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Some of ecological features and relations with reproductive success in the populations of *Dianthus erinaceus* var. *erinaceus* endemic to Turkey

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Abstract

Dianthus erinaceus Boiss. var. *erinaceus* is an endemic living on tops of four mountains in the Aegean region of Türkiye. The aim of this study was to investigate the distribution area, the risk category according to IUCN V 3.1, the habitat features and the relations between some of these features and reproductive success *Dianthus erinaceus* Boiss. var. *erinaceus*. The number of individual is highest on Spil Dağ and lowest on Sarıkaya Tepe. The widest distribution area is on Nif Dağ.

The soils supporting these populations are slightly alkaline with pH 7.1 and 7.5, nonsaline, rich in $CaCO_3$ content and poor in organic matter. Total yearly rainfall is little over 1000 mm in the study area except Sarıkaya Tepe and about 950 mm on Sarıkaya Tepe. The temperatures are below 0 ^{0}C from December to March at Spil Dağ and Nif Dağ.

Plants of Nif Dağ population are bigger than other populations with bigger leaves. Number of flowers is highest in Sarıkaya Tepe population. Mean viable seed number in a flower is maximum in the individuals of Spil Dağ while this number is minumum in Sarıkaya Tepe individuals. Due to lowest mean number of viable seed in the individuals of Sarıkaya Tepe, number of viable seeds in unit is also low.

There is a negative relation between annual mean temperature but positive between total annual rainfall and number of individual. A negative corralation was obtained between the amounts of K^+, Fe^{2+}, organic matter; positive with $CaCO_3$ and P with mean plant height of populations. Mean number of flowers in a unit is positively correlated with temperature and negatively correlated with rainfall. A negative correlation was found between mean viable seeded flower number and mean viable seed number with mean plant height of populations. A positive correlation between mean viable seed number and organic matter, Fe^{2+}, Ca^{2+}, K^+ ; but $CaCO_3$ and P are negatively correlated.

Key words: *Dianthus erinaceus* var. *erinaceus,* population ecology, conservation biology

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Türkiye endemiği *Dianthus erinaceus* Boiss. var. *erinaceus*' un bazı ekolojik özellikleri ile üreme başarısı ilişkileri

Özet

Türkiye endemiği bir bitki, *Dianthus erinaceus* Boiss. var. *erinaceus*, Ege bölgesindeki 4 dağın tepelerinde yaşar. Bu çalışmanın amacı, populasyonlardaki bitkilerin yayılış alanlarını, IUCN V 3.1 göre tehlike sınıfını, habitat özeliklerini ve bu özelliklerin bazıları ile üreme başarısı arasındaki ilişkileri araştırmaktır. Birey sayısı Spil dağında en çok, Sarıkaya Tepe'de en azdır. En geniş yayılış alanı Nif dağındadır.

Populasyonların toprakları, hafif alkali, pH 7.1-7.5 tuzsuz, çok kireçli, organik maddesi azdır. Toplam yıllık yağışlar ise Sarıkaya dışındakilerde 1000 mm'nin biraz üzerinde, Sarıkaya'da 950 mm civarındadır. Spil ve Nif 'te Aralık- Mart arasında eksi yada 0 ^{0}C sıcaklıklar görülür.

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Nif dağı populasyonunda bitki ve yapraklar, diğer populasyonlarından daha büyüktür. Çiçek sayısı Sarıkaya Tepe populasyonunda en yüksektir. Bir çiçekte ortalama verimli tohum sayısı, Spil Dağı bireylerinde en yüksek iken, Sarıkaya bireylerinde ise en azdır. Sarıkaya bireylerinde ortalama verimli tohum sayısı çok düşük olduğundan, birimdeki olgun tohum sayısı da düşüktür.

Birey sayısı ile yıllık ortalama sıcaklık arasında negatif; yıllık toplam yağış ile pozitif ilişki vardır. Populasyonların ortalama bitki boyları ile K^+, Fe^{2+} ,organik madde miktarları arasında negatif; $CaCO_3$, P arasında pozitif ilişki bulunmuştur. Bir birimdeki ortalama çiçek sayısı ile sıcaklık pozitif, yağış ise negatif ilişkilidir. Populasyonların ortalama bitki boyları ile ortalama canlı tohumlu çiçek sayısı ve ortalama canlı tohum sayısı arasında negetif ilişkiler bulunmuştur. Ortalama verimli tohum sayısı ile $CaCO_3$ ve P arasında negatif korelasyon olmasına rağmen; organik madde, Fe^{2+},Ca^{2+}, K^+ arasında pozitif ilişki vardır.

Anahtar kelimeler: *Dianthus erinaceus* var. *erinaceus*, populasyon ekolojisi, koruma biyolojisi

1. Introduction

Recently, several investigations have been undertaken for conservation of biodiversity; particularly, endemic taxa for their importance for being rare and occurance in habitats with restricted requirements, and facing increasing risk of extinction. Many species either become extinct or are subjected to pressures such as climatic changes and habitat losses while sustaining their populations. Recently, many papers have been published to overcome these problems (Menges, 1998; Matthies, 2004)

It is thus necessary to know the causes of threat for conservation of species and determine the causes either deterministic such as habitat loss or stoechastic such as demographic, genetic and climatic changes. Many appropriate strategies have been determined and one of the possible approaches is to observe the population behaviour of threatened species for a sufficent level of protection (Marrero-Gomez et al., 2003). Another approach is to prevent the fragmentation of populations. Generally extinction due to narrowing of borders of habitats and unfavourable effects on reproductive potential of insect-pollinated plants increases fragmentations in populations (Guttmann, 1999; Hooftman et al., 2004). Fragmented populations are mostly seen in habitats above tree line at high mountains. Many parameters change in short distances at these altidudes (Ellenberg, 1998).

