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Plant ecological groups and soil properties of common hazel (*Corylus avellana* L.) stand in Safagashteh forest, north of Iran

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Abstract

In Safragashteh forest of Fuman in north of Iran, there is a hazel stand, which has grown naturally. The aim of this research was to evaluate the plant communities and soil characteristics in the area. This study included 50 ha of hazel protected area. A selective sampling method was utilized to record 30 400 m^2 for tree and shrub layers, and sub-plots of 100 m^2 for herbaceous species. Soil samples were collected at the 30 plots. We found three ecological species groups in the study area. *Corylus avellana* and *Epimedium* pinnatum in first group, *Fagus orientalis*, *Asperula odorata*, *Euphorbia amygdaloides*, *Carex* sp., *Fragaria vesca* and *Viola sylvestris* in second group, and *Crataegus microphylla*, *Ilex spinigera*, *Primula heterochroma*, *Sedum stoloniferum* and *Vicia crocea* in thirth group were the indicator species. Sand percent was significantly highest in *Corylus avellana* group, while clay, nutrients elements, pH and SP were significantly highest in the other groups. Biodiversity indices in *Corylus avellana* group were significantly less than other stands. We recommend to provide comprehensive conservation and management programs in order to protect of common hazel, associated plant species, and to prevent of human activities such as recreational use and livestock.

Key words

Corylus avellana L., ecological species groups, conservation, soil properties, north of Iran

Introduction

Mountains are generally biologically diverse, support a high proportion of endemic species and harbor most of the world's protected areas (Khuroo et al. 2011). The biodiversity of plants in mountain ecosystems and their geographical distribution have received considerable interest from ecology and biogeography researchers over the last decade because understanding biodiversity patterns is important for biodiversity conservation, sustainable use and natural reserve area planning and management (Lee and Chun 2015). The lack of detailed information about spatial distribution of organisms often hampers an effective selection of conservation or management activities. Complete inventories of genes, species and ecosystems are almost impossible to be achieved, given the time and cost constraints (Reyers et al. 2000). Despite a considerable amount of scientific efforts, quantifying biodiversity at coarse scales still remains difficult, especially for rich communities such as

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tropical invertebrates or plants. Standards in measuring the completeness of species lists are still lacking and this affects the capacity to assess and monitor biodiversity at coarse scales in short time periods. As a consequence, biodiversity surrogates with easily recordable data are necessary to detect spatial and temporal patterns of biodiversity (Giorgini et al. 2015).

Diversity relationships and interactions between forest strata are currently an important research topic. It is particularly crucial to study the effects of tree-layer composition variations on herb-layer vegetation, since herb-layer vegetation contributes significantly to the ecosystem functioning and biodiversity in forests (McEwan and Muller, 2011). Productive and species-rich herb-layer vegetation can contain significant amounts of aboveground biomass and nutrients, during periods of high potential leaching, the temporary storage of elements by ground-layer herbs reduces nutrient losses into surface water (Mölder et al. 2014). Furthermore, many forest plant species are specially protected and high valued in nature conservation (Hermy et al. 1999; Jolls 2003). In general, the tree-layer composition has an effect on ground vegetation due to its influence on various ecosystem processes, e.g. nutrient cycles, light transmittance, and soil water supply (Chávez and Macdonald 2010).

Understory plants provide a crucial role in maintaining the structure and function of forest ecosystems. They contribute to forest biodiversity, generate the initial competitive interactions with regeneration phases of dominant canopy species, determine energy flow and nutrient cycling, and respond complexly to both natural and anthropogenic disturbances (Gilliam 2007). The ecosystem integrity of temperate forests depends on understory plant species conservation, as well as the stability and survival of other organisms, such us micro- and meso-fauna (Clement 2001). However, understory plant species have heterogeneous abundance and distribution patterns, which depends on the over-story species and structure (e.g., site quality of the stands or gap presence) (Lencinas et al. 2011).

Hazel with the scientific name of "*Corylus avellana* L." is a shrub belonging to "Fagales" phylum, from "Betulaceae" family and "Coryluideae" subfamily. Turkey is in the first position by producing 70 percent of hazelnuts of the world, and Italy is in the second position by producing 20 percent. After these countries, U.S.A, Azerbaijan, Georgia, Iran, Spain, China and French are the most significant countries producing the hazelnuts (Hosein Ava and Pir Khezri 2011(. Due to its need to light, this plant cannot survive inside the forests and it usually grows at the edge of the forests (Moraghebi et al. 2010). Native hazel species are grown in the northwest of Iran and they are planted in north of Iran as garden products. In Safagashteh forest of Fuman in north of Iran, there is a hazel stand, which has grown naturally. According to the fact that no research has ever been conducted in this region, the aim of this research was to determine plant ecological groups and soil properties in the study area.

