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Plant diversity in natural forest of Guilan Rural Heritage Museum in Iran

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ABSTRACT

Abedi R, Pourbabaei H (2010) Plant diversity in natural forest of Guilan Rural Heritage Museum in Iran. Biodiversitas 11: 182-186. The aim of this study was to determine plant species diversity in Guilan Rural Heritage Museum in Iran. Eighty nine sampling plots were sampled based on systematic random method. Data analysis was carried out using diversity indices of richness, diversity (Shannon-Wiener, Simpson, Mc Arthur's (N_1) and Hill's (N_2) and Smith and Wilson's evenness index (E_{var}). Results indicated that Rosaceae and Labiatae families have the highest number of species. *Quercus castaneifolia* and *Ruscus hyrcanus* were the most dominant woody plants for class of tree and shrub, respectively. *Carex divolsa* and *Viola odorata* were dominant herbaceous species. Herbaceous layer had the highest richness, evenness and diversity. Mc Arthur's N_1 index had the highest value among diversity indices.

Key words: diversity, richness, evenness, Rural Heritage Museum, Guilan.

INTRODUCTION

Deforestation is one of the primary causes of biodiversity loss. Forests represent about 30% of terrestrial habitats, and support an exceptional number of species. Forests also provide economically important products and services. Small, isolated forest fragments are typically less able to provide these goods and services, or support a full complement of native species (Mayer and Tikka 2006). Natural forests decline in both extent and quality worldwide; there is an increasing recognition of the biodiversity conservation value of production landscapes (Le Brocque et al. 2009). Maintenance of biodiversity has been recognized as an important component of sustainable development and protection of native forests is a major means of biodiversity conservation (Muller et al. 2006). Efficiency of management and maintain of endangered species of a region could be evaluated when we have entire consciousness about biodiversity (Asri 2008).

Plant biodiversity consists of diversity into plant population structure, distribution, composition and abundance patterns. It is used as an index for comparison of forest ecosystems conditions (Pourbabaei 2001). Biological diversity has an indispensable value to society in that it (i) serves as a reservoir of genetic material that enhance productivity and stress tolerance of domesticated species and a source of new medicine, energy and industrial feed stock, (ii) provides ecological services such as amelioration of climate, water purification, soil stabilization and flood control and (iii) provides animals and natural landscape which have an overall benefit on human health and well-being through various forms of outdoor recreation (Brockway 1998).

Biological diversity is the richness and evenness of species amongst and within living organisms and ecological complexes (Polyakov et al. 2008). Biodiversity is mostly studied in species level. There are different indices to measure biodiversity. The most commonly considered facet of biodiversity is species richness. Evenness is another important factor of biodiversity. (Kharkwal et al. 2004). Evenness has been considered as a fundamental fact in habitats with more than one species (Hashemi 2010). Nowadays, numerous efforts to incorporate biodiversity into forests management and planning are encouraging (Brockway 1998).

Many studies have been carried out on plant biodiversity indices in Iran and around the world. Gholami et al. (2007) compared plant diversity, richness and evenness indices around protected area of the Bazangan Lake in Khorasan province, northeast of Iran. They indicated the highest value in Shannon-Wiener index. Ravanbakhsh et al. (2007) studied under-storey and over-storey plant biodiversity in Gisoom reserved forest in Guilan province, north of Iran and they showed that under-storey vegetation was disturbed and affected by human impacts. Abasi et al. (2009) investigated the effects of conservation on woody species diversity in protected regions of Oshtorankooh in Lorestan province, west of Iran. They expressed that trees and shrubs living in the protected regions species have significantly higher diversity, richness, evenness and better living condition than they living in non-protected region. Comparison of species richness and Hill's diversity indices showed that total species richness was higher in natural stands. Also, more fertile sites have significantly higher values of Hill's diversity index in mature stands of spruce plantation and natural stands in Southeaster New Brunswick, Canada

(Roberts 2002). Measurement of Shannon-Wiener and evenness indices on *Pinus massoniana* communities in Conservation project of plant biodiversity in Yangtze Three Gorges reservoir area, China showed that biodiversity of shrubs layer was the highest, followed by grass layer and the middle, while tree layer was the lowest (Tian et al. 2007).

Main objective of this study was to quantitatively analyze the biodiversity of vegetation cover in tree, shrub, herbaceous and regeneration layers in Guilan Rural Heritage Museum, Iran.

