A Syntaxonomical Study of the Pseudo-Alpine Vegetation of Kazdagi (Turkey) and Two New Endemic Associations

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Abstract
The purpose of this study was the pseudo-alpine vegetation of Kazdagi Mountain, which has a high number of endemic and rare plant species, as a result of the presence of different geological massives, and is an important gene center. The pseudo-alpine meadows of the Kazdagi containing siliceous and calcareous mother rocks was investigated according to, the classical Braun-Blanquet method between 2003 and 2006 and evaluated with Correspondence analysis (CA) and unweighted pair-group method using arithmetic average (UPGMA). Two new endemic associations described in the area; Armerio trojanae-Hypericetum kazdaghense and Diantho trojanus-Sideridetum trojanae attached to the alliance Trifolion parnassi.

Keywords: Endemic association, Kazdagi, pseudo-alpine vegetation, syntaxonomy, Turkey.

INTRODUCTION
In the global assessment, three belts identified as montane, alpine and nival are distinguished for mountain regions where precipitation regimes allow forest growth. In treeless arid or semiarid regions, analogues to these belts can be defined (Körner and Ohsawa 2005). The alpine of these belts is the temperature-driven treeless high-altitude life zone between the natural climatic forest limit and the snow line that occurs worldwide.

According to Heywood (1995), overall, about 3% of the terrestrial surface of the Earth is covered by alpine ecosystems, where about 4% of the Earth's flora is found (Nagy and Grabherr 2009). Approximately 10 000 plant species in the world are distributed in the alpine zone. Local floras of individual mountains (except for isolated volcanic peaks) throughout the world consist of 200-300 species, a surprisingly constant number (Körner 1995). High altitudes have greater endemism ratio, higher biodiversity, and more different local vegetation types than low altitudes. In other words, geographical isolation, climate changes, glaciation, existence of microhabitats, historical changes in floral composition, and adaptations cause extinction of some plant species and speciation of new ones at higher altitudes which results in high endemism ratios. The studies on the vegetation of Turkey are, so far, particularly focused on the sylvatic and steppic vegetation while the herbaceous ones have a broad geographical distribution (Louis 1939, Krause 1940, Walter 1962, Cetik 1963, Akman 1974, Yaltirik 1995).

Most of the old investigations of high mountain vegetation in western Anatolia were made by Quézel and Pamukcuoglu (1970) and Quézel (1973). Then, the flora and vegetation of the high mountains in west and south-east Anatolia were investigated in the context of a TÜBİTAK project (Gemici et al. 1994).

Finally, the latest investigation, based on field works and including previous studies especially focused on the (oreal) subalpine to subnival mountain vegetation of Turkey, were published by Parolly (2004). According to the paper, the vegetation structures were determined in a broad sense and listed the current hierarchy between vegetational categories.

The subalpine zone in Turkey is of importance, due to anthropogenic pressure. Today the heavy and permanent anthropogenic pressure on this type of vegetation decreases its distribution area and makes it restricted to patches (Kılıç and Karakaya 1992, Vural 1996).

Kazdagi (Mt. Ida) is situated in north-western Anatolia and forms a natural border between the Marmara and Aegean Regions of Turkey and the Canakkale and Balikesir Provinces. It is also phytogeographically at the transition area of the Euro-Siberian and Mediterranean regions. Kazdagi is the gene center of the west Anatolian region. Endemic and rare taxa have been preserved on the different geological massive and especially in the subalpine zone (Uysal 2010).

In fact, the term of sub-alpine refers to the biotic zone immediately below the tree line around the world. However, our research area at Kazdagi covers the area above the treeless zone. The alpine is usually at an altitude of about 3000 m or more. This biome lies just below the snow line of the mountain. Common plant life-forms include prostrate shrubs, graminoids forming a tussock, herbaceous perennial plants, cushion plants, and cryptogams, such as bryophytes and lichens (Körner 2003). In most cases, the grassland and shrub vegetation on Kazdagi found below these isotherms would not be truly alpine. For the presence of alpine vegetation at these latitudes the height of the Kazdagi is not high enough and also there is not any sub-alpine zone which is characterized by small trees, so it is better to name the vegetation as pseudo-alpine. Close to

our research area, some floristic and vegetation studies were carried out by Karamanoglu (1964), Quézel and Pamukcuoglu (1970), Pamukcuoglu (1976), Gemici et al. (1998), Ozel (1999), Ozel and Gemici (2003), and Uysal (2010).