Caryophyllaceae with its distribution center in the Mediterranean region and adjecent European and Asian parts is an important family in the Flora of Turkey representing 479 species which 193 of them are endemics (Erik and Tarıkahya, 2004, Heywood, 1978). *Dianthus erinaceus* Boiss. is one of these endemic taxa in this family and lives above the tree line on the tops of high mountains. It is represented by two varietas in the Flora of Turkey; var. *erinaceus* is only known from type locality, Spil Dağı-Manisa and var. *alpinus* Boiss. from type locality, Kazdağı-Balıkesir and second record from Murat Dağı–Kütahya (Davis, 1967). *Dianthus erinaceus* Boiss. var. *erinaceus* is found in the treeless zones of Nif dağı, Mahmut Dağı (İzmir-Kemalpaşa) and Bakırdağı-Sarıkaya Tepesi (Manisa-Kırkağaç). The field observations revealed that very few seeds germinate and presence of young seedlings in the populations exposes the plant to an endangered situation.

The aims of this study were to determine the distribution areas, approximate numbers of indivudials, risk category according to IUCN V 3.1, habitat features, and reproductive success together with relations between habitat characteristics and reproductive success.

2. Materials and methods

2.1. *Study area*

Studies have been done 2004 -2005 and data is taken by the first author from his M. Sc.Thesis work. Study area were treeless high mountain belts starting from 1160 m. at Spil Dağı (1536 m), 1200 m. at Nif Dağı (1500 m), 1120 m. at Mahmut Dağ (1360 m) and 900 m. at Sarıkaya Tepesi (1078 m) (Figure 1).

Limestone, bare and rubble rocks and lithosol soils mostly predominate the study area. According to Emberger's (1955), summer drought index the study area is under the effect of mediterranean climate and total rainfall in summer less than 200 mm. Vegetation of the study areas was high mountain step and subalpin cushion shrubs. *Pinus nigra* lives at the lower bounderies of the study areas. *Dianthus erinaceus* Boiss. is seen at the end of this belt. The plant cover consist of many cushion shrubs and herbs (Seçmen, 1982).

Figure 1. Distribution of populations

2.2. *Study plant*

Populations of narrowly distributed endemic plant, *Dianthus erinaceus* Boiss. var. *erinaceus*, were studied in Spil Dağı, Nif Dağı, Mahmut Dağı and Sarıkaya Tepe-Bakır Dağı (Kırkağaç-Manisa) between 2004 and 2005.

Dianthus erinaceus Boiss. var. *erinaceus* is spiny, round shaped plant and looks like hedgehog thus an epitet has been given for this diagnostic feature. Leaves become narrow towards the tip and tips are spiny. Flowers at the tip of shoots are frequently solitary. There are 6-10 bracteols. Sepals are linear, long-mucronate and petals pink, barbulate and dentate. Fruit is a capsule.

2.3. *Methods*

Number of ındividuals and defining the borders of distribution areas: The borders of the populations were determined by using GPS coordinates of the individuals at the lowest altitudes. Individuals were counted for each population in the 200 m^2 quadrats taken randomly on 50 m. long transect line. Data was transfered to the PC-GIS 3.2 programme. Spil population was taken as start point for positions and distances of populations with each other.

Biometric measurements: 30 individuals were selected and numbered per population. Width, lenght and height per individual was measured. At least 3 flowered shoots, flowerless shoot and flowers with mature fruits (capsule) were selected from each individual. The morphological features used in the identification key were recorded from 360 samples.

Soil Analysis: Approximately 1, 5 kg soil samples from 20 cm depth were taken from the populations with dense individuals. Samples were sieved using 1 mm^2 sieve, and analysied in Soil Department of Agricultural Faculty, Ege University.

Climatic Interpretaion: Temperature and rainfall values of the study area were calculated according to Sezer's(1993) extrapolation formula using Manisa and İzmir 's 30 year's monthly mean temperature (^{0}C) and rainfall (mm) taken from General Management of Meteorological Affairs (Meteoroloji İşleri Genel Müdürlüğü).

Reproduction of flower and seed: A 100 cm^2 in size(unit area) was left at different places of numbered individuals. 2-5 frames were taken according to the size of cushion and flowers and flowered shoots counted within these frames.

The number of shoots with flowers was calculated as below where S_1 indicates mean number of flower shoots in a unit per individual; S_T, mean number of flowered shoots in a unit in total individuals; Y_1, cushion area of an individual; Y_T, total cushion area of individuals; $Ç_S$, calculated number of flowered shoot in a unit area(100 cm^2).

$S_1=(Y_1/100)A_1$;

$S_T=S_1+S_2+S_3+S_4+$ .....$+S_{30}$

$Y_T=Y_1+Y_2+Y_3+Y_4+$ .....$+Y_{30}$

$Ç_S=(S_T \times 100)/Y_T$

Number of flowers in a unit area was calculated with the following formula, $((B/A)\ Ç_S))/100$ A represents number of flowered shoots of samples and B number of flowers in a shoot. Flowers with at least one viable seed were

accepted as productive and percentange of these flowers calculated in the populations in accordance with this counting. Number of viable seeded flowers in unit area (100 cm^2) was found by multiplying the numbers of viable seeds in populations with percentage of productive flowers. Number of viable seeds produced in unit area was calculated by multiplying number of viable seeds per flower with this number.

