

An ecological study on *Betula medwediewii* Regel and *Veratrum album* L. naturally distributed in the subalpine region of West Transcaucasia

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Abstract: This investigation presents ecological characteristics of *Betula medwediewii* Regel, a relict woody species and *Veratrum album* L., an important medicinal plant, both naturally distributed in Western Transcaucasia. Elemental analyses in plants and soils was carried out and soil-plant relationships in the leaves evaluated. The findings obtained from leaves of *B. medwediewii* revealed that nitrogen, phosphorus, potassium, calcium, iron and copper concentrations were within the limit values in contrast to those of, magnesium and nickle, which were higher. It was also seen that in the lower cauline leaves of *V. album*, the nitrogen, phosphorus, potassium, calcium, magnesium and copper showed normal values while iron and nickle concentrations exceeded the normal levels. In general, the concentrations of all elements investigated in the soil samples of both species were low.

Keywords: Conservation, ecology, plant-soil interactions, Medwediew's birch, relict, white hellebore

INTRODUCTION

The diversity of plant species in an ecosystem plays an important role in its stability and productivity [Ozturk et al., 1996a, 1996b, 2012; Egamberdieva, Ozturk, 2018]. Plants are the basis of food chains, especially in terms of ecological functionality, and provide important support for the survival of other organisms as they depend on them for food and shelter [Boersma et al., 2008; Altay et al., 2015; Imanberdieva et al., 2018a].

Plant communities also support the overall health of the ecosystem by improving soil fertility, nutrient cycling, and water filtration [Eisenhauer et al., 2018; Altay, 2019]. Despite the global importance of plant diversity, it is threatened by many factors including habitat destruction, deforestation, pollution, climate change and invasive species which lie at the forefront [Ozturk et al., 2011a, 2019; Imanberdieva et al., 2018b; Altay, 2019]. To overcome such threats, studies on the ecological relationships between plants and their habitats are of importance while studying different ecosystems [Ozturk et al., 1998, 2010; Corlett, 2016]. The diversity of plants in different ecosystems stresses the fact that it is crucial to study and analyse the measures for the protection of plants in such ecosystems [Ozturk et al., 2008].

The plant species conservation includes studies on the distribution and ecology of plant taxa [Altay et al. 2013, 2016a, 2016b, 2017; Ozturk et al., 2011b]. The ecological niches of plants are fixed, therefore habitat characteristics in their life cycle are of paramount importance [Altay et al. 2017]. The habitat of a plant is of critical value as it provides information on the existing edaphic and biotic characteristics in an area [Eskin et al., 2013; Eroglu et al., 2014; Ozturk et al., 2015, 2017, 2020, 2021, 2022; Altay et al. 2017].

Despite their ecological and economic values, no detailed ecological studies have been carried out on the current status of *Betula medwediewii* Regel (Betulaceae) and *Veratrum album* L. (Melanthiaceae) in vulnerable ecosystems. Keeping this in view, the present work was undertaken to provide insights into some of the characteristics of these two species, considering them primarily as ecological indicators and as such an evaluation of soil and leaf values was carried out for this purpose.

MATERIAL AND METHODS

Studied species: The identification of the plant species was done by Ozturk and Altundag with the help of "Flora of Turkey and the East Aegean Islands" [Davis, 1982, 1984].

B. medwediewii is found in subalpine mixed forests and open hillsides (especially in *Picea orientalis* forests and among *Rhododendron* scrub communities) at altitudes varying between 600 to 2400 m in the western

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Table 1. Elemental analysis in the plant samples of *B. medwediewii* and *V. album* and limit values of analyzed elements.

| Elements | <i>Betula medwediewii</i> | <i>Veratrum album</i> | Limit values* |
|---------------------------|---------------------------|-----------------------|---------------|
| N (%) | 3.49 | 3.91 | 1-6 |
| P (%) | 0.41 | 0.21 | 0.1-1 |
| K (%) | 1.4 | 3 | 0.1-5 |
| Ca (%) | 0.45 | 1.13 | 0.3-3 |
| Mg (%) | 0.25 | 0.30 | 0.01-0.1 |
| Fe (mg kg ⁻¹) | 125 | 900 | 50-250 |
| Cu (mg kg ⁻¹) | 17 | 22 | 5-30 |
| Ni (mg kg ⁻¹) | 13 | 10 | 0.5-5 |

* [Kabata-Pendias, Pendias, 2001; Barker, Pilbeam, 2015; Yalcin, Altay, 2023].