These studies mostly cover the classification of flora and forest vegetation, only Quézel and Pamukcuoglu (1970) classified the area according to the mother rock. The increase in anthropogenic pressures like tourism and the date of the last study (dating back about 40 years) of the vegetation by Quézel and Pamukcuoglu (1970) which only evaluated the general vegetation, results in a demand for a repetition of the study of the subalpine meadows of Kazdagi in detail.

The objectives of this research were to complete the classification of the vegetation for the pseudo-alpine region of Kazdagi, provide a guide for managers to use in determining vegetation types and their potential based on environmental factors, and establish a scientific basis for restoration activities based on probable successional pathways. Primarily, the research focused mainly on identifying the synecological and syntaxonomical characters of the land.

**MATERIALS AND METHODS**

This study was accomplished between 2003 and 2006. The Flora of Turkey and the Aegean Islands (Davis 1965-1985, Davis et al. 1988, Güner et al., 2000) and Flora Europaea (Tutin et al. 1964-1980) were used for the identification of the specimens and the specimens were prepared as herbarium materials. All of specimens were kept as part of the E. Karabacak’s personal collection.

For the analysis of the vegetation, 23 quadrates were taken and evaluated according to Braun-Blanquet (1964) and the modified scale of Barkman, Doing, and Segal (1964) was used for the combined valuation of abundance and cover. The sizes of the quadrates were estimated by means of "minimal area" which is 25 m².

The 23 quadrates and the cover-abundance values of the 151 taxa in these quadrates were recorded in a preliminary table. All the cover-abundance values of the Braun-Blanquet were transformed to the scale of van der Maarel (1979). The correspondence analysis and the cluster analysis with UPGMA were applied using Multivariate Statistical Package (MVSP) version 3.1 (Anonymous 1985-2000). The floristic composition and structure
of plant associations exhibiting a certain physiognomy, was established and they were identified and classified by the aid of the characteristic and differential species (Braun-Blanquet, 1964) "The International Code of Phytosociological Nomenclature Principles" was followed for naming the new syntaxa (Weber et al., 2000). Moreover, to categorize the syntaxa correctly, relevant literatures was used (Quézel 1973, Quézel et al. 1985, 1987). The life forms of the species were classified according to Raunkier (1934).

Brief Description of the Area

Kazdagi, which is called Mount Ida in Greek Mythology, forms a natural border between the Çanakkale and Balıkesir Provinces in northwest Turkey. Kazdagi National Park was established in 1993 and 25 km² of the area is still protected (Rix 2002).

The pseudo-alpine zone of Kazdagi is a composite of high-altitude enclaves centred and includes the highest peaks. The study area is in between 39° 42' N - 39° 41' N latitudes and 26° 49' E - 26° 52' E longitudes at an altitude of 1774 m at its highest point (Karataş Tepe), and the other peaks are; Baba Tepe (1765 m), Sarıkız Tepe (1720 m), Çaplak Tepe (1700 m), and Arabûn Yaylası (Pamukçuoğlu 1976).

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Kazdagi is one of the most important floristic areas in Turkey (Ozhatay et al. 2003). Approximately 800 vascular plant taxa belonging to 101 families were found on Mount Kazdagi (Gemicî et al. 1998). In this study, 189 specific and infraspecific taxa of vascular plants from 132 genera and 52 families were collected with 45 taxa (23.81%) being endemic and 21 of them (46.67%) have only been reported as being from this area. The new taxa for the scientific world and new records have been reported from the site. The following Matthiola trojanae Dirmenci, Satîl & Tümen was recorded as a new species, and Nepeta sibthorpii Benth. subsp. tumeniana Dirmenci was recorded as a new subspecies of Iberis saxatilis L. and as a new record for Turkish flora (Dirmenci 2005, Dirmenci et al. 2005, Dirmenci et al. 2006).

RESULTS AND CONCLUSION

Phytogeographically the study area is a transitional region between the Euro-Siberian and Mediterranean Floristic Region. The pseudo-alpine zone of Kazdagi is under the influence of the Mediterranean climate (Table 1).

According to the CA and the cluster analysis results, the quadrates are divided into two groups (Table 2). These groups constitute the quadrates of association A and association B. According to the statistical results of CA the first two axes have eigenvalues equal to or greater than 0.5 which means that the distributions of quadrates with respect to these axes are statistically important. The first axis explains the 12.45% of the variance and the second 9.09% (Figs. 2 and 3).

Description of the two new endemic associations found in the study area.

1-Association: Armerio trojanae-Hypericetum kazdaghense Ass. nova (Holotype: Table 3, Quadrat no: 1)

This association is firstly described from the study area (Holotype: Table 3; Quadrat number 1) and has a limited distribution on the North, Northwest and Northeast slopes of Kazdagi. It distributes on the slopes with an inclination of 0-45° and altitude between 1600-1760 m on the siliceous parent rock.