Mean and Standart Error of Mean were given in the biometrical measurements. Attempt was made to present the relations by regression between parameters of soil and climate with numbers and height of plants and reproductive capasity. Mean annual temperature and rainfall values of 2005 were correlated with mean flower number in an unit area. The single linear model (y=a.x+b) were used to find the relationship between features of some soil and climate with numbers and height of plants and seed productivity. All significance levels were at $P<0.05$. NS refers not significant.

3. Results

3.1. *Numbers of individual and size of area*

Spil Dağı population is found at the highest elevation with widest belt among other populations. Nif Dağı population follows it. Sarıkaya Tepe population exists in the lowest elevation with narrowest belt. The highest number of individuals are in Spil Dağı and Nif Dağı populations in according with the distribution. The other two populations are very low in number from first two populations. Spil Dağı, Nif Dağı and Mahmut Dağı populations are close to each other and there are 13-25 km distances among them. Sarıkaya Tepe population is far from these and distances among them are 59-82 km (Figure 2).

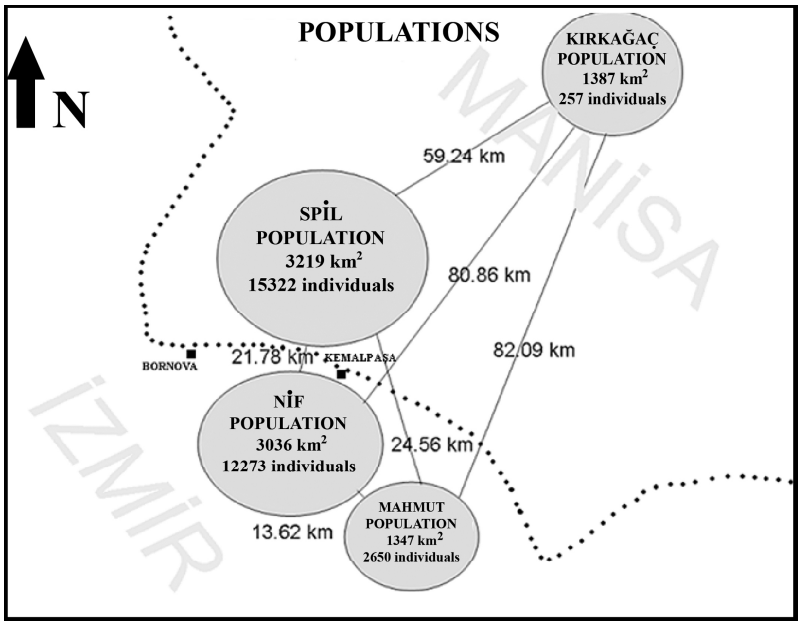

Figure 2. Distances among the populations

3.2. *Soil features*

The soils supporting plants are slightly alkaline with 7.10 and 7.53 pH values. Stone content is between 80 and 84 %. Nonsaline, rich in $CaCO_3$ (37.83-43.02 %) with sandy-loamy texture. Organic matter changes between 3.44-6.40 %. Soils are rich in metals such as Fe^{2+}, Cu^2, Zn^{2+} and Mn^{2+}, but sufficient in K^+ and poor in P. The amount of total nitrogen, Ca^{2+}, Fe^{2+}, available Cu^{2+} and Mn^{2+} are highest in the Spil Dağı whereas P^+ is higher in the Nif Dağı. Organic matter, K^+, Mg^{2+} and available Zn^{2+} amounts are highest in the Mahmut Dağı and Na^+ amount is highest in Sarıkaya Tepesi (Table 1).

3.3. *Climatic features*

According to 30 year's mean measurements; mean annual total summer rainfall is 83,6 mm in Spil Dağı, 72,3 mm in Nif Dağı, 66,3 mm in Mahmut Dağı and 64,4 mm in Sarıkaya Tepe. Total mean annual rainfalls are a little over 1000 mm except at Sarıkaya Tepe and about 950 mm in Sarıkaya Tepe (Table 2). The temperatures are below 0 ^oC from December to March at Spil Dağ and Nif Dağı. Mahmut Dağı and Sarıkaya Tepe are more warmer than these.

Table 1. Soil features of populations.

	Spil Dağı	Nif Dağı	Mahmut Dağı	Sarıkaya Tepesi
pH	7.42	7.53	7.34	7.10
Stoness (%)	85	80	84	84
Total salt (%)	0.03	0.03	0.03	0.03
$CaCO_3$ (%)	37.83	43.02	39.61	39.04
Sand (%)	53.57	68.40	59.72	60.33
Clay (%)	30.11	26.0	32.21	25.24
Loam (%)	5.3	5.6	4.7	6.2
Texture (%)	Sandy-loam	Sandy-loam	Sandy-loam	Sandy-loam
Organic matter (%)	6.2	3.44	6.4	5.1
Total nitrogen (%)	0.34	0.23	0.27	0.29
P (ppm)	2.22	3,45	2,19	2.57
K (ppm)	83	55	97	76
Ca (ppm)	4367	3236	3742	3122
Mg (ppm)	179	169	184	143
Na (ppm)	22	34	18	42
Fe (ppm)	31.44	15.52	27.31	23.47
Available Cu (ppm)	1.92	0.79	1.64	0.88
Available Zn (ppm)	1.65	0.53	2.56	2.17
Mn (ppm)	5.68	2.97	4.33	3.70

The temperatures in the area exceed 5 ^{0}C in April and 10 ^{0}C in May. The number of days exceeding 5 ^{0}C are approximately 214 in all populations. 30 year's mean temperatures are 6,7 ^{0}C at Spil Dağı, 7,1 ^{0}C at Nif Dağı, 8,1 ^{0}C at Mahmut Dağı ve 10,2 ^{0}C at Sarıkaya Tepesi.

