is <1.400 km^2. Area of occupancy is calculated <10 km^2 and there are <450 individual in the population. According to criteria of geographic range size (criteria B) in IUCN cetegories [27], threat category of this species is proposed as **EN B1ab(i,v); B2ab(i,v).**

A. drabiformis Boiss.
This species is endemic to Turkey. It's only distributed in **A** series and 1 squares. (Table 4) The plants only reported in the Uludağ Mountains in Bursa (Figure 12). Extent of occurrence of this species is <67 km^2 which is calculated in the location by field studies [32]. Main species distribution area is used winter sport. Area of occupancy is calculated <2 km^2 and there are <1.000 individual in the population. According to criteria of geographic range size (criteria B) in IUCN cetegories [27], threat category of this species is proposed as **CR B2ab(i,v).**

A. erikii Mutlu
This species is endemic to Turkey. It was firstly collected in 2000 by Mutlu [9]. Another specimen's haven't been collected. This species have extremely local and very scarce in one locality in Sivas, Kümbet. It's only distributed in **B** series and 1 square. (Figure 13). Extent of occurrence of this species is <10 km^2 which is calculated in the location by field studies. Area of occupancy is calculated <1 km^2 and there are <100 individual in the population. Main species distribution area is used to grazing in the summer. Habit of this species is annual. Grazing is especially very important for declined of population size of annual species. According to criteria of geographic range size (criteria B), and small population size and decline (criteria C) in IUCN cetegories [27], threat category of this species is proposed as **CRB1 ab(i,v); B2ab(i,v);C1.**

A. hirsuta (L.) Scop
This species distributed in 9 squares (6 squares in **A** series and 3 square in **B** series). (Figure 14). Extent of occurrence of this species is <46.500 km^2. Area of occupancy is calculated <5.000 km^2 and there are >10.000 individual in the population. According to criteria of geographic range size (criteria B), and small population size and decline (criteria C) in IUCN cetegories [27], threat category of this species is proposed as **LC**.

A. ionocalyx Boiss.
This species distributed in 5 squares (1 square in **B** series and 4 squares in C series). (Figure 15).

Extent of occurrence of this species is <56.500 km^2. Area of occupancy is calculated <4.000 km^2 and there are >10.000 individual in the population. Because of its have widespread and abundant populations, threat category of this species is proposed as **LC.**

A. kaynakiae Daşkın
This species species is an endemic and only known from two close populations from Gülnar district (Mersin province), south Anatolia [8]. It's only distributed in **C** series and 1 square. (Figure 16). The extent of occurrence and area of occupancy of the species are less than 100 km^2 and 10 km^2, respectively. Furthermore, its habitats and populations are damaged during opening of the new road. According to criteria of geographic range size (criteria B) in IUCN cetegories [27], threat category of this species is proposed as **CR B1ab(i,v); B2ab(i,v).**

A. lycia Parolly & P. Hein
This species is endemic to Turkey. It was firstly collected in 1992 by P.Hein. Second collection had made same area by G. Paroly and he was published as a new species [5]. A second population of *Arabis lycia* has been found on a neighbouring summit, a few kilometres distant from Bakırlı Mountain in 2004 [33]. We made some excursion in different time but it wasn't collected in these locality.

It's only distributed in **C** series and 1 square (square C2). This species have extremely local and very scarce in one locality in Antalya, Saklıkent, Bakır Mountain. Saklıkent is a recreation area espacialy for winter sport. South-West side of Bakır Mountain is used as ski trail and the top of the mountain is used as sky observation area. Observatory build, three telescope, car park and road had been constructed in there, after it was firstly collection in this area. Population of *A. lycia* was destroyed in this reason (Figure 17). Extent of occurrence of this species is <10 km^2. Main species distribution area is used winter sport. Area of occupancy is calculated <2 km^2 and there are <100 individual in the population. According to criteria of geographic range size (criteria B), and small population size and decline (criteria C) in IUCN categories [27], threat category of this species is proposed as **CR B1ab(i,v); B2ab(i,v); C1.**

