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ECOLOGICAL STUDY OF *BETULA PENDULA* STANDS IN HYRCANIAN FORESTS, NORTH IRAN

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This study was carried out in the rocky forests of Dodangeh, south of Sari, an area extended as a narrow strip from east to west in the heights of Hyrcanian forests, with the area of *ca* 2,000 ha and the altitude of 2,500–2,950 m a.s.l. Regarding vegetation history, Dodangeh is a refuge for *Betula pendula* Roth. This species together with *Corylus avellana* L. are the first ones formed a plant community in Hyrcanian region since the glaciation of the Tertiary period and gradual retrogression of conifers. A number of 181 plant species belonging to 52 families were identified through sampling of 20 relevés of the size 400 m^2. Out of these, 17% were endemic of Hyrcanian and Irano-Turanian regions including four species viz. *Aconitum iranshahrii* Renz., *Cortusa mathioli* subsp. *iranica, Delphinium elbursense* var. *elbursense* and *Doronicum wendelboii* which could be found nowhere else in the world. *Querco macrantherae-Betuletum pendulae* association is recorded in the Hyrcanian and Euro-Siberian regions for the first time. Chorological studies of *Querco macrantherae-Betuletum pendulae* showed that the elements of Irano-Turanian, Euro-Siberian and Hyrcanian regions are more than those of the other existing vegetational regions in the area. Dynamic processes of this association and its restoration were also considered in the study.

Key words: chorology, conservation, endemic species, Hyrcanian forest, *Querco macrantherae-Betuletum pendulae*, restoration, vegetation profile

INTRODUCTION

The northern forests of Iran are diverse ecosystems of Euxine-Hyrcanian Province in Euro-Siberian region (Takhtajan 1986). They are extended in the north aspects of Elburz mountains to the south of Caspian Sea with 20–80 km width, 800 km length and the altitude range of –21 to 2,600 m a.s.l. Geomorphological and relief characteristics, precipitation of about 700–2,100 mm yr^{-1} and closeness of the forests to the Caspian Sea have made suitable habitats for a variety of plant and animal species. So far about 1,300 plant species have been identified from which 220 are woody plants. Variations in alti-

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tudes and aspects have made the establishment of plant associations such as *Fagetum oriental*, *Parrotio-Carpinetum*, *Pterocaryo-Alnetum*, *Querco-Buxetum* and *Querco-Carpinetum*. These forests have long been studied by ecologists and botanists such as Rechinger, Wendelbo, Bobeck, Gauba, Renz, Probst, Sabeti, Javanshir and Asadi.

Some areas like rocky forests of Dodangeh, in south of Sari, have not been ecologically and biologically well investigated. Regarding vegetation history, these forests seem to be the last habitat and refuge of *Betula pendula* Roth. that along with *Corylus avellana* L. formed a plant community in Hyrcanian region since the glaciation of the Tertiary period and gradual retrogression of conifers. Dodangeh is located in the heights of the Hyrcanian forests with the area of about 2,000 ha and the altitude of 2,500–2,950 m a.s.l. Special geomorphological features of the limestone and rocky mountains of Elburz in this area have made a special microclimate and caused the establishment of unique plant communities. This area is also the mere remaining habitat of *Betula pendula*. The mixed type includes species such as *Acer hyrcanum*, *A. platanoides*, *Berberis integerrima*, *Betula pendula*, *Carpinus orientalis*, *Fagus orientalis*, *Lonicera caucasica*, *Quercus macranthera*, *Q. petraea*, *Rhamnus cathartica*, *Ribes bieberstina* and *Sorbus aucuparia*.

MATERIALS AND METHODS

Study area

Dodangeh forests are located in south of Sari, North Iran, with the latitude of 35° 10′ to 36° 30′ and longitude of 53° 10′ to 53° 27′ (Fig. 1). The altitude is varied from 2,500 to 2,950 m a.s.l. The mean annual precipitation is 850 mm.