Table 2. Elemental analysis in the soil samples of *B. medwediewii* and *V. album* and limit values of analyzed elements.

| Elements | <i>Betula medwediewii</i> | <i>Veratrum album</i> | Limit values* |
|---------------------------|---------------------------|-----------------------|---------------|
| N (%) | 0.00 | 0.003 | 0.02-2 |
| P (%) | 0.12 | 0.11 | 0.05-5 |
| K (%) | 0.004 | 0.006 | 0.5-2.5 |
| Ca (%) | 0.09 | 1.08 | 0.7-1.5 |
| Mg (%) | 0.001 | 0.011 | 0.03-0.84 |
| Fe (mg kg ⁻¹) | 28 | 25.2 | 5000-50000 |
| Cu (mg kg ⁻¹) | 0.00 | 0.44 | 25-75 |
| Ni (mg kg ⁻¹) | 2.06 | 2.06 | 0.2-450 |

* [Kabata-Pendias, Pendias, 2001; Barker, Pilbeam, 2015; Yalcin, Altay, 2023].

Transcaucasian mountains. The phytogeographical origin of this tertiary relict taxon is presented as an “Euxine element” [Browicz, 1982; Shaw et al., 2014].

V. album is found on damp grassy slopes and at the edge of forests at altitudes between 1400 and 1900 m in the western Transcaucasian region [Edmondson, 1984].

Study sites: The plant and soil samples were collected at two different locations in the subalpine vegetation layer of the East Black Sea region of Turkiye, namely Artvin-Murgul, Tiryal Mountain (1900 m; 41°14'25"N, 41°37'24"E) for *B. medwediewii* and Artvin-Şevvaltepe (1700 m; 41°13'57"N, 41°39'34"E) for *V. album*.

Sample analysis: Soil samples were collected from the depth varying between 0-30 cm. These were air dried and sieved using 2 mm mesh. The physical/chemical characteristics were determined following the methods outlined by Ozturk et al. [1997]. Plant samples were collected at the same time, isolated and placed in sterile bags. The samples were wrapped in separate blotting papers, and dried in an oven at 80 oC until

constant weight. The plant samples were pulverized with a “Lavion 500 Gr High-Speed Grinder” and stored for further evaluation. Total nitrogen (N) content was determined by the Kjeldahl method; phosphorus (P) was estimated spectrophotometrically and total potassium (K) by flame photometer [Ozturk et al., 1997]. The concentrations of calcium (Ca), magnesium (Mg), iron (Fe), copper (Cu), and nickel (Ni) were determined in the plant samples and their soils by inductively coupled plasma optical emission spectroscopy (ICP-OES) [Ozturk et al., 2017, 2019, 2020].

RESULTS

The results of elemental analysis of plant and soil samples for both investigated species are presented below in tables 1 and 2.

The elemental concentrations of N, P, K, Ca, Fe, and Cu in *B. medwediewii* leaves were within the limit values while Mg and Ni above the limit values. For lower cauline leaves of the *V. album*, N, P, K, Ca, Mg, and Cu

concentrations were within the limit values, whereas Fe and Ni concentrations were above the limits. In general concentrations of all elements in the soil samples were generally low in both cases.

Habitat loss is one of the most important factors affecting the extinction of plant species. For this reason, it is necessary to enlighten the ecology and distribution of endemic, rare, or relict plants with limited distribution for conservation purposes [Ozturk et al., 2004, 2020]. Relict plants have demonstrated significant success in ecological adaptation due to their ability to survive successfully for a long time under severe ecological pressures [Ronikier et al., 2012; Vogler, Reisch, 2013; Ozturk et al., 2020]. The existence of these long-existing plants adds to their importance for preservation of such genetic diversity [Hampe, Jump, 2011; Grandcolas et al., 2014; Lázaro-Nogal et al., 2016; Ozturk et al., 2020].

B. medwediewii is an ecologically important taxon for Transcaucasica region as a relict woody species. It needs special attention from the perspective of biodiversity as a relict heritage that has been living with us since the Tertiary period. In "*The Red List of Betulaceae*" it is emphasized that *B. medwediewii* is subject to intense grazing by wild and domestic animals in the habitats where it thrives. This negative interference is damaging the seeds of this plant, disrupting its reproductive capacity [Shaw et al., 2014]. At the same time uncontrolled logging is reported as another negative factor for this species [Shaw et al., 2014]. Although it is a drought-resistant tree, its inability to tolerate shade and slow growth make it difficult to compete with other fast-growing woody plants in ecological terms [Shaw et al., 2014].