This association has a structure composed of chamaephytes and hemicyryptophytes with a height of 5-50 cm. It shows a homogenous physiognomy and the coverage of the species is about 15-100%. The main physiognomy of it is formed by Astragalus angustifolius Lam. subsp. angustifolius, which is a chamaephyte within the association with a coverage of 40-60%. Diagnostic species of the association are Hypericum kazdaghense Gemicî & Leblebici, Armeria trojanae Bokhari & Quézel, Verbascum scamandri Murb., Jasione idaea Stej., Hieracium idae (Zahn) Sell & West, and Achillea fraasii Sch.Bip. var. troiana Asch. & Heimrl.

2-Association: Diantho trojanus-Sideridetum trojanae Ass. nova (Holotype: Table 3, Quadrat no: 19)

This association occupies the calcareous parent rock unlike the first association. The main physiognomy is formed by Acaulithimon ulicinum Boiss. subsp. ulicinum which is a chamaephyte with a coverage of 40-60% in the association. It is characterized by the presence of Sideritis trojana

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Bornm., Dianthus trojanus Bornm. & Sint., and Arenaria serpyllifolia L. and Centaurea odyssei Wagenitz.

This association occurs on the North and Southwest slopes with an inclination of 10-45° and with an altitude of 1530-1720 m. It has a structure particularly composed of chamaephytes with a height of 5-25 cm. The coverage of the species is about 10-95%.

Due to their floristic composition and ecological similarities, the associations were included in the alliance Trifolion parnassi Quézel 1964 comprising of high mountain formations in Northern Anatolia. Molinio-Arrhenatheretea R.Tx. 1937 and Alchemillo retinervis-Sibbaldietea parviflorae Vural 1987 classes and order Arrhenatheretalia R. Tx. 1931 are represented by a low number of species.

The associations described here have been considered within the syntaxa in light of the latest works.

**Synopsis of the syntaxonomical units deal with**

- **Order:** Trifolieta parnassi Quézel 1964.
- **Alliance:** Trifolion parnassi Quézel 1964.
- **Association:** Armerio trojanae-Hypericetum kazdaghense Ass. nova
- **Association:** Diantho trojanus-Sideridetum trojanae Ass. nova

The communities described here were gathered in the order of Trifolieta parnassi Quézel 1964 including hygro- to mesophytic siliceous carpet turfs of Greece and NW Anatolia, often with a long-lasting snow cover.

*Trifolion parnassi* Quézel 1964 is the only major subunit (including 3 associations) of the order; recorded on Uludag, Bozdag, and Kazdagi (Quézel and Pamukcuoğlu 1970).

Soil is the major determinative of the distribution of the associations attached to the alliance. While the association Armerio trojanae-Hypericetum kazdaghense nova prefers the areas with an inclination 0-45° on the North, Northwest, and Northeast slopes of 1600-1760 m on siliceous
Table 3. Vegetation analysis of the pseudo-alpine area of Kazdagi (C: calcareous; S: siliceous).

<table>
<thead>
<tr>
<th>Quadrat No.</th>
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<th>22</th>
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<td>ENE</td>
<td>E</td>
<td>ESE</td>
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<td>Elevation (m)</td>
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<td>Dominant species</td>
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<tr>
<td>Coverage total (%)</td>
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<td>35</td>
<td>40</td>
<td>45</td>
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<td>135</td>
<td>140</td>
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<td>150</td>
</tr>
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</table>

**Characteristics of the associations**

**Hyperionia helvetica**

| | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 |

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parent rock, *Diantho trojanus-Sideridetum trojanae* nova occupies North and Southwest slopes with an inclination of 10-45° and with an altitude of 1530-1720 m. This association occupies the calcareous parent rock unlike the other association.

Although both of the associations described here
show a homogenous physiognomy, they have a quite heterogeneous floristic composition due to the anthropogenic impact on them.

There has been a weak affinity and a poor similarity between the alliance and the adjacent communities with respect to the floristic composition.

The similarity ratio (Sørensen 1948) is defined as 20.6-21.3% by this study Quézel and Pamukcuoglu (1970).

The study area is a famous area with its valuable touristical properties, biodiversity and religious visiting regions. All these characteristics, unfortunately, result in a negative influence on wildlife. Uncontrolled plant collection and construction of touristic places are important threats on the region. The area is one of the most important floristic areas in Turkey and has been chosen as a pilot area for the "In-situ conservation of plant genetic diversity project" in Turkey (Uysal 2010).

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KAYNAKLAR


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