MATERIALS AND METHODS

Study area

The study was carried out at the Guilan Rural Heritage Museum with approximately 260 ha in extent that is located in Saravan Forest Park in the north of Iran (37˚6' to 37˚8' N latitude and 49˚37' to 49˚39' E longitude). The altitude ranges from 60 to 120 m asl. The climate is humid and very humid with cool winter according to Emberger climate classification. Mean annual temperature is 16.33˚C and annual precipitation is 1366.64 mm. Maximum and minimum temperature is 27.8˚C in August and 4.1˚C in February, respectively (data obtained from 1985 to 2005, http://www.weather.ir) (Figure 1). This area is located at about 15 km far away from Rasht, the capital city of Guilan province, Iran.

Field sampling

Sampling procedure was the systematic random method. In this method, the sampling network size was 100×200 m. The distances between sampling strips were 200 m and the distances between circular plots on strips were 100 m. Then, start point was randomly selected and the sampling network was systematically located on the map (Poorbabaei et al. 2008; Pourmajidian et al. 2009; Poorbabaei and Poorrostam 2009; Shafiei et al. 2010). Totally, 89 sampling plots were taken. Data was collected to the class of tree (≥10 cm dbh) and shrub layers (number of individual) in 1000 m^2 circular plots (Zobeiry 2005; Pourmajidian et al. 2009; Shafiei et al. 2010). In the center of these plots, the cover percentage of herbaceous species, including herbs, ferns and mosses, was estimated using Domin criterion by minimal area method with 32 m^2 areas. Number of regeneration in two classes include, sapling (≥1.30 m height and ≤10 cm dbh) and seedling (<1.30 m height) were sampled in 100 m^2 circular plots. Plant specimens were collected and stored in the Herbarium of Department of Forestry in Faculty of Natural Resources at University of Guilan.

Data analysis

Data analysis was carried out using diversity indices of Shannon-Wiener, Simpson, Mc Arthur's N_1, Hill's N_2, and Smith and Wilson's evenness (E_{var}). The diversity indices were calculated separately to different life forms: trees, shrubs, saplings, seedlings and herbs. Indices were used as following (Pitkanen 1998; Krebs 2001; Nagendra 2002; Nangendo et al. 2002; Small and McCarthy 2005; Lamb et al. 2009; Hashemi 2010):

Shannon-Wiener' H': $H' = -\sum_{i=1}^{S} P_i \ln P_i$

Simpson' 1-D: $1 - D = 1 - \sum_{i=1}^{S} P_i^2$

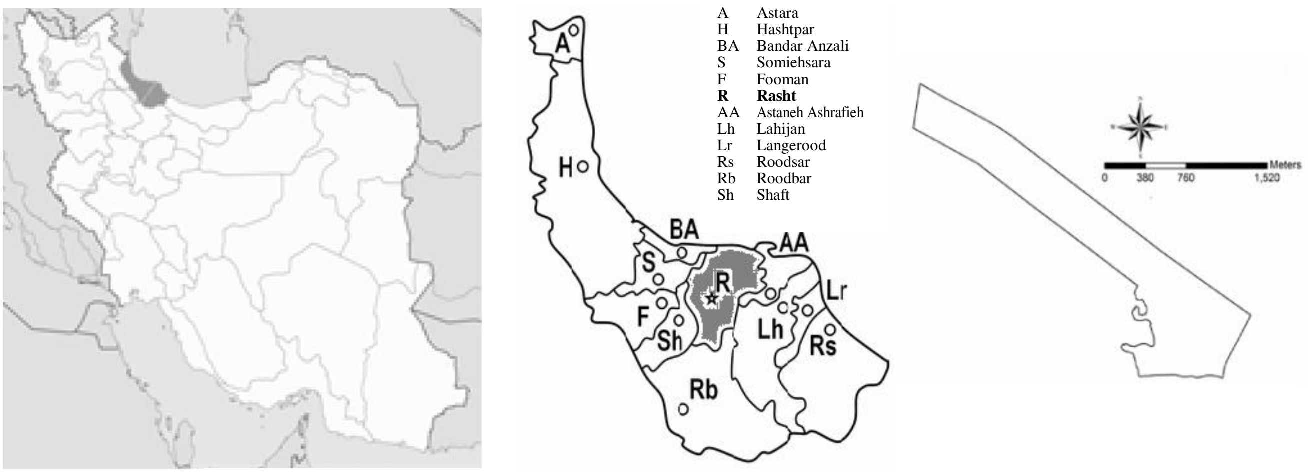
Mc Arthur's N_1: $N_1 = 2^{H'}$

Hill's N_2: $N_2 = \frac{1}{\sum_{i=1}^{S} P_i^2}$

S: the total number of species in the sample.

