

# A floristic survey of the Hyrcanian forests in Northern Iran, using two lowland-mountain transects

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**Abstract** We investigated the floristic composition of the Hyrcanian forests and the related forest-steppe ecotone in Northern Iran by using two long ecological transects, from lowland to upper mountain areas. The study was conducted during 2008 and 2009 and yielded the identification of 395 plant taxa belonging to 233 genera and 78 families. Dicots with 300 taxa were the richest groups of the flora, followed by monocots with 75 taxa, pteridophytes with 18 species, and gymnosperms with two species. The largest families were Asteraceae (33 taxa); Rosaceae (32 taxa); and Poaceae (30 taxa), and the most diverse genera included *Carex* (15 taxa); *Alchemilla* (7 taxa); and *Poa*, *Geranium* and *Acer* (6 taxa each). Hemicryptophytes were the most dominant life forms in the area (40 %); followed by geophytes (31.4 %); phanerophytes (15.4 %); therophytes (11.4 %); and chamaephytes (1.8 %). Phytogeographically, Euro-Siberian/Irano-Turanian elements (86 taxa, 21.8 %) and Euro-Siberian elements (85 taxa, 21.5 %) were the most common chorotypes in the area. Out of 395 taxa, 66 taxa (16.7 %) were endemics and subendemics in Iran, of which 26 taxa were exclusively endemics of Iran. According to the IUCN Red List Categories, 48 threatened plant taxa were found in the study area. Plant diversity, life

form, and chorotypes in the current study were compared with similar transect studies in other areas of the Hyrcanian forests and in different altitudinal belts, using Sørensen similarity indices. Floristic composition of the surveyed transects demonstrated almost 50 % similarity between them.

**Keywords** Hyrcanian forest · Ecological transects · Sørensen similarity index · IUCN Red List · Endemism

## Introduction

Studies on ecology and the distribution of organisms within a long elevational gradient have been considered in many ongoing projects in mountainous ecosystems across the world (McCain and Grytnes 2010), particularly with an emphasis on flora and species attributes (Rahbek 1995; Montana and Valientebanuet 1998; Kessler 2000; Pavón et al. 2000; Grytnes and Vetaas 2002; Wang et al. 2002; Grytnes 2003; Klimeš 2003). The study of floristic composition is considered to be more suited to direct study (Nicholes 1930). Furthermore, knowledge of plant species and their diversity within the long gradient is a prerequisite for any ecological and vegetation investigations, particularly for poorly known areas. With these tools, it is possible to expand conservation and management activities in each area (Jafari and Akhiani 2008).

Only the northern section of the Alborz mountain ranges in Iran, that is the Hyrcanian area, is located in the Euro-Siberian phytogeographical region (sensu Zohary 1973; Léonard 1989; Akhiani 1998) and includes deciduous forests and forest-steppe ecotones, unlike the arid and semi-arid landscapes throughout most of Central and Southern Iran (Naqinezhad et al. 2008). The forests are one of the

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few remnants of natural closed-canopy deciduous forests in the world (Bobek 1951) and are located in three Northern provinces of Iran, namely, Gilan, Mazandaran and Golestan with approximately 800 km in length, 110 km width and a total surface area of 1.84 million hectares.

In spite of rather long history of studies on the flora and vegetation ecology of the Hyrcanian area (Hamzeh'ee et al. 2008; Siadati et al. 2010; Naqinezhad et al. 2013), floristic studies, particularly within the long lowland-upper mountain forest transects are scarce. A rough, general description of the flora and vegetation of the Hyrcanian area within such transects was already provided by (Mobayen and Tregubov 1970), Zohary (1973) and Frey and Probst (1986). Detailed description of flora, however, is unknown for many parts of this area. Siadati et al. (2010) firstly reported all plants within their ecological transects in the Kheyroud forest, a protected forest in the center of Hyrcanian area.

The purpose of the current investigation is to provide the first floristic inventory of the vascular plants of the two forest and forest-steppe ecotone transects in Gilan and Mazandaran provinces and to determine the life forms, chorotypes, IUCN Red List categories of the plants, and to estimate similarity between all the studied transects. The findings should provide insights into the potential of biodiversity within the Hyrcanian forests and their conservation values, and the changing of floristic composition of the forests in different surveyed transects.

## Materials and methods

### Study areas

Two well-protected forest lines along an altitudinal gradient from the Caspian Sea to timberline were selected in the Hyrcanian area (Fig. 1). The Rudsar transect close to Rudsar city (Gilan province) ranging from 300 to 2,600 m a.s.l. (50°20'–50°30'E, 37°05'–36°50'N) and, the Savadkuh transect adjacent to Savadkuh city (Mazandaran province), ranging from 300 to 2,300 m a.s.l. (52°45'–53°10'E, 35°55'–36°20'N). The majority of both transects are listed as protected areas by the Iranian Department of the Environment.