Table 2. Mean of 30 year's annual temperatures and rainfalls in the populations (values extrapolated according to Sezer, 1993, Karaburun Yarımadası Fiziki Coğrafyası, Ph D. Thesis. Ege Üniv., Sosyal Bilimler Enst., Coğrafya Anabilim Dalı).

	Spil Dağı		Nif Dağı		Mahmut Dağı		Sarıkaya Tepe	
Months	^{0}C	mm	^{0}C	mm	^{0}C	mm	^{0}C	mm
January	-5.88	157.32	-3.87	161.78	-2.67	158.14	0.26	145.41
February	-3.60	138.15	-3.29	137.31	-2.08	133.25	0.34	124.87
March	0.55	96.56	0.94	101.72	1.95	99.9	3.87	90.61
April	6.40	94.76	6.62	84.79	7.46	81.19	9.16	82.85
May	10.98	75.68	11.19	69.35	12.02	65.43	13.70	62,85
June	**14.53**	**45.39**	**14.78**	**39.99**	**15.77**	**36.77**	**17.76**	**34.86**
July	**17.28**	**30.74**	**17.53**	**27.58**	**18.52**	**25.20**	**20.50**	**22.95**
August	**17.42**	**7.51**	**17.67**	**4.69**	**18.63**	**4.41**	**20.56**	**6.60**
September	12.63	29.4	12.88	32.62	13.87	31.22	15.85	24.82
October	7.87	64.21	8.12	65.64	9.12	63.12	11.14	55.96
November	3.16	121.07	3.43	136.40	4.50	134.30	6.63	114.20
December	-0.43	201.40	-0.15	203.57	0.92	197.27	3.09	180.79
Total	6.7	1062.17	7.1	1065.45	8.1	1030.2	10.2	946.76

3.4. Plant measurements (vegetative and reproductive parts)

Mean height of plants changes between 165 mm and 240 mm. Smallest plants were observed in Spil dağı population which presents the type sample in the Flora of Turkey. But, measurements are higher than those given in the Flora which mentions maximum 140 mm height. The highest plants are among Nif Dağı population. Leaf sizes in populations are rather close to each other though being a little small in Sarıkaya Tepe population. Flowerless shoots in Spil Dağı, flowered shoots in Mahmut Dağı are a little bigger than other populations. The measurements of reproductive structures show that all structures of Spil Dağ population are longer than others except length of bracts. There is no considerable differance in the lenght of fruits (Table 3).

3.5. *Relations between some habitat features with plant height and population size*

The relations of K^+ (ppm), $CaCO_3$ (%), Fe^{2+} (ppm), organic matter (%) and P^- (ppm) in the soils of populations with plant heights were investigated. A negative correlation was found between the amount of K^+ (NS), Fe^{2+} ($P<0,05$),

Table 3. Measurements of vegetative and reproductive parts of induviduals in the populations.

	Spil Dağı	Nif Dağı	Mahmut dağı	Sarıkaya Tepe
Plant height (mm)	165±5	240±12	175±8	185±1
Leaf lenght (mm)	19.8±0.4	20.1±0.5	19.8±0.6	18.7±0.4
Flowerless shoot lenght (mm)	20.6±1.8	18.3±1.0	18.7±1.4	18.5±1.3
Flowered shoot lenght (mm)	73.9±3.9	73.8±3.2	74.9±3.0	72.5±3.5
Baract lenght (mm)	17.1±0.5	16.4±0.4	18.2±0.4	16.6±0.4
Bracteol lenght (mm)	17.5±0.4	16.0±0.3	15.0±0.3	15.0±0.4
Sepal lenght (mm)	18.5±0.3	16.5±0.3	17.0±0.3	16.5±0.3
Petal lenght (mm)	21.0±0.2	19.0±0.3	18.8±0.3	18,0±0,2
Fruit lenght (mm)	9.7±0.2	9.5±0.2	9.5±0.2	9.5±0.2

organic matter ($p<0,05$) and plant height, however positive correlation was obtained between with $CaCO_3$ ($p<0,05$), P^- ($p<0,05$) and plant heights (Figure 3).

Studies on the correlations between temperature and rainfall values and number of individuals revealed that there was a negative relation between annual mean temperature and number of individuals ($y = -0,0002x + 9,4986$; $R^2 = 0,8126$, NS); positive between annual total rainfall and number of individuals ($y = 0,0064x + 977,27$; $R^2 = 0,7169$, NS).