P_i: the proportion of individuals in the ith species ($P_i = n_i/N$, n_i is the number of individuals in the ith species and N is the total number of individuals)

Smith and Wilson's evenness (E_{var}) (Krebs 2001; Gosselin 2006):



Islamic Republic of Iran *Guilan Province* *Guilan Rural Heritage Museum*

Figure 1. Location of the study area: Guilan Rural Heritage Museum, Guilan Province, Islamic Republic of Iran.

$$E_{var} = 1 - \left[\frac{2}{\pi \arctan\{\sum_{i=1}^{S} (Log_e(n_i) - \sum_{j=1}^{S} Log_e(n_j)/S)^2/S\}} \right]$$

Arctan: measured as an angle in radians

n_i: basal area for over-storey species and is coverage for the under-storey of the ith species in the sampling plot

n_j: basal area for over-storey species and is coverage for the under-storey of the jth species in the sampling plot

S: total number of species in the entire sample

Numbers of species per plot was taken as a measure of species richness (S) (Timilsina et al. 2007). Data were calculated in Ecological Methodology software (Krebs 2001).

Species importance value (SIV) was calculated for all species by summing relative frequency, relative density and relative dominance values for woody species and summed relative frequency and relative dominance for herbaceous species. SIV was used to identify dominance species in the study area. The following formulas were used for each calculation (Maingi and Marsh 2006; Adam et al. 2007):

$$\text{Relative frequency} = \frac{\text{Number of plots that contain a species}}{\text{Number of all plots}} \times 100$$

$$\text{Relative density} = \frac{\text{Number of a species in all plots}}{\text{Total Number of species in all plots}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Total basal area of a species in all plots}}{\text{Total basal area of all species in all plots}} \times 100$$

RESULTS AND DISCUSSION

Results

Totally, 75 plant species including 73 native species belong to 43 families and 72 genera were recorded throughout the study area (Table 1). Rosaceae and Labiatae families had the highest number of species (Figure 2). *Quercus castaneifolia* (227.24%) and *Ruscus hyrcanus* (126.60%) had the highest value of SIV and were the most dominant woody species to tree and shrub layers, respectively. *Carex divulsa* (76.47%) and *Viola odorata* (75.80%) were the most dominant herbaceous species. Mean richness of species (S) was higher in herbaceous layer and followed by regeneration, tree and shrub layers (Figure 3). Herbaceous layer had the highest amount of Smith and Wilson's evenness index (E_{var}) and followed by shrubs, regeneration and tree layers (Figure 4). Diversity indices of Simpson (1-D), Hill's N_2, Shannon-Wiener (H') and Mc Arthur's N_1 in tree, shrub, herbaceous and regeneration layers were showed in Figures 5. Mc Arthur's N_1 was higher diversity index and followed by Hill's N_2, Shannon-Wiener and Simpson in all layers of vegetation cover in the study area.

Table 1. List of plant species in Guilan Rural Heritage Museum.