In addition to a comparison of floristic composition between the two studied transects here, data from two other earlier transects (i.e., Ramsar transect and Kheyroud transect) were also included in the analyses (Naqinezhad et al. 2010; Siadati et al. 2010). The Ramsar transect (located close to Ramsar city in Mazandaran province) has 63 studied plots, ranging from 300 to 2,300 m a.s.l. (50°31'–50°42'E, 36°48'–36°54'N). The Kheyroud transect, with 117 plots, is located close to Nowshahr city (Mazandaran

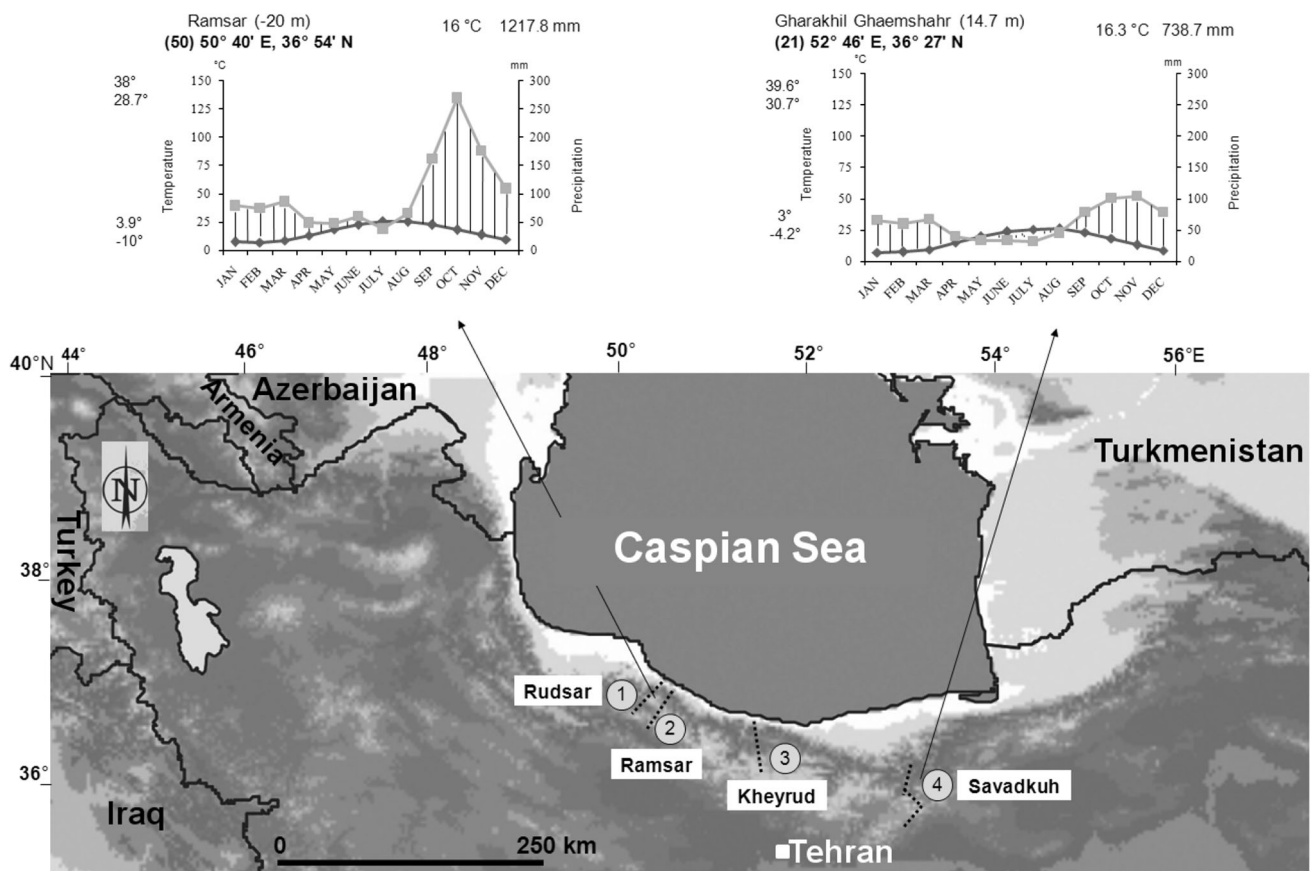
province), between Savadkuh and Ramsar ranging from 100 to 2,100 m a.s.l. (51°33'–51°39'E, 36°33'–36°45'N) (Fig. 1). The size of plots, elevation interval between the plots, data collection, nomenclature, and other species attributes in these transects were similar to that of recent transects.