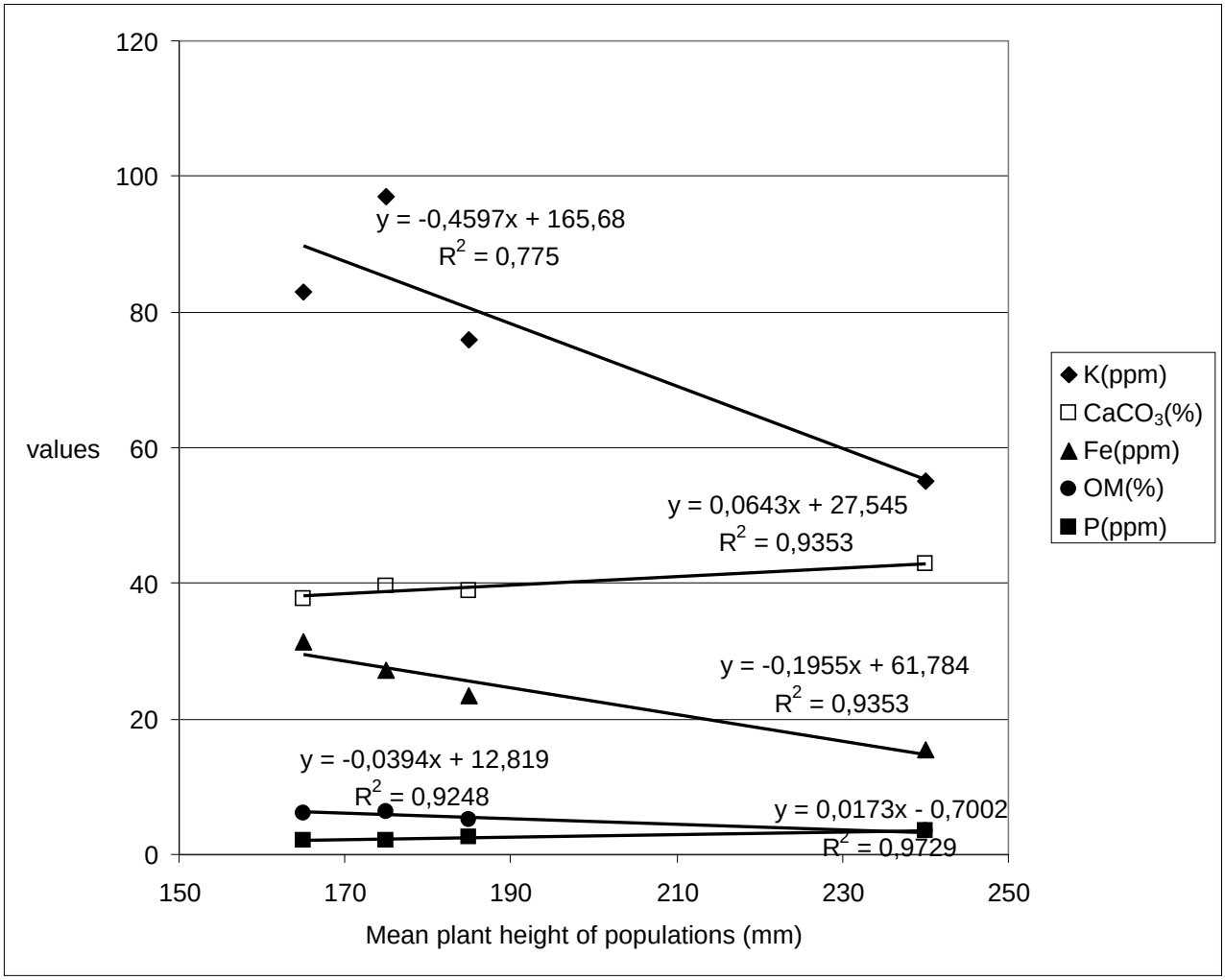

Figure 3. The relations between some of nutritional minerals in the soil and mean plant heights of populations.

3.6. *Reproductive success and relations with some habitat features*

Mean number of flower in unit area in the individuals of Mahmut Dağı and Sarıkaya Tepe are higher than Spil Dağı and Nif Dağı populations. Mean Viable Seeded Flower Number (MVSFN) in unit in the individuals of these

populations are higher than others because of maximum mean flower number in unit in the individuals of Sarıkaya Tepe and Mahmut Dağ populations. Due to lowest mean number of viable seed in the individuals of Sarıkaya Tepe, Mean Viable Seed Number (MVSN) in unit is low (Table 4). However, the case of Nif Dağı population is interesting. It was determineted that this population is most unsuccessful with lowest reproduction phase though being second biggest in number and area.

Table 4. Seed productivity of populations.

Populations	Mean Flower Number in unit area (100 cm^2) (MFN)	Mean Viable Seeded Flower Number in unit (MVSFN)	Mean Seed Number in a Flower (MSNF)	Mean Viable Seed Number in a flower (MVSNF)	Mean Viable Seed Number in unit (MVSN)
Spil Dağ	80.022	38.35	15.09	4.34	166.43
Nif Dağ	64.830	32.58	12.25	3.39	110.44
Mahmut Dağ	98.356	41.51	12.65	3.80	157.73
Sarıkaya Tepe	106.927	42.58	14.54	2.65	112.83

Mean flower number in a unit area at Spil Dağ and Mahmut Dağ populations was higher than Nif Dağ, but lower than Sarıkaya Tepe population. Mean number of flowers in an unit is positively correlated with mean annual temperature of 2005 ($y = 12{,}56x-50{,}116$; $R^2= 0{,}5523$, NS) and negatively correlated with total rainfall of 2005 ($y = -0{,}22x + 349{,}8$; $R^2 =0{,}6732$, NS). An evaluation of micronutriets in the soils showed that, it is found that organic matter (NS), Ca^{2+} (NS) , K^{+} (NS), Na^{+} ($P<0{,}05$), Mg^{2+} (NS), Fe^{2+} (NS), Cu^{2+} ($P<0{,}05$), and Zn^{2+} (NS) are positively correlated whereas P (NS) and $CaCO_3$ (NS) are negatively correlated with mean viable seed number (Figure 4).