Scientific Name	Family
Acalypha australis L.	Euphorbiaceae
Acer insigne Boiss.	Aceraceae
Albizia julibrissin Durazz.	Mimosaceae
Alisma plantago-aquatica L.	Alismataceae
Alnus subcordata C. A. Mey.	Betulaceae
Artemisia annua L.	Asteraceae
Asplenium adiantum-nigrum L.	Aspleniaceae
Athyrium filix-femina (L.) Roth.	Athyriaceae
Azolla filiculoides Lam.	Salviniaceae
Brachythecium plumosum (Hedw.) Schimp.	Brachytheciaceae
Carex divulsa Stokes.	Cyperaceae
Carpinus betulus L.	Betulaceae
Chelidonium majus L.	Papaveraceae
Convolvulus betonicifolius Mill.	Convolvulaceae
Cirsium arvense (L.) Scop.	Asteraceae
Crataegus ambigua M. B.	Rosaceae
Cynodon dactylon (L.) Pers.	Poaceae
Cyperus rotundus L.	Cyperaceae
Danae racemosa (L.) Moench.	Liliaceae
Diospyros lotus L.	Ebenaceae
Epipactis latifolia All.	Orchidaceae
Erigeron canadensis L.	Asteraceae
Euphorbia amygdaloides L.	Euphorbiaceae
Ficus carica L.	Moraceae
Fragaria vesca L.	Rosaceae
Geum heterocarpum Boiss.	Rosaceae
Gleditsia caspica Dest.	Caesalpiniaceae
Hedera helix L.	Araliaceae
Hedera pastuchovii Woron. Ex Grossh.	Araliaceae
Hypericum androsaemum L.	Hypericaceae
Hypericum perforatum L.	Hypericaceae
Ilex aquifolium L.	Aquifoliaceae
Juncus bufonius L.	Juncaceae
Juncus glaucus Ehrh.	Juncaceae
Lamium album L.	Labiatae
Lycopus europaeus L.	Labiatae
Mentha pulegium L.	Labiatae
Mespilus germanica L.	Rosaceae
Morus alba L.	Moraceae
Nepeta involucrate (Bunge) Bornm.	Labiatae
Oplismenus undulatifolius (Ard.) P.	Poaceae
Oxalis corniculata L.	Oxalidaceae
Palamocladium sp.	Brachytheciaceae
Parrotia persica C. A. Mey.	Hamamelidaceae
Periploca graeca L.	Asclepiadaceae
Phyla nodiflora (L.) Greene.	Verbenaceae
Phyllitis scolopendrium (L.) Scop.	Aspleniaceae
Plagiomnium cuspidatum	Mniaceae
Polygonum aviculare L.	Polygonaceae
Polypodium vulgare L.	Polypodiaceae
Populus caspica Bornm.	Salicaceae
Potentilla reptans L.	Rosaceae
Primula heterochroma Starf.	Primulaceae
Prunella vulgaris L.	Labiatae
Prunus domestica L.	Rosaceae
Pteridium aquilinum L. Kuhn in Decken.	Hypolepidaceae
Pteris cretica L.	Pteridaceae
Pterocarya fraxinifolia (Lam.) Spach.	Juglandaceae
Pyrus communis L.	Rosaceae
Quercus castaneifolia C. A. Mey.	Fagaceae
Rubus persicus Boiss.	Rosaceae
Ruscus hyrcanus Woron.	Liliaceae
Salix alba L.	Salicaceae
Salix aegyptiaca L.	Salicaceae
Sambucus ebulus L.	Caprifoliaceae
Scutellaria albida L.	Labiatae
Setaria glauca (L.) P. Beauv.	Poaceae
Smilax excelsa L.	Liliaceae
Solanum dulcamara L.	Solanaceae
Solidago virga-aurea L.	Asteraceae
Ulmus carpinifolia G. Suckow.	Ulmaceae
Urtica dioica L.	Urticaceae
Viburnum lantana L.	Caprifoliaceae
Viola odorata L.	Violaceae
Zelkova carpinifolia (Pall.) Dipp.	Ulmaceae

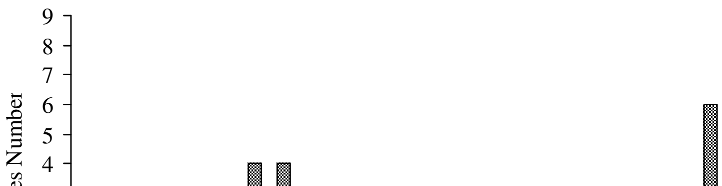


Figure 2. Number of species in each family of plants in Guilan Rural Heritage Museum, Iran.

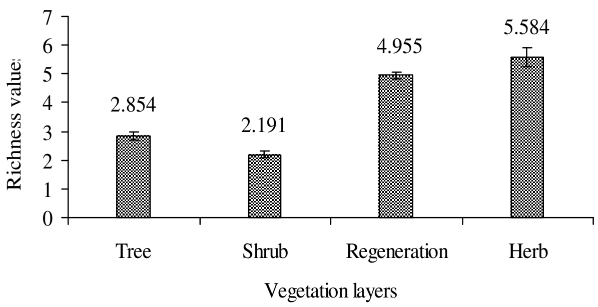


Figure 3. Mean and standard error of richness in tree, shrub, Regeneration and herbaceous layers