Middle Jurassic to Upper Cretaceous limestone formations form very high rock cliffs along the East–West directed thrust fault zones in northern section of the Alborz (Stöcklin 1974). The northern foothills of Alborz are mainly composed of Neogene continental clastic and marine sediments, with some high peaks of Mesozoic limestones along the main faults (Axen et al. 2001; Davidson et al. 2004). The majority of area under 500 m a.s.l. particularly in Rudsar transect, belongs to Quaternary formation which includes old marine deposits, new and old costal deposits and deltaic alluvials. The age of this area is determined to be related to the Pleistocene and Holocene. In upper altitudes, volcanic units of Cretaceous formation are dominant features.

Two climate stations, Ramsar (time period: 1955–2005) and Gharakhil in Ghaemshahr (time period: 1984–2005), are the closest to the studied transects. The mean monthly temperature is the lowest in January and February and the highest in July and August in both stations. Mean total annual precipitation in Ramsar and Gharakhil is 1217.8 and 738.7 mm with the highest precipitation in October (269.6 and 100.6 mm), respectively (Fig. 1). In a recent bioclimatic classification of Iran, the climate of the area varies from Temperate oceanic in the Ramsar site to Mediterranean pluviseasonal-oceanic in the Gharakhil site (Djamali et al. 2011).

The vegetation structure and relevant floristic composition of ecotone places in the two studied transects (upper than 2,000 m a.s.l.) are clearly different. The Rudsar transect harbors species, such as *Acer hyrcanum*, *Quercus macranthera* and *Viburnum lantana* as dominant species accompanied with *Geranium purpureum*, *Lapsana communis*, *Phuopsis stylosa*, *Stachys byzantine* and *Veronica rechingeri* in greater than 2,000 m a.s.l. *Acer campestre*, *Berberis integerrima*, *Pyrus boissieriana* are the dominant species in the ecotone area of Savadkuh transect. The latter species are accompanied with *Centaurea hyrcanica*, *Crepis sancta* subsp. *nemausensis*, *Saponaria cerastioides*, *Stellaria holostea*, and *Veronica mazanderanae* in this area.

In contrast to the ecotone area, forest sectors of both transects show relatively similar floristic composition in the same altitudinal bands. In the lowlands (up to 800 m a.s.l.), *Parrotia persica*, *Diospyrus lotus*, *Alnus subcordata* var. *villosa*, *Acer velutinum* and *Ruscus hyrcanus* are more prominent. Furthermore, in the higher altitudes up to 1,900 m a.s.l. *Acer cappadocicum*, *Carpinus betulus*, *Quercus castaneifolia* subsp. *castaneifolia*, *Tilia platyphyllos* subsp. *caucasica* become dominant accompanied by some species like



**Fig. 1** Locations of the four ecological transects in the Hyrcanian forest accompanied with climatic curves of two stations near to the studied areas (1 Rudsar transect, 2 Ramsar transect, 3 Kheyroud transect and 4 Savadkuh transect)

*Epipactis persica*, *Euphorbia amygdaloides*, *Festuca drymeia*, *Galium odoratum* in the herbal layer. However, the bulk of forests, ranging from 1,000 to 1,900 m a.s.l., are dominated by *Fagus orientalis* accompanied by *Acer velutinum*, *Laurocerasus officinalis* and *Vaccinium arctostaphylos*, *Aruncus vulgaris*, *Brachypodium sylvaticum*, *Cardamine impatiens* var. *pectinata*, *Carex pendula*.

#### Data collection and analyses

Data collections were performed during 2008 and 2009. Three 20 × 20 m plots in the forest area and three 10 × 10 m plots in the ecotone and upper mountain areas were allocated in each 100 m elevation interval. Selection of plot size was determined by the main dominant physiognomy of vegetation. A total of 122 plots were allocated, of which 68 belonged to Rudsar transect and 54 belonged to Savadkuh transect. The cover of all vascular plant species was estimated using the old Braun-Blanquet scale (r, +, 1–5). The nomenclatures are mainly based on Rechinger (1963–2010), Assadi et al. (1988–2011), Frey et al. (2006) and Khoshravesh et al. (2009).

The distribution data of species were extracted from *Flora Iranica* (Rechinger 1963–2010), *Flora of Turkey* (Davis 1965–1988) and mainly from the above-mentioned nomenclature sources. The main concepts of phytocoria are based on Zohary (1973), Takhtajan (1986), and Léonard (1988). We used the following abbreviations in the current paper: ES (plants distributed in the Euro-Siberian region), IT (plants distributed in the Irano-Turanian region), M (plants distributed in the Mediterranean region), PL (pluriregional elements, referring to plants ranging over three phytogeographical regions); and COS (cosmopolitan, referring to plants that have a broad worldwide distribution).

For statistical purposes, four altitudinal belts within the studied transects were defined: lowland belt between 300 and 500 m; submountain belt between 501 and 1000 m; mountain belt between 1001 and 1900 m and upper mountain/ecotone belt, between 1901 and 2600 m. This delimitation is according to the floristic information provided by Zohary (1973), Frey and Probst (1986).