A. mollis Steven

There are two subspecies of this plant in Turkey. subsp. ***mollis*** - This subspecies distributed in 1 squares in **B** series (Figure 18). Extent of occurrence of this species is <500 km^2 which is calculated in the location by field studies. Area of occupancy is calculated <10 km^2 and there are <250 individual in the population. According to criteria of geographic range size (criteria B), and very small population or very restricted distribution (criteria D) in IUCN cetegories [27], threat category of this species is proposed as **EN B2ab(i,v); D.**

subsp. ***graelsiiformis*** - This subspecies distributed in 3 squares (1 square in **B** series, 2 square in **C** series). (Figure 18). Extent of occurrence of this species is <7.100 km^2 which is calculated in the location by field studies. Area of occupancy is calculated <10 km^2 and there are <1.000 individual in the population. According to small population size and decline (criteria C) in IUCN cetegories [27], threat category of this species is proposed as **EN C1.**

A. montbretiana Boiss.

This species distributed in 10 squares (5 square in **B** series and 5 squares in **C** series). (Figure 19). Extent of occurrence of this species is <101.000 km^2 which is calculated in the location by field studies. Main species distribution area is used to grazing in the summer. Area of occupancy is calculated <5.000 km^2 and there are >10.000 individual in the population. Because of its have widespread and abundant populations, threat category of this species is proposed as **LC.**

A. nova Vill.

This species distributed in 23 squares (8 squares in **A** series, 9 square in **B** series and 6 squares in **C** series). (Figure 20). Extent of occurrence of this species is <221.000 km^2 which is calculated in the location by field studies. Main species distribution area of this species is steppe and this areas used to grazing in the summer. Area of occupancy is calculated <10.000 km^2 and there are >10.000 individual in the population. Because of its have widespread and abundant populations, threat category of this species is proposed as **LC.**

A. sagittata (Bertol) DC.

This species distributed in 18 squares (7 squares in **A** series, 6 square in **B** series and 5 squares in **C** series). (Figure 21). Extent of occurrence of this species is <320.000 km^2 which is calculated in the location by field studies. Area of occupancy is calculated <15.000 km^2 and there are >10.000 individual in the population. Because of its have widespread and abundant populations, threat category of this species is proposed as **LC.**

A. verna (L.) DC.

This species distributed in 11 squares (3 squares in **A** series, 2 squares in **B** series and 6 squares in **C** series). (Figure 22). Extent of occurrence of this species is <104.500 km^2 which is calculated in the location by field studies. Area of occupancy is calculated <1.000 km^2 and there are >10.000 individual in the population. Because of its have widespread and abundant populations, threat category of this species is proposed as **LC.**

Pseudoturritis turrita (L.) Al-Shehbaz

This species distributed in 8 squares (4 squares in **A** series, 1 square in **B** series and 3 squares in **C** series). Know from over 11 localities in 25.000 km^2 in western side of Euro-Siberian phytogeographic region and two enclaves (in 6.500 km^2) of this region (Figure 23). Extent of occurrence of this species is <31.500 km^2. Area of occupancy is calculated <1.000 km^2 and there are >1.000 individual in the population. According to criteria of very small population or very restricted distribution (criteria D) in IUCN cetegories [27], threat category of this species is proposed as **VU D1.**

Turritis glabra L.

This species distributed in 17 squares (9 squares in **A** series, 6 square in **B** series and 2 squares in **C** series). (Figure 24). Extent of occurrence of this species is <160.000 km^2. Area of occupancy is calculated <5.000 km^2 and there are >10.000 individual in the population. Because of its have widespread and abundant populations, threat category of this species is proposed as **LC.**

Turritis laxa (Sibth. & Sm.) Hayek

This species distributed in 15 squares (5 squares in **A** series, 5 square in **B** series and 5 squares

in **C** series). (Figure 25). Extent of occurrence of this species is <120.500 km^2. Area of occupancy is calculated <5.000 km^2 and there are >10.000 individual in the population. Because of its have widespread and abundant populations, threat category of this species is proposed as **LC.**

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