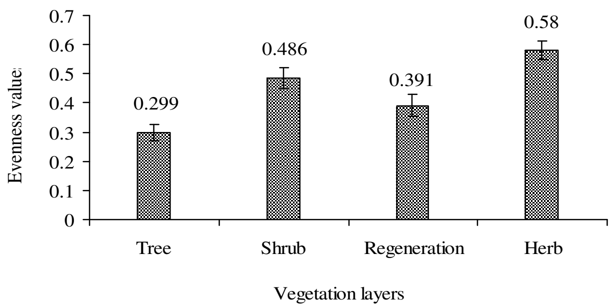


Figure 4. Mean and standard error of evenness index in tree, shrub, regeneration and herbaceous layers

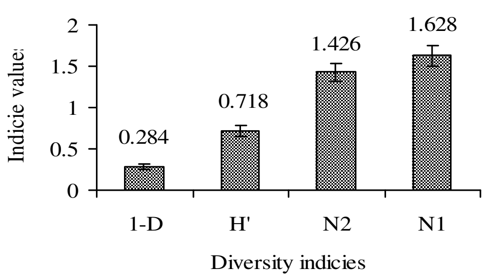


Figure 5. Mean diversity indices, richness, evenness and their standard errors in tree layer

Discussion

The assessment of biodiversity in forest has become an important issue for studying ecosystems and their conservation (Aubert et al. 2003). Biodiversity measurement is recognized as guidance for conservation plans in local scale. Species biodiversity is used greatly in vegetation studies, and environmental evaluation is one of the main criteria to determine ecosystems condition. So that, many research considered that high species diversity is equal to stability in ecological systems (Mirdavoodi and Zahedi Pour 2005).

The presence of 75 plant species in 260 ha area indicates considerable plant diversity in the study area. Our results showed that herb layer had the highest diversity indices (richness, diversity and evenness). The light penetration was high due to forest disturbance and decreasing canopy coverage, it led to increasing herbaceous species. Also, response of under-storey species to physiographical condition will be used as index of disturbances and changes in environmental and edaphical condition in sites (Mirzaei et al. 2008).

Many studies have emphasized the effects of slopes, aspect and elevation on plant diversity. It seems that high plant diversity in our study area is due to topographic and physiographic condition. This study area is flat in most parts (average of slope in most parts is 0-30 % and in some parts is 30-60%). High plant diversity is also due to fertility and humidity of sites. Steep slopes cause negative effects on site qualities by drainage of available water, soil erosion and decrease of soil nutrients (Sohrabi et al. 2007). In the other hand, low degree of slope and humidity were the most important factors of increasing diversity of herbaceous species (Gholami et al. 2007).

Studies showed that the highest values of richness and evenness occurred in the middle altitudes because of favorable temperature (Mirzaei et al. 2008). Thus, altitude ranging from 60 to 120 m asl. in our study area can be an appropriate condition for plant diversity. Northern slopes have more diversity due to must humidity (Kooch et al. 2009). Our study area was flat in many parts but have northern slopes in some parts. This can be evaluated as a reason of acceptable plant diversity.

Study on the effective environmental condition such as slope, aspects, altitudes and specially edaphic, climatic and anthropogenic factors on plant species diversity should be considered. Mc Arthur's N_1 is sensitive to the number of species (Pourbabaei and Ahani 2004). It was the highest value in herbaceous layer due to high number of herbaceous species in the study area. Simpson index is sensitive to the frequency of species (Pourbabaei and Ahani 2004). The highest Simpson index is herb layer, followed by shrub, regeneration and tree layers (shrubs have the lowest number of species but dispersed distributed in the study area). Roberts (2002) showed that fertile sites have the highest value of Hill's N_2 index and this index is significantly higher in natural stands. In our study, value of this index for herb layer was the highest and followed by shrubs, trees and regeneration layers. Comparison of this study area to Gisoom reserved forest in the west of Guilan province (both of them are coastal plain forests in north of Iran) showed that species richness was the same but biodiversity in Gisoom has better condition than in our study area. It seems that conservation strategies are important factor in plant diversity conservation in Gisoom (Ravanbakhsh et al. 2007).

CONCLUSION

Attempts to establish a diverse ecosystem with aesthetic values and help for plant conservation are necessary in Guilan Rural heritage Museum. Diversity is one of the main factors of sustainable forest management. Identifying plants species of a region and their biodiversity is very effective way to identify disturbance factors and develop recovery plans. It is also essential to maintain a high proportion of native woody species, create protection programs and preserve the area against human and livestock disturbances.

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