Threatened categories were proposed for the endemic and rare taxa in the study area according to the IUCN risk categories (Jalili and Jamzad 1999; IUCN 2001). The

following abbreviations are used: EN, endangered; VU, vulnerable; LR, lower risk; and DD, data deficient.

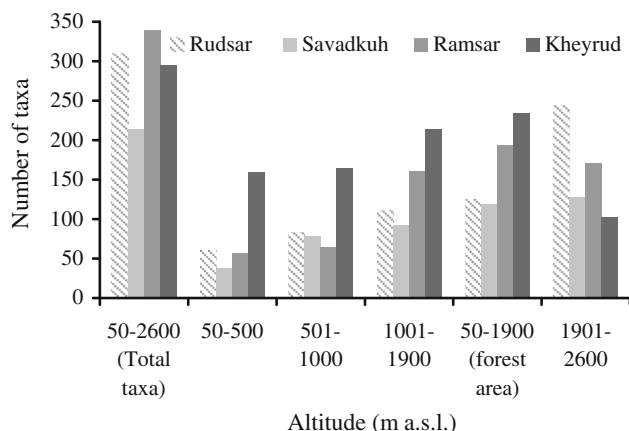
Sørensen's similarity indices between the studied transects were determined by using the following formula (Kent and Coker 2002):  $S_s = 2a/(2a + b + c)$ , where a, number of species common to both stands (A, B); b, number of species only in stand A; and c, number of species only in stand B.

## Results

### Floristic richness in the two transects

In total, 395 plant taxa belonging to 233 genera and 78 families were determined in the two studied transects. Of the total families, 56 families were dicotyledons, 12 families were monocotyledons, two families were gymnosperms, and eight families were pteridophytes (Appendix 1). A total of 89 plant taxa (22.5 %) were restricted exclusively in the forest areas (located in 300–1,900 m a.s.l.); 231 plant taxa (58.5 %) were exclusively found in the ecotone and upper mountain areas (located between 2,000–2,600 m a.s.l.); and 75 plant taxa (19 %) were shared between two habitats. In total, 306 plant taxa were observed in the ecotone and upper mountain areas (Fig. 2). The most species-rich families in the current study were Asteraceae (33 taxa, 8.4 %), Rosaceae (32 taxa, 8.1 %), Poaceae (30 taxa, 7.6 %), Fabaceae (24 taxa, 6.1 %), and Lamiaceae (21 taxa, 5.3 %), respectively. The genera with the larger number of species were *Carex* (15 taxa), *Alchemilla* (7 taxa) and *Geranium*, *Poa* and *Acer* (6 taxa each), respectively (Table 1).

The dominant life forms were hemicryptophytes (158 taxa, 40 %), followed by geophytes (124 taxa, 31.4 %),



**Fig. 2** The number of plant taxa within four transects in the Hyrcanian area and in different altitudinal belts

phanerophytes (61 taxa, 15.4 %), therophytes (45 taxa, 11.4 %), and chamaephytes (7 taxa, 1.7 %) (Fig. 3). Phytogeographically, Euro-Siberian/Irano-Turanian elements (86 taxa, 21.8 %) and Euro-Siberian elements (85 taxa, 21.5 %) were the most common chorotypes in the area. Out of 395 taxa, 66 taxa (16.7 %) were endemic and/or subendemic in Iran, of which 26 taxa were exclusively endemic of Iran. Furthermore, 20 taxa were Iranian Hyrcanian endemic. Eleven taxa (2.8 %) were not identified down to species level in our checklist.

### Comparison of the species attributes among the four ecological transects

The number of plant taxa and life form spectrum in the four ecological transects and within four altitudinal bands (50–500, 501–1,000, 1001–1900, 1901–2600 m a.s.l.) are shown in Figs. 2, 3, and 4. In the Rudсар transect, 17 taxa were exclusively found in the level higher than 2,300 m a.s.l. and in the Kheyroud transect, 28 taxa were exclusively collected in the level lower than 300 m. In all transects, hemicryptophytes and geophytes possessed the highest proportions. Moreover, the rate of geophytes were relatively constant in the different altitudinal belts in all transects (Fig. 4).

Calculating the Sørensen similarity indices indicated that the floristic composition of the surveyed transects had almost 50 % similarity between them (Table 2). For a more comparable survey, only the forest parts of all transects were separately evaluated, which showed that Rudсар and Savadkuh had only 64 % similarity in their forest components. A total of 125 taxa in Rudсар and 118 taxa in Savadkuh were collected, of which 78 taxa were common in these two transects. Comparison of the forest parts of the two remaining transects did not show any remarkable departure from the latter overall comparison (Table 2).