The plant species grouped under *Veratrum* genus have medicinal value. This has been demonstrated by pharmacological studies conducted by several researchers and it is reported that the leaves have anti-inflammatory, analgesic, antioxidant, antihypertensive, antiplatelet and antitumor activities as well as teratogenic toxicity [Li et al., 2016; Dumlu et al., 2019; Zhang et al., 2020; Xie et al., 2021; Lu et al., 2022]. These plants have been reported to be antagonists of the Hedgehog (Hh) signaling pathway, a common target for anticancer therapy [Li et al., 2016; Ghirga et al., 2018; Masoodi et al., 2020; Lu et al. 2022].

V. album also attracts attention with its ecological features. Looking at its eco-physiological adaptations, its above-ground growth cycle is completed during spring within a short time. In this way, the exposure of the above-ground parts of the plant to risks such

as crushing or early frost in late summer and autumn is minimized. This plant is a rhizomatous species showing very low phenotypic plasticity, which makes its survival easier in subalpine regions, especially in the habitats such as damp grassy slopes, and the edges of forests [Edmondson, 1984; Kleijn et al., 2005].

CONCLUSION

The ecologically important plants in the Caucasus region are of great significance. Their management will allow us to follow protection measures of the ecosystems inhabiting valuable species and will add to the future comparative detailed ecological studies in this region. *B. medwediewii*, a relict woody species, and *V. album* a roset like species are of economic and medicinal value. The results presented here cover ecological findings undertaken on these plant species. Such studies are expected to help in enlightening their ecological requirements for conservation as well as regional cooperation in the protection of economically and ecologically important plant taxa. To preserve this ecogenetic diversity, these need to be monitored carefully and regularly. Moreover, detailed ecological studies on these taxa need to be urgently supported together with comprehensive eco-physiological and molecular studies to provide a better overall understanding [Altay et al., 2024].

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Qərbi Zaqafqaziyanın subalp bölgəsində təbii şəkildə yayılmış *Betula medwediewii* Regel və *Veratrum album* L. növlərinin ekoloji tədqiqi

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Bu araşdırma Qərbi Zaqafqaziyada təbii şəkildə yayılmış reliktd ağac növü olan *Betula medwediewii* Regel və mühüm dərman bitkisi olan *Veratrum album* L. növünün ekoloji xüsusiyyətlərini təqdim edir. Bitki və torpaqlarda element analizləri aparılıb və yarpaqlarda torpaq-bitki münasibətləri qiymətləndirilib. *B. medwediewii* növünün yarpaqlarından əldə edilən nəticələrə görə azot, fosfor, kalium, kalsium, dəmir və mis konsentrasiyaları limit dəyərləri daxilindədir, bunun əksinə olaraq maqnezium və nikel isə daha yüksəkdir. Həmçinin *V. album* növünün aşağı kaulin yarpaqlarında azot, fosfor, kalium, kalsium, maqnezium və misin normada olduğu, dəmir və nikel konsentrasiyasının isə normadan artıq olduğu müşahidə edilmişdir. Ümumiyyətlə, hər iki növün torpaq nümunələrində tədqiq edilmiş bütün elementlərin konsentrasiyası aşağı olmuşdur.

Açar sözlər: *qorunma, ekologiya, bitki-torpaq qarşılıqlı əlaqəsi, Medvedyev ağcaqayını, reliktd, ağ asırqal*

Экологическое исследование видов *Betula medwediewii* Regel и *Veratrum album* L., естественно распространенных в субальпийском регионе Западного Закавказья

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В исследовании представлены экологические характеристики *Betula medwediewii* Regel, реликтового древесного вида, и *Veratrum album* L., важного лекарственного растения, естественно распространенных в Западном Закавказье. Проведен элементный анализ растений и почв, оценены почвенно-растительные взаимоотношения в листьях. Результаты, полученные на листьях *B. medwediewii*, показали, что концентрации азота, фосфора, калия, кальция, железа и меди находились в пределах предельных значений, в отличие от концентраций магния и никеля, которые были выше. Было также замечено, что в нижних стеблевых листьях *V. album* азот, фосфор, калий, кальций, магний и медь имели нормальные значения, тогда как концентрации железа и никеля превышали нормальные уровни. В целом концентрации всех исследованных элементов в пробах почв обоих видов были низкими.

Ключевые слова: *охрана, экология, растительно-почвенное взаимодействие, береза Медведева, реликт, чемерица белая*