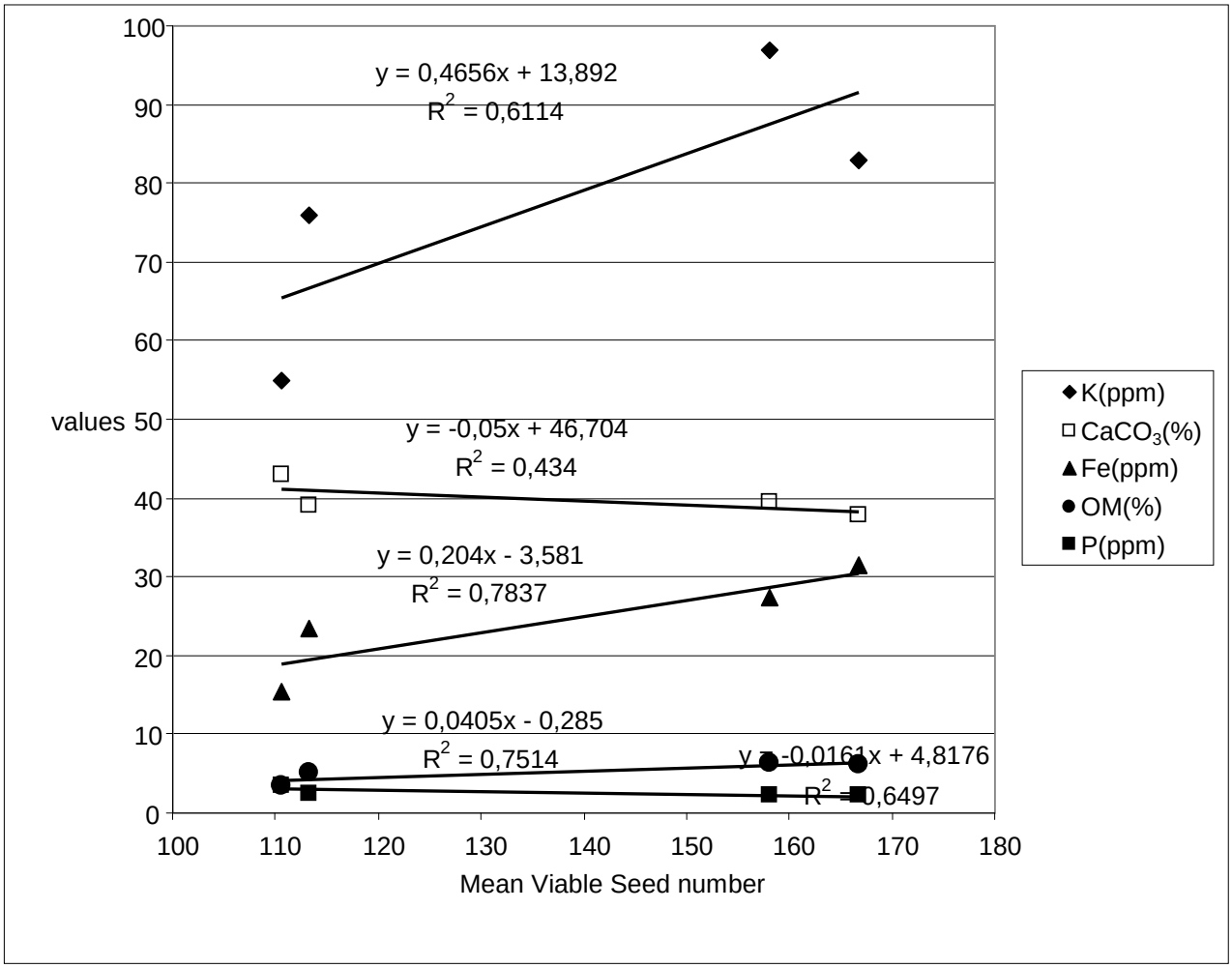

Figure 4. The relations of mean viable seed number (MVSN) with some of nutritional minerals.

On the hand, a negative correlation was found between mean viable seeded flower number (NS) and mean viable seed number (NS) with mean plant heigth (Fig. 5). There is also positive correlation between mean viable seed number and population size ($y = 0{,}0011x + 128{,}8$; $R^2 = 0{,}074$, NS).

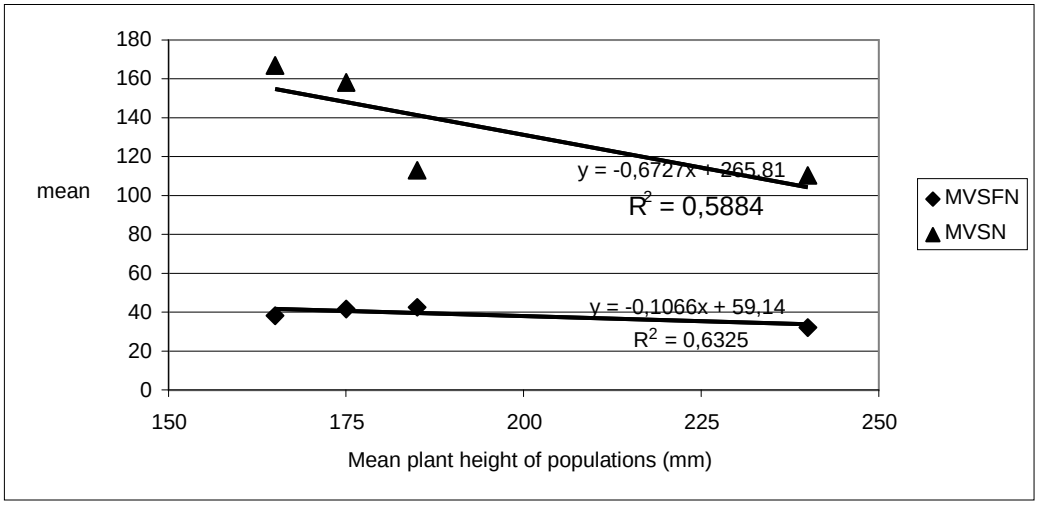

Figure 5. The relations of mean viable seeded flower number (MVSFN) and mean viable seed number (MVSN)with mean height of individuals in populations.