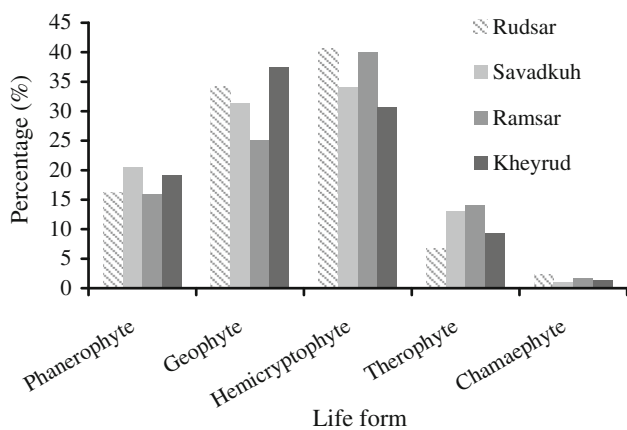
### IUCN categories and threatened plants

A total of 47 endemic and rare taxa were included in the risk categories defined by IUCN (Table 3). Distribution of the threat categories of these taxa is as follows: three endangered (EN) taxa, six vulnerable taxa (VU), 33 lower risk (LR) taxa and five data deficient (DD) taxa. Out of the total, 16 endemic taxa are in northern Iran (Hyrcanian endemics), five taxa are endemic to Iran (endemics of Irano-Turanian parts of Iran), and five taxa are subendemics. It should be noted that four endemic taxa of northern Iran (*Arenaria serpyllifolia* var. *macrosepala*, *Cousinia pterocaulos*, *Ilex spinigera*, *Scabiosa columbaria* subsp. *caespitosa*), and one endemic taxon of Iran (*Crucianella gilanica* subsp. *demavendensis*) have not yet been included in the IUCN categories.

**Table 1** The richest families, genera, chorotypes as well as endemism rate in the four transects in the Hyrcanian area

Transects	Families	Genera	Chorotypes (%)	Rate of endemism (%)
Rudsar (300–2,600 m, 68 plot)	Rosaceae (27), Asteraceae (25), Poaceae (24)	<i>Carex</i> (12), <i>Alchemilla</i> (6), <i>Poa</i> (6)	ES-IT (20.6), ES (18.7), ES-IT-M (16.8)	20 (6.45)
Savadkuh (300–2,300 m, 54 plot)	Fabaceae (17), Asteraceae (17), Poaceae (16)	<i>Carex</i> (9), <i>Campanula</i> (5), <i>Euphorbia</i> (4)	ES-IT (22.9), ES (20.6), PL (15.4)	8 (3.7)
Ramsar (300–2,300 m, 63 plot)	Asteraceae (30), Rosaceae (29), Lamiaceae (23)	<i>Carex</i> (9), <i>Viola</i> (7), <i>Trifolium</i> (7)	ES (23.8), PL (19.9), ES-IT (19.3)	10 (2.9)
Kheyroud (50–2,200 m, 117 plot)	Rosaceae (24), Lamiaceae (19), Poaceae (19)	<i>Carex</i> (8), <i>Rubus</i> (6), <i>Dryopteris</i> (5)	ES (24.7), PL (19.2), ES-IT-M (14)	13 (4.6)

ES Euro-Siberian, IT Irano-Turanian, M mediterranean, PL pluriregional

**Fig. 3** The proportion of different life forms across the four transects

## Discussion

The Hyrcanian area represents a region with high species richness (ca. 3200 taxa) (Akhani 1998; Akhani et al. 2010) that also has numerous endemic species, particularly in the upper mountain and alpine areas (Noroozi et al. 2008). Flora of ecotone and upper mountain areas of the studied transects were more heterogeneous (with 306 plant taxa) compared to the forest sectors. Ecotones are frequently encountered in the transitional zone between the Hyrcanian forests in the South Caspian region and their adjacent semi-arid steppes (Djamali et al. 2009; Naqinezhad et al. 2010). These ecosystems are among the most sensitive sections of the biosphere to environmental change and can shift considerably in response to climate change (Neilson 1993).

The occurrence of a high number of Euro-Siberian elements in the surveyed transects indicated the floristic linkage of the study area to the Euro-Siberian phytogeographical region (sensu Zohary 1973; Léonard 1989; Akhani 1998; Jafari and Akhani 2008). The number of Irano-Turanian elements increased with increasing altitude. This is due to the occurrence of a high number of Irano-Turanian elements in the steppe parts of upper mountain