Data collection and analysis

In order to determine floristical composition, ecological characteristics of *Betula pendula* and distribution range of the species, 20 relevés of the size 400 m^2 were located along a transect of 250 m based on the distribution of species and geomorphology of the area. The data collected by Braun-Blanquet method (Braun-Blanquet 1983) were subjected to analyses by Syn-Tax 5.0 (Podani 1995) and PC-ORD for Windows (McCune and Mefford 1999) to characterise ecological groups and importance of *Betula pendula* in successional trends. Life form spectrum of the area was obtained according to the Raunkiaer's life form. Nomenclature and chorology of the species follow Asadi (1989–2002), Davis (1965–1988), Ghahreman (1980–2002), Komarov and Shishkin (1963–1974), Rechinger (1963–1998) and Zohary *et al.* (1980–1993).

RESULTS AND DISCUSSION

Altogether 181 plant species belonging to 129 genera and 52 families were identified in the study area based on Flora of Iranica (Rechinger 1963–1998), Flora of USSR (Komarov and Shishkin 1963–1974), Flora of Turkey (Davis 1965–1988), Flora of Iran (Asadi 1989–2002), Colour Flora of Iran (Ghahreman 1980–2002). Out of these, 17% (31 species) were endemic of Hyrcanian and Irano-Turanian regions including four species, viz. *Aconitum iranshahrii* Renz., *Cortusa mathioli* subsp. *iranica, Delphinium elbursense* var. *elbursense* and *Doronicum wendelboii* which could be found nowhere else in the world. Despite the small size of the sampled area (20 relevés of 400 m^2), about 1.7% of the endemic plants of Iran (31 out of the total 1800) are present in this area. Rosaceae, Asteraceae, Poaceae, Lamiaceae and Caryophyllaceae had 23 (13%), 20 (11%), 15 (8%), 8 (4%) and 7 (4%) species, respectively (Fig. 2).

Based on the table method of Braun-Blanquet (1983), we obtained one association named *Querco macrantherae-Betuletum pendulae* including *Scabiosetosum hyrcanii* subassociation as well as *Acer hyrcanum* and *Delphinum elbursense* var. *elbursense* variants. This association is recorded, for the first time, in the Hyrcanian and Euro-Siberian regions. The results of some analyses by Syn-Tax 5.0 and PC-ORD, by using TWINSPAN method, indicated two ecological groups with different ecological characteristics (Table 1 and Fig. 3). The first group with *Cotoneaster nummularioides* indicates a habitat of poor and cal-

Fig. 1. Map of Iran showing the location of study area in south of Sari, Mazandaran province

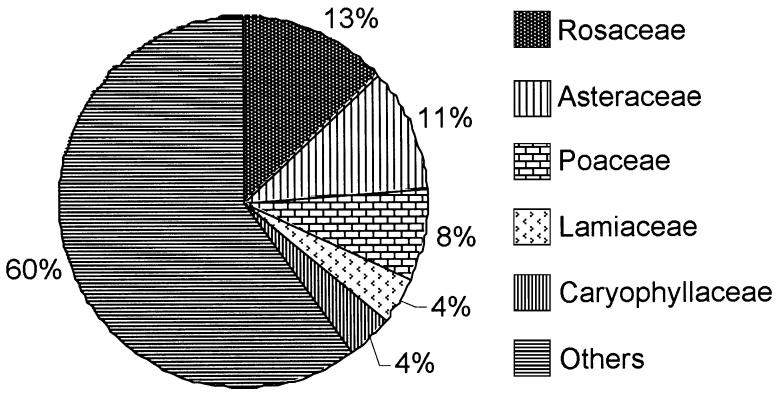

Fig. 2. Relative contribution of the plant families in the study area

careous soil with high C:N ratio. The second with *Actaea spicata* and indicates a habitat of rich and weak acidic to acidic soil with low C:N ratio. The biological activity of the soil is low in the first and high in the second one, therefore decomposition process will be longer in the first than the second group.