Material and methods

Study area

The study area (Safagashteh forest) is located in Masouleh, near Fouman City, which is in Guilan Province, north of Iran (37°09'13" N and 48°59'14" E). Elevation ranges from 950 to 1150 m a.s.l., with 55% slopes that generally face east. Parent materials include limestone and shill. The mean annual precipitation and temperature is 1200 mm and 12°C, respectively.

Data collection

This study carried out in 50 ha of hazel protected area. A selective sampling method was used to record 30 400 m^2. We recorded slope percentage, geographical aspect, elevation, crown canopy percentage and individual number of tree and shrub species in each plot. In addition, litter depth was measured within each plot. Subplots of 100 m^2 were utilized for herbaceous species measurements, which consisted of percent cover of each species in the basis of the Domin criterion. Soil samples were taken at these 30 sampling plots in the study area. At each sampling plot, soil samples were collected from 0 to 20 cm depth to studying physical and chemical properties. Soil factors including soil texture, N, P, K, pH, OC, OM, C/N were analyzed in the laboratory.

Data analysis

At first, TWINSPAN (Two Way Indicator Species Analysis) was applied to classify the 30 sampling plots. The cut-off level of 'pseudo-species' followed the software's default. We then used ISA (Indicator Species Analysis) to extract those significantly associated with each group.

TWINSPAN and ISA were performed by PC-Ord 5.10. CANOCO 4.5 was performed to explore the relationship between the soil factors and the plant ecological groups in hazel forest. To evaluate herbaceous diversity, we used three indices. Species diversity was assessed with the Shannon–Wiener index, species richness was estimated according to the Margalef index. In addition, the Smith–Wilson index was utilized to calculate species evenness. All three indices were computed using Ecological Methodology and PAST softwares. Significance of differences between means was analyzed by one-way ANOVA, followed by Tukey test at 95% confidence level. All statistical analyses were conducted using SPSS software (version 22.0).

Results

TWINSPAN outputs

The outputs of TWINSPAN revealed three ecological groups: the first group, was characterized by *Corylus avellana* and *Epimedium pinnatum* which were included in sixteen sampling plots. The second group comprised of six sampling plots in which *Fagus orientalis*, *Asperula odorata*, *Euphorbia amygdaloides*, *Carex* sp., *Fragaria vesca* and *Viola sylvestris* were the indicator species. The third group consisted of eight plots in which *Crataegus microphylla*, *Ilex spinigera*, *Primula heterochroma, Sedum stoloniferum* and *Vicia crocea* were the indicator species (Tab. 1).

Table 1. Results of TWINSPAN and ISA analyses of study area

Species Group	Number of Plots	Indicator Species
1	16	*Corylus avellana*, *Epimedium pinnatum*
2	6	*Fagus orientalis*, *Asperula odorata*, *Euphorbia amygdaloides*, *Carex* sp., *Fragaria vesca* and *Viola sylvestris*
3	8	*Crataegus microphylla*, *Ilex spinigera*, *Primula heterochroma, Sedum stoloniferum* and *Vicia crocea*

RDA ordination results

The RDA ordination was used because the length of the gradient was calculated (2.94) to be less than 3. The first (0.305) and second (0.173) axes had the largest eigenvalues, which accounted for 60.5% of the change and variation. The results of RDA indicated that only sand was the most important factor in the first group. Phosphorus, nitrogen, potassium, carbon, organic material, clay, silt, BD, SP and pH were the most important factors in the second and third group (Fig. 1).

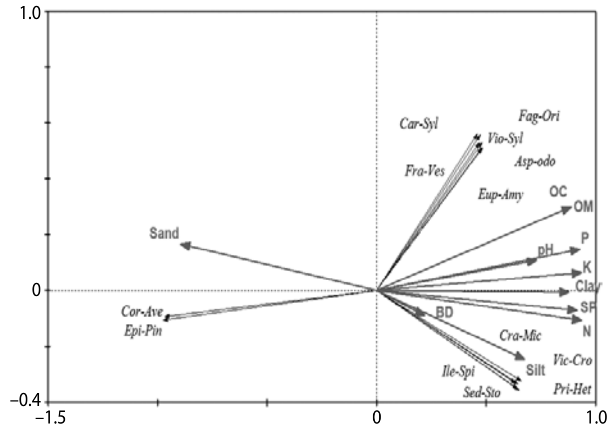

Figure 1. Result of RDA analysis of ecological species groups and soil variables in the study area

ANOVA results of soils

Clay, phosphorus, nitrogen, potassium, carbon, organic material, pH and SP were significantly the highest value in the second and third group. In contrast, Sand was significantly the highest value in the first group. In addition, BD and silt were significantly higher in first group than other groups (Tab. 2).