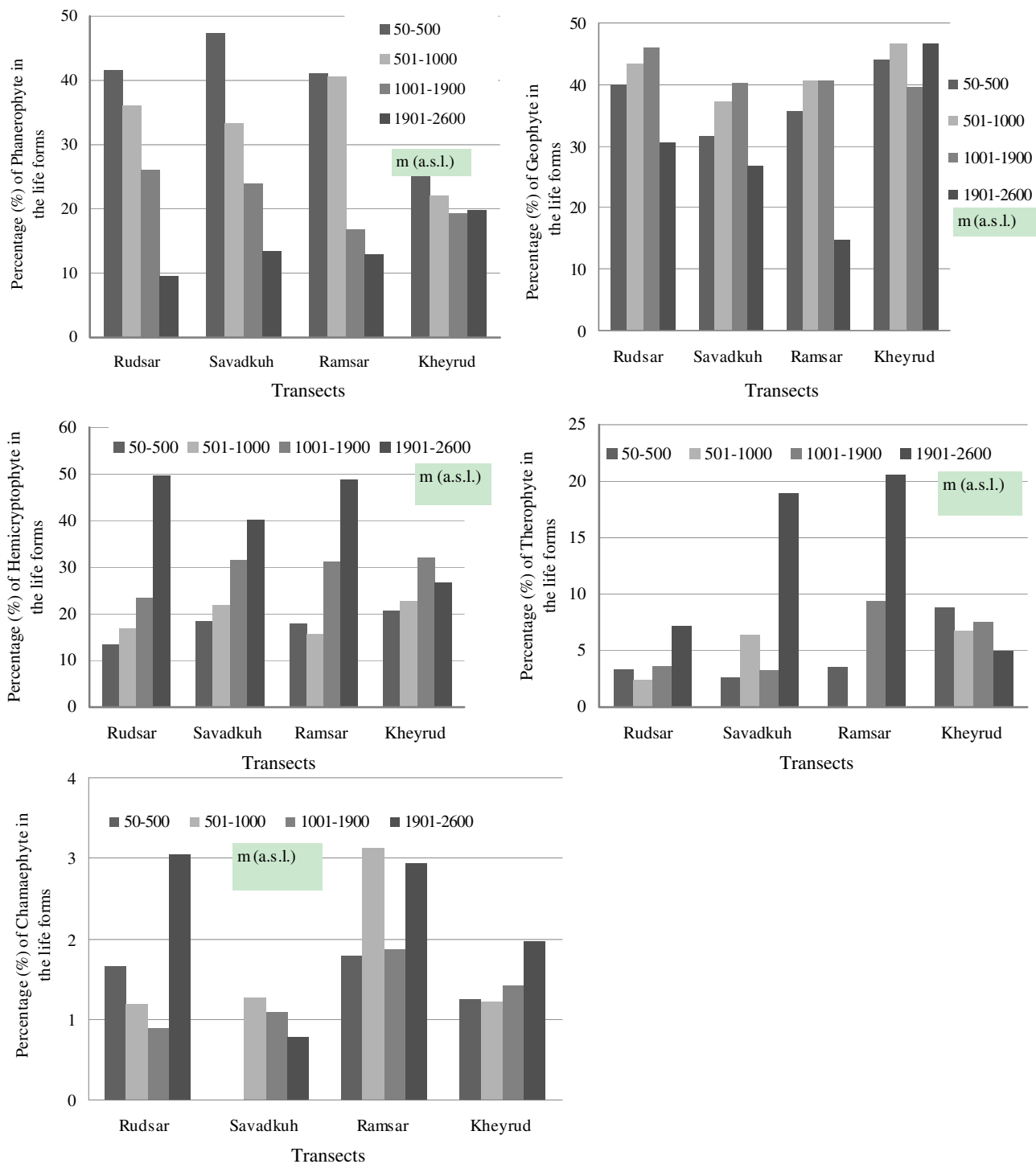
areas of Alborz (Klein 1991, 2001; Noroozi et al. 2008). Consequently, this caused a concentration of biregional Euro-Siberian/Irano-Turanian elements in some transects.

The study of plant life forms is important because it provides the basic structural components of vegetation stands (Box 1981). It is also indicative of habitat conditions (Archibold 1995). Hemicryptophytes increased with increasing altitude, particularly above 2,000 m. This was compatible with the fact that hemicryptophytes were related to humid and cold climates in upper altitudes (Raunkiaer 1934).

The high occurrence of geophytes in the forest parts has been previously reported (Akbarinia et al. 2004; Ghahreman et al. 2006; Naqinezhad et al. 2010; Siadati et al. 2010). Likewise, increasing geophytes was considered to be related to increasing of altitudinal bands (Fig. 4). The lower proportion of phanerophytes in the higher altitudes indicated they were susceptible to frost and extreme cold. The lower frequency of this life form across different altitudinal belts and among surveyed transects proved this finding.

The surveyed transects exhibited almost 50 % similarities among them. Contrary to the homogenous flora of the four transects, the similarity of floristic composition was not very prominent. The following reasons provide some explanation for this moderate similarity:

1. Species difference might be related to the different number of plots and relevant altitudinal bands surveyed.
2. Different management regimes in the transects could contribute to discriminatory species adaptation.
3. Differences in climatic features (temperatures and precipitations) between the stations demonstrate, to a degree that there is a clear trend of decreasing precipitation from the west to east of the Hyrcanian area (e.g. Khalili 1973; Akhani et al. 2010).
4. The authors provided supplementary plant collections of the two surveyed transects (Ramsar and Kheyroud)



**Fig. 4** The proportion of various life forms (%) in different transects and within different altitudinal belts

that showed how the forest margins and all surrounding habitats had shifted beyond their original plots (Naqinezhad et al. 2010; Siadati et al. 2010).