Life form spectrum of the area was obtained based on life form system of Raunkiaer (Küchler and Zonneveld 1988) (Fig. 4).

Chorological studies of *Querco macrantherae-Betuletum pendulae* showed that the number of plant elements of Irano-Turanian (Ir.-Tur.), Euro-Siberian (Euro-Sib.) and Hyrcanian (Hyrc.) regions exceed other existing vegetational regions (19 chorotypes) (Fig. 5). The reason is that this association is located in the upper part of Hyrcanian and in the vicinity of Irano-Turanian region so that it can be exposed to the invasion of vegetation elements of the two regions. Since elements of Hyrcanian areas belong to Euro-Siberian regions, the presence of Euro-Siberian elements in this association is both natural and indicator of Hyrcanian areas.

Natural history and dynamic studies of the northern forests of Iran denote that *Betula pendula* and *Corylus avellana* are the first species developed in the Hyrcanian area. Climatic changes of the Tertiary period, emerging and migrating of the overwhelmed broad-leaved species and competition caused retrogressive process of *Betula pendula* stands, subsequently not to be observed in other parts of the Hyrcanian forests. Dynamic process of the forest communities indicates that Dodangeh, in spite of having the same altitude with the other areas, has exceptionally acted as a mesohabitat and preserved *Betula pendula* from competitors such as *Acer velutinum*, *Alnus subcordata*, *Carpinus betulus*, *Cerasus avium*, *Fagus orientalis*, *Fraxinus coriariifolia*, *Parrotia persica* and *Quercus castaneifolia* during climatic variations. Sample analysis of different years shows that in spite of the ecological conditions, current stability and pro-

cess in *Betula pendula* stands, this ecosystem is a combination of individuals of *Betula pendula*, *Carpinus orientalis*, *Juniperus communis* subsp. *hemisphaerica*, *Quercus macranthera* and *Sorbus aucuparia.* Phytosociological analysis and investigations on individuals of different ages (Zare 2002) indicate a stable eco-

Table 1
Part of the phytosociological table arranged according to the Braun-Blanquet method

	R17	R8	R20	R3	R16	R4	R2	R1	Species / Relevés	Sp. no.
Character species of Querco-Betuletum association	0	2	2	2	3	3	5	5	*Viburnum lantana*	177
	3	3	3	3	3	3	3	3	*Berberis integerrima*	22
	2	2	2	3	3	0	2	3	*Cervaria caucasica*	36
	3	0	3	2	3	2	2	2	*Cystopteris fragilis*	55
Differential species of *scabiosetosum* subassociation					3	2	3	3	*Lapsana communis*	97
					0	3	3	2	*Leontodon hispidus*	100
					2	3	2	3	*Scabiosa hyrcanica*	147
					4	3	1	3	*Thalictrum foetidum*	169
							7	5	*Acer hyrcanum*	2
							6	5	*Fagus orientalis*	74
							5	5	*Galium spurium*	78
							5	5	*Lonicera caucasica*	104
							6	5	*Carpinus orientalis*	32
							5	3	*Silene schafta*	155
							3	3	*Doronicum wendelboii*	63
							3	5	*Polygonatum oriental*	124
							3	3	*Acer platanoides*	3
							2	2	*Alchemilla farinosa*	8
							2	3	*Iranecio othonae*	90
							3	2	*Lecockia cretica*	99
							2	1	*Jurinella frigida*	95
Differential species of *Delphinium elbursense* var. *elbursense* variant						7			*Delphinium elbursense* var. *elbursense*	59
						4			*Thymus pubescens*	171
						4			*Stachys persica*	163
						5			*Rhamnus cathartica*	131
						3			*Saxifraga wendelboii*	146
						3			*Anthemis triumfetti*	12
						3			*Sorbus graeca*	158
						3			*Sempervivum iranicum*	151
						3			*Rosa hemisphaerica*	137
						3			*Bromus beneckeni*	27
						3			*Heracleum persicum*	85