4. Conclusions

Extinction of small populations is a result of stochastic events like environmental, demographic, catastrophic, genetic impacts and of deterministic events such as habitat destruction and climatic changes (Brussard, 1991). Due to global warming and destruction of habitats, populations of some endemic species are becoming smaller and are exposed to risk of extinction. Enough scientific data is needed to improve an effective conservation program for species in danger (Washitani at all. 2005). These data are insufficient for many threatened plants in Turkey.

At present, some very narrowly distributed populations show that these are in danger of extinction, because they are so homogenous and have not genetic potential for adaptation to changing conditions (Guttman, 1999). One of these plants is *Dianthus erinaceus* Boiss. var. *erinaceus.* These plants flourish at highest places in four mountains in West Anatolia. Spil Dağı and Nif Dağı populations are very close to each other as number of individual and area size among four populations. Farthest distance is between Mahmut Dağı and Sarıkaya Tepe populations.

The heighest plants are at Nif Dağı while the shortest are at Spil Dağı populations. As against this, the biggest flowers are in the plants of Spil Dağ. It was observed that plant heights shorten with increased amount of K^+, Fe^{2+} and organic matter and lenghten with $CaCO_3$, and P^-. This could be accepted as a sign of being calcicolous.

The total distribution area of four populations is less than 10 km^2 and number of individuals is about 30,000. In the light of this data, *Dianthus erinaceus* Boiss. var. *erinaceus* is categorized as CR B2ab(iii)+V according to IUCN (2001) 3.V.1 criterion. The risk category has been placed under Vu earlier in Red Data Book (Ekim et al., 2000) but changed to CR with this study.

The narrow distribution and less number of individuals is related with annual mean temperatures and rainfall. It is known that number of individuals decreases with increase in temperatures, and increases with increase in rainfall. This is a common result. Increased tempetatures and decreased rainfalls effect most of plants and have deterministic effects on *Dianthus erinaceus* Boiss. var. *erinaceus* populations. The Sarıkaya Tepe population lives in the driest and warmest habitats among all populations and are most effected by these conditions and is in a high risk.

A mean temperature of 5-7 ^{0}C during growing season is important for plant life in the treeless belt at high mountains. The number of days when daily mean temperatures are over 10 ^{0}C determine the growth season. (Körner, 2001). Many woody plants need over 5 ^{0}C daily mean temperature for an increase total dry weight (Ellenberg, 1988). Long-time meteorological data show that the mean temperatures rise over 5 ^{0}C in April, 10 ^{0}C in May in the habitats of *Dianthus erinaceus* Bois. var. *erinaceus*. Temperatures 10 ^{0}C and above favour blooming and especially insect activities to achieve pollination, while temperaratures 5 ^{0}C and above stimulate the shoot and bud formation. The temperatures rise over 15 ^{0}C during second week of June. Temperatures decrease to 5 ^{0}C at the end of November, then temperatures around zero or below zero govern a period from this month to mid of April that any plant activities are seen. This case indicates the short growth season of the study area.

30 year's extrapolated annual mean rainfall amount is minumum in Sarıkaya Tepe. There is approximately 100 mm difference with others. Summer rainfalls are highest in Spil Dağı, lowest in Sarıkaya Tepe. This helps plants to continue their life cycle at Spil Dağı.

Habitat realibility and genetic diversity are important for sustaining the populations. High number of indivials and successful sexual reproduction are important for conserving the diversity in the gene pool (Bosch et al., 1998) Sustainability of populations depend the viability and producing new offspring of individuals. Occurance of new individuals is closely related with seed formation, germination and succesful performance in competition. To determine the reasons effecting seed production is important among these stages (Colas et al., 2001).

Reproductive success of *Dianthus erinaceus* Boiss. var. *erinaceus* are effected by annual mean temperatures and mean annual amounts of rainfall. It was found that mean numbers of flower in a unit is positively correlated with annual mean temperature and negatively annual mean rainfall. It can be concluded that these two parameters may be source of stress. In spite of this response, because of low percentage of viable seeds in a flower at Sarıkaya Tepe, these two populations almost have the same reproductive capacity. Number of flowers in a unit area at Spil Dağı and Mahmut Dağı populations is higher than Nif Dağı, but lower than Sarıkaya Tepe population. It can be concluded that environmental factors have less effect to situmulate production of plants in Nif Dağı, higher number of flowers increase productivity in Spil Dağı and Mahmut Dağı but productivity decreases though increased number of flowers in a unit area in Sarıkaya Tepe. In view of the population dynamics, habitat of Spil Dağı is most suitable for life cycle of *Dianthus erinaceus* Boiss. var. *erinaceus* among all other population habitats.

It was found that negative correlations exist between mean viable seeded flower number and mean number of viable seed with mean plant height. This attitude opposed to general expectation that growth increases production is another sign for population being at risk.

The work done by Oostermeijer et al., (1998) in Holland on *Gentiana pneumonanthe* L. report that number of viable seeds per fruit and formation of seeds are positively correlated with population size; positive correlation between number of ovuls and Ca^{2+}, K^{+}, SO_4^{2-}, EC and negative correlation between P^{-} and pH. These findings coincide with our results as mean viable seed number positevely correlated with population size. Same relations occur with P^{-}, $CaCO_3$ and K^{+} in reproductive success. P is negatively, $CaCO_3$and K^{+} are positevly correlated with mean viable seed number. Similarly, mean viable seed number decreases with increase in $CaCO_3$ content and increase with organic matter.