The high occurrence of therophytes in the two latter transects (particularly in Kheyroud) makes this claim reasonable. Therophytes are considered indicators for highly

stressful habitat factors such as forest roads and margins (Archibold 1995; Naqinezhad et al. 2008).

In a separate account, only forest sectors of the four transects (300–1,900 m) were specifically analyzed. However, similarity indices did not obviously change except for the two transects of Rudsar and Savadkuh that showed a

**Table 2** Sørensen similarity indices between four transects

Transects				
Rudsar (300–2,600 m, 68 plot)	Rudsar	–	–	–
Savadkuh (300–2,300 m, 54 plots)	[49–64 %] [129–78]	Savadkuh	–	–
Ramsar (300–2,300 m, 63 plots)	[50–57 %] [161–91]	[47–56 %] [131–87]	Ramsar	–
Kheyroud (50–2,200 m, 117 plots)	[46–48 %] [138–87]	[52–51 %] [133–90]	[50–54 %] [159–116]	Kheyroud

Above bracket Sørensen index in overall comparison–Sørensen index only in forest part (300–1,900 m a.s.l.); below bracket Common taxa in total–Common taxa in the forest area (300–1,900 m a.s.l.)

**Table 3** The threatened flora of the study area and its IUCN Red Data List categories

Taxa	Conservation status	Taxa	Conservation status
<i>Buxus hyrcana</i>	EN Subendem	<i>Geranium pusillum</i>	LR
<i>Danae racemosa</i>	EN	<i>Medicago rigidula</i> var. <i>submitis</i>	LR
<i>Taxus baccata</i>	EN	<i>Orchis mascula</i> subsp. <i>mascula</i>	LR
<i>Alchemilla surculosa</i>	VU Endem (Hyr)	<i>Ornithogalum sintensisii</i>	LR Endem (Hyr)
<i>Aremonia agrimonoides</i>	VU	<i>Parrotia persica</i>	LR Subendem
<i>Aruncus vulgaris</i>	VU	<i>Polygala platyptera</i>	LR Endem (Hyr)
<i>Astragalus vereskensis</i>	VU Endem (IT)	<i>Polygonatum orientale</i>	LR
<i>Bupleurum ghahremanii</i>	VU Endem (Hyr)	<i>Potentilla adscharica</i>	LR
<i>Saxifraga ramsarica</i>	VU Endem (Hyr)	<i>Pterocarya fraxinifolia</i>	LR
<i>Alchemilla amardica</i>	LR Endem (Hyr)	<i>Ranunculus amblyolobus</i>	LR Endem (IT)
<i>Alchemilla melancholica</i>	LR Endem (Hyr)	<i>Saxifraga paniculata</i> subsp. <i>cartilaginea</i>	LR
<i>Alchemilla microscopica</i>	LR Endem (Hyr)	<i>Sempervivum iranicum</i>	LR Endem (Hyr)
<i>Alyssopsis mollis</i>	LR Subendem	<i>Senecio vulcanicus</i>	LR Endem (Hyr)
<i>Anthyllis boissieri</i>	LR	<i>Sesleria phleoides</i>	LR
<i>Astragalus nurensis</i>	LR Endem (Hyr)	<i>Silene palinotricha</i>	LR Endem (IT)
<i>Centaurea elbrusensis</i>	LR Endem (Hyr)	<i>Vaccinium arctostaphylos</i>	LR
<i>Cephalanthera caucasica</i>	LR Subendem	<i>Veronica mazanderanae</i>	LR Endem (Hyr)
<i>Coronilla orientalis</i>	LR	<i>Veronica rechingeri</i>	LR Endem (Hyr)
<i>Echinops koelzii</i>	LR Endem (IT)	<i>Bupleurum flexile</i>	DD Endem (Hyr)
<i>Echium amoenum</i>	LR	<i>Dolichorrhiza persica</i>	DD Endem (IT)
<i>Epipactis microphylla</i>	LR	<i>Phleum alpinum</i>	DD
<i>Festuca pinifolia</i>	LR	<i>Scrophularia rostrata</i>	DD Endem (Hyr)
<i>Fraxinus excelsior</i> subsp. <i>coriariifolia</i>	LR Subendem	<i>Vicia hirsuta</i>	DD
<i>Geranium gracile</i>	LR		

EN endangered; VU vulnerable; LR lower risk; DD data deficient; Hyr hyrcanian area; IT Irano-Turanian area

similarity of 64 %. This might be due to different climatic regimes in the areas.