Table 2. Comparison of the soil variables amongst the species groups

	Group 1	Group 2	Group 3
N	0.18[b]	0.29[a]	0.32[a]
P	6.5[b]	12[a]	11.8[a]
K	123[b]	180[a]	176[a]
OC	1.72[b]	2.73[a]	2.67[a]
OM	2.65[b]	3.88[a]	3.7[a]
Sand	70[a]	54.5[b]	59[b]
Silt	14[c]	18.5[b]	25[a]
Clay	8.75[b]	18.75[a]	17.25[a]
BD	0.8[c]	0.93[b]	1.05[a]
SP	40.37[b]	49.5[a]	51.6[a]
pH	6.62[b]	7.03[a]	6.92[a]

ANOVA results of diversity indices

Biodiversity indices (diversity, richness and evenness) for the second and third groups were significantly higher than first group, but there was no significant difference between second and third groups (Tab. 3).

Table 3. Means (±SE) of biodiversity indices in the study area

	Group 1	Group 2	Group 3
Shannon-Wiener diversity	1.09 ± 0.23	2.21 ± 0.65	2.14 ± 0.71
Pielou evenness	0.56 ± 0.03	0.872 ± 0.18	0.858 ± 0.29
Margalef richness	1.3 ± 0.09	2.39 ± 0.52	2.26 ± 0.11

Discussion

The results are evident that almost half of the study area is dominated by hazel species, and it has created a pure community of hazel. However, in other parts they have grown sporadically and they are dominated by *Fagus orientalis* Lipsky tree and *Ilex spinigera* Loes and *Crataegus microphylla* C. Koch shrub species. Pena et al. (2011) in the Basque region of the northern Iberian Peninsula, and Boulanger et al. (2015) in the Haute-Marne administrative region in north-eastern France found that *Corylus avellana* L. is an accompany species with beech. Onaindia and Mitxelena (2009) showed that *Corylus avellana* is accompany species with *Fagus sylvatica, Ilex aquifolium* and *Crataegus monogyna* at the Ibaizabal river basin in Basque region in the north of Spain. In fact, hazel is not able to compete with other species and it grows in site where other species are present less. In the study area, *Fagus orientalis*, *Ilex spinigera* and *Crataegus microphylla* were found the most of the forest, but hazel grew in higher altitudes.

The results of analyzing soil indicated that hazel is grown in habitats with sandy soil and little nutrient elements. As seen in Figure 1 and Table 2, *Fagus orientalis* and *Ilex spinigera* and *Crataegus microphylla* species in contrast to hazel, prefer more fertility soils. Moreover, the hazel is usually found in soils with less nutrient elements such as NPK. On the other hand, results revealed that hazel live in habitats with almost acidic condition. Koorem and Moora (2010) showed that nitrogen, phosphor and pH in hazel community were less than other communities. Coroi et al. (2004) observed that *Corylus avellana*. Is an indicator species in the area and inhabit on sandy soils in south of Ireland. Adel et al. (2014) and Eshaghi Rad (2010) identified soil texture, pH, N, P, K, C and organic material as the main factors that affect the distribution of beech communities in northern Iran.

Diversity of herbaceous species in hazel stand was lower than the two other ecologic groups. The most important reason of this seems to be the high percentage of canopy cover of hazel stand which doesn't allow light reaches the ground well. Understory vegetation composition in temperate forests is largely determined by soil fertility, light conditions and water availability (Hardtle et al. 2005). In addition, woody plants also affect understory composition by modifying the abiotic microclimate and resource availability (Augusto et al. 2003). For example, light is commonly an important factor which impacts on forest understory richness and composition, and available light depends on canopy structure (Scheller and Mladenoff 2002). The other reason might be presence of *Epimedium pinnatum* Fisch which is the indicator species in the understory of pure hazel community and it has a significant role in competition with other species and to prevent in their growth. In a research in Koeru, central Estonia, Koorem and Moora (2010) found that indicator species composition in *Corylus avellana* understory were different from other communities. The other reason seems to be deficiency of nutrient elements in this community. As a result, these species prefer to grow in a more suitable environmental condition with higher nutrient elements, as we can see in *Fagus orientalis* and *Ilex spinigera* and *Crataegus microphylla* sites which have a better situation than hazel habitats. The presence of more indicator herbaceous species in the two other ecologic groups might be the indicative of this fact. Different tree and shrub species influence on species richness and understory composition through modification of local soil properties (Wulf and Naaf 2009).

In this research, we have conducted early identification of the study area. Hazel forests play an important role in protecting habitat against rockfall hazard, therefore conservation programs should be applied to it (Jancke et al. 2009). Considering the fact that hazel natural stands are rare in the forests of northen Iran, we recommend to provide comprehensive conservation and management programs in order to protect of common hazel, associated plant species, and to prevent of human activities such as recreational use and livestock.

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