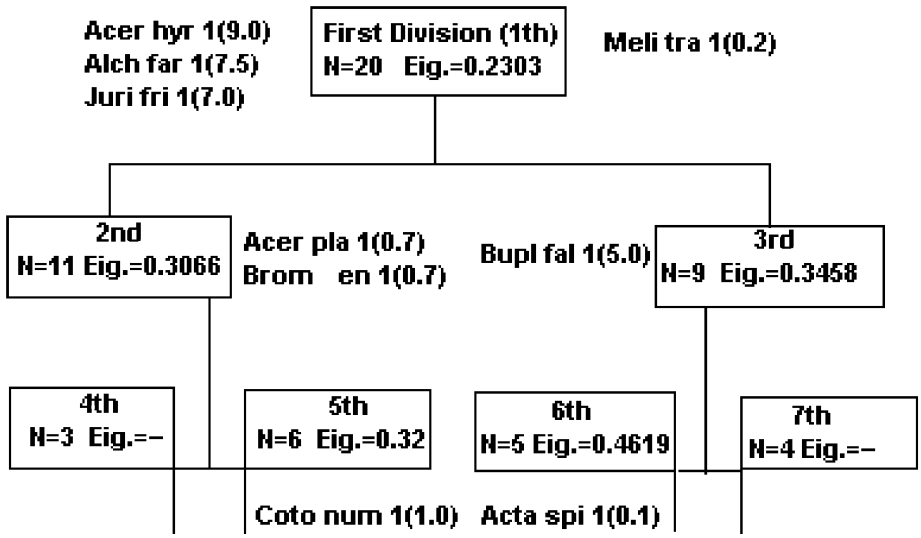

Fig. 3. The ecological groups derived from TWINSPAN analysis

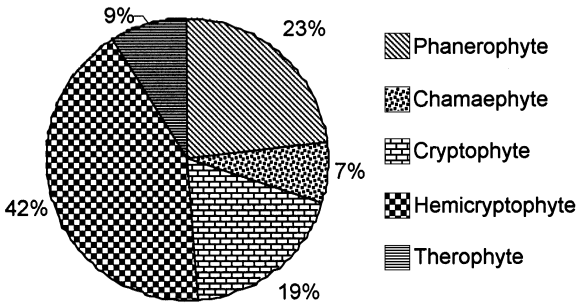

Fig. 4. Life form spectrum of Raunkiaer in the area

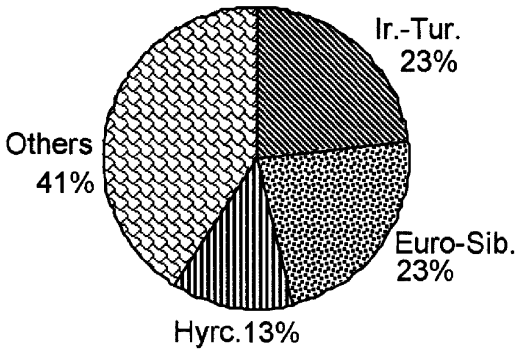

Fig. 5. Relative contribution of the chorotypes in Dodangeh

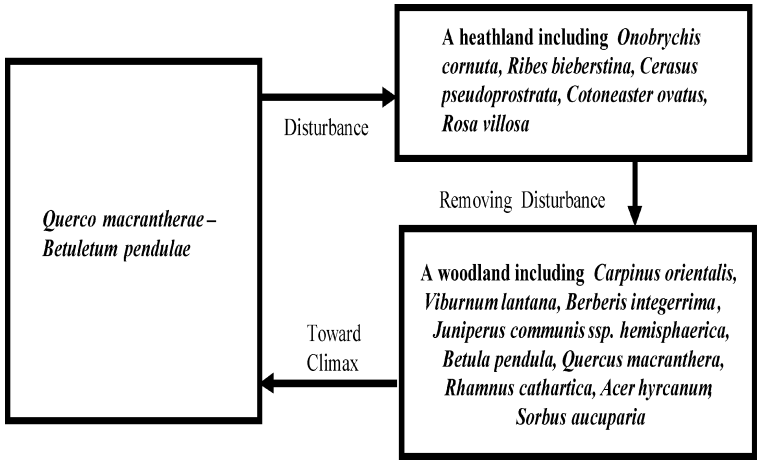

Fig. 6. Dynamic process of *Querco macrantherae-Betuletum pendulae* association affected by disturbance

logical situation in *Querco macrantherae-Betuletum pendulae* association. This association, as a climatic climax, is in a balance with its environment. Therefore the existing succession in undisturbed and inaccessible associations is the climax of *Querco macrantherae-Betuletum pendulae* (Fig. 6).

The profile of woody plants in *Querco macrantherae-Betuletum pendulae* association was also provided in a strip of 40 m length and 10 m width (Fig. 7).

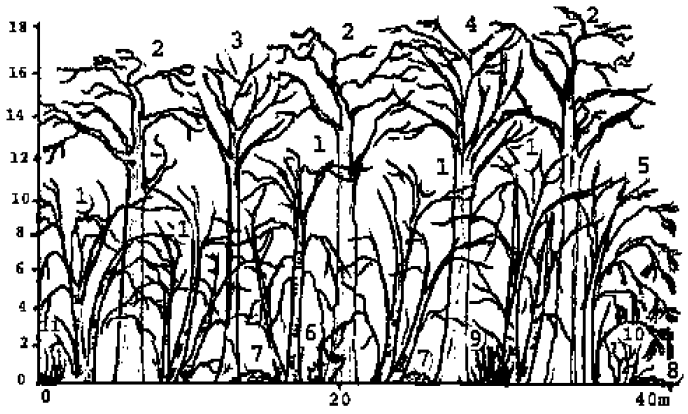

Fig. 7. Vegetation profile of woody species in *Querco macrantherae-Betuletum pendulae* association (1 = *Betula pendula*, 2 = *Quercus macranthera*, 3 = *Acer hyrcanum*, 4 = *A. platanoides*, 5 = *Sorbus aucuparia*, 6 = *Rosa villosa*, 7 = *Juniperus communis* subsp. *hemisphaerica*, 8 = *J. sabina*, 9 = *Berberis integerrima*, 10 = *Viburnum lantana*, 11 = *Lonicera caucasica*)

CONCLUSIONS

The following conclusions could be obtained from this study:

1. Peculiar geomorphology of the area is an important factor both to protect *Betula pendula* and to form special habitat since it catches the clouds as it stands before them.

2. *Betula pendula* is in its optimum ecological niche in the current habitat since the competitors and invaders have made the distribution limited to such rocky habitat so that to be protected from competition and invasion of fast growing plants.

3. Since there has not been anywhere recorded about the presence of *Betula pendula* in Hyrcanian region and the distribution is restricted to this small area, it could be considered as a rare and endemic species. To concern this fact, there should be real protective measures regarding social, cultural and environmental protection conditions such as gradual removing of grazing animals, enclosing the vital patches and training of rangeland and forest habitats.

4. In the disturbed *Fagetum* associations, *Betula pendula*, *Cerasus avium*, *Mespilus germanica* and *Salix aegyptica* are of the pioneer species in the early stage of secondary succession.

5. The data of permanent plots show that if the disturbance is limited, *Betula pendula* stands could restore themselves in a short period by self-renewal. If the disturbance is extended and led to removing *Betula pendula* and not to disturb closing stands, it will take much time for it to restore. This is because of arriving of the seeds from the vicinity of the disturbed area. In the case of removing *Betula pendula* stands to a great extent and the absence of closing stands, as observed in the low accessible parts, restoring of *Betula pendula* will be impossible unless disturbance is artificially removed.

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