The low percentage of similarity across the surveyed transects could be due to different factors, including climate, slope inclination and exposition, other topographic and soil features, and controlling floristic composition in the area (Abella and Convington 2006; Sang 2009; Wang et al. 2002; Naqinezhad et al. 2008).

Habitat loss, clearing of natural vegetation for cultivation, overgrazing, and overharvesting are the main threats in the study areas. Space for threatened plants will

become even more restricted because of human impacts on the natural process and the limited geographical distribution of the species (Jalili and Jamzad 1999). Among all plants listed as threatened species in the paper (Table 4), some have been under massive economic uses and thus considered within Red data list of Iran. Of which, three endangered species are harvested for economic gain (e.g. *Buxus hyrcana* and *Taxus baccata*) and ornamental purposes (*Danae racemosa*). *Buxus hyrcana* is a shrub distributed once in majority parts of the lowland Hyrcanian area. There are only some small fragmented

patches of this endemic shrub in the area. Furthermore, *Taxus baccata* is becoming rare and mainly constricted in very steepy and non-reachable places in the forest. The importance of these species as sources of information is crucial to guide conservation efforts (Rodrigues et al. 2006). Conservation policies and ecological management schemes should be applied in order to protect the remaining important, vital but ever so fragile ecosystems of the Hyrcanian area.

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## Appendix 1

See Appendix Table 4

**Table 4** Checklist of identified plant species in the two transects in Gilan and Mazandaran province. Species (life form-chorotype-MUH No.)

### Pteridophytes

- Aspleniaceae: *Asplenium adiantum-nigrum* L. [GR-PL-3378]; *Asplenium ruta-muraria* L. [GR-PL-3379]; *Asplenium trichomanes* L. [GR-PL-3380]; *Asplenium scolopendrium* (L.) Newm. [GR-PL-3381]
- Blechnaceae: *Blechnum spicant* (L.) Roth [GR-PL-3384]
- Dryopteridaceae: *Dryopteris affinis* (Lowe) Fraser-Jenkins [GR-ES-3385]; *Dryopteris caucasica* (A. Braun) Fraser-Jenk. & Corley [GR-ES (Euxino-Hyr)-3386]; *Dryopteris filix-mas* (L.) Schott [GR-ES-3387]; *Dryopteris pallida* (Bory) Fomin [GR-ES, M-3388]; *Polystichum aculeatum* (L.) Roth [GR-PL-3389]; *Polystichum woronowii* Fomin [GR-ES (Euxino-Hyr)-3390]
- Onocleaceae: *Matteuccia struthiopteris* (L.) Tod. [GR-PL-3391]
- Ophioglossaceae: *Botrychium lunaria* (L.) Sw. [GR-PL-3392]
- Polypodiaceae: *Polypodium vulgare* L. [GR-PL-3393]
- Pteridaceae: *Adiantum capillus-veneris* L. [GR-PL-3377]; *Pteris cretica* L. [GR-PL-3394];
- Woodsiaceae: *Athyrium filix-femina* (L.) Roth [GR-PL-3382]; *Cystopteris fragilis* (L.) Bernh. [GR-PL-3383]

### Gymnosperms

- Cupressaceae: *Juniperus communis* L. subsp. *hemisphaerica* (Presl) Nyman [P-ES-3375]
- Taxaceae: *Taxus baccata* L. [P-ES, IT, M-3376]

### Dicots

- Adoxaceae: *Sambucus ebulus* L. [C-ES, IT, M-3000]; *Viburnum lantana* L. [P-ES-3001]
- Apiaceae: *Anthriscus nemorosus* (M.B.) Spreng. [H-ES, IT, M-3002]; *Anthriscus sylvestris* (L.) Hoffm [H-PL-3003]; *Bupleurum flexile* Bornm. & Gauba [H-ES (End-Hyr)-3004]; *Bupleurum ghahremanii* Mozaff. [H-ES (End-Hyr)-3005]; *Caucalis platycarpus* L. [T-ES (Euxino-Hyr), IT, M-3006]; *Cervaria cervariifolia* (C. A. Mey) M. Pimen. [H-ES (Hyr), IT-3007]; *Chaerophyllum meyeri* Boiss. & Buhse [H-ES (Hyr), IT-3008]; *Eryngium billardieri* F. Delaroché [H-ES (Euxino-Hyr), IT, M-3009]; *Eryngium caeruleum* M. B. [H-ES (Euxino-Hyr), IT-3010]; *Heracleum persicum* Desf. ex Fischer [H-ES (Hyr), IT-3011]; *Laser trilobum* (L.) Borkh. [H-ES (Euxino-Hyr), M-3012]; *Pimpinella affinis* Ledeb. [H-ES (Euxino-Hyr), IT-3013]; *Pimpinella tragiium* Vill