The action of pollinators in seed formation also have to be considered in this evaluation but this subject also needs further investigations.

We propose that the life histories of endemic taxa should be carried out where protection is necessary in particular in the taxa which have difficulties in reproduction and distribution in habitats. More studies are needed to produce acceptable models for other plants living the same habitat. Studies done in these habitats and areas will have important contribution for the protection of taxa as well as biodiversity.

We believe that the belt beyond tree line of high mountains with many endemic taxa should to be included among the important protected areas.

References

Bosch, M., Simon, J., Molero, J., Blanche, C. 1998. Reproductive biology, genetic variation and conservation of the rare endemic diploid *Delphinium bolosii* (*Ranunculaceae*). Biological Conservation. 86: 57-66.

Brussard, P. F. 1991. The role of ecology in biological conservation. Ecological Application. 1/1: 6-12.

Burne, H.M., Yates, C.J., Ladd, P.G. 2003. Comparative population structure and reproductive biology of the critically endangered shrub *Grevillea althoferorum* and two closely related more common congeners. Biological conservation. 114: 53-65.

Colas, B., Olivieri, I., Riba, M. 2001. Spatio-temporal variation of reproductive succes and conservation of the narrow-endemic *Centaurea corymbosa* (*Asteraceae*). Biological Conservation. 99: 375-386.

Davis, P. H. 1967. Flora of Turkey and the East Aegean Islands. Vol. 2, 126. Edinburgh University Press.

Debussche, M., Thompson, J.D. 2003. Habitat differentiation between two closely related mediterranean plant species, the endemic *Cyclamen balearicum* and the widespread *C. repandum*. Acta Oecologica. 24: 35-45.

Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z., Adıgüzel, N. 2000. Red Data Book of Turkish Plants. Barışcan offset, Ankara.

Emberger, L. 1955. Une classification biogeographique des climats. Rec.Tav. Lab.Bot. Fac.Sc. Montpellier.

Ellenberg, H. 1998. Vegetation ecology of central Europe. Cambridge University Press, Cambridge.

Erik, S.,Tarıkahya, B. 2004. Türkiye florası üzerine. Kebikeç, 17: 139-163.

Greuter, W. 1979. Mediterranean conservation as wieved by a plant taxonomist. Webbia. 34/1:88-99.
Guttmann, B.S. 1999. Biology, Population Genetics, WCB/McGraw-Hill, U.S.A, 464-478.
Heywood,V. H. 1979. Flowering Plants of the World, Oxford University Press, London.
Heywood, V.H., Iriondo, J.M. 2003. Plant conservation: old problems, new perspectives. Biological Conservation. 113: 321-335.
Hooftman, D.A.P., Billeter, R.C., Schmid, B., Diemer, M. 2004. Genetic effects of habitat fragmentation on common species of Swiss fen meadows. Conservation Biology. 18: 1043-1051.
IUCN Species Survival Commision. 2001. IUCN red list categories version 3.1, 51st meeting of the IUCN Council Gland, Switzerland and Cambridge, UK.
Körner, C. 2001: Alpine ecosystems - In: Encyclopedia of Biodiversity. Academic Press, 133-144.
Marrero-Gomez, M. V., Banares-Baudet, A., Carque-Alamo, E. 2003. Plant resource conservation planning in protected natural areas: an example from the Canary Islands, Spain. Biological Conservation. 80: 269-281.
Mathhies, D., Brauer, I., Maibom, W., Tscharntke, T. 2004. Population size end the risk of local extinction: empirical evidence from rare plants. Oikos. 105/3: 481-488.
Medail, F., Verlaque, R. 1997. Ecological characteristics and rarity of endemic plants from southeast France and Corsica: implications for biodiversity conservation. Biological Conservation. 80: 269-281.
Menges, E. 1998. Demographic viability of populations of *Silene regia*, in midwestern prairies: relationships with fire management, genetic variation, geographic location, population size and isolation. Journal of Ecology. 86: 63-78.

Oostermeijer, J. G. B., Luijten, S. H., Křenová, Z. V., Den Nijs, H. C. M. 1998. Relationships between population and habitat characteristics and reproduction of the rare *Gentiana pneumonanthe* L. Conservation Biology. 12/5: 1042–1053.
Schwarz, O. 1936. Die vegetationsverhaltnisse Westanatoliens. Englers Bot. Jb. 67: 297- 436.
Seçmen, Ö. 1982. Subalpinic vegetation of Nif mountain. E.Ü. Fac.of Scien Jour. B,1:31-40.
Washitani, I., Ishikama, F., Matsumura, C., Nagal, M., Nishihiro, J., Nishihiro, M.A. 2005. Conservation ecology of *Primula sieboldii*: Synthesis of information toward the prediction of the genetic/demographic fate of a population. Plant Species Biology. 20: 3-15.
Watson, L.E., Uno, G.E., McCarty, N.A., Kornkven, A.B. 1994. Conservation biology of rare plant species, *Ericocaulon kornickianum* (*Ericocaulaceae*). American Journal of Botany. 81/8: 980-986.
Young, A.G., Brown, A.H.D., Zich, A.F. 1999. Genetic structure of fragmented populations of the endangered daisy *Rutidosis leptorrhynchoi*. Conservation Biology. 13: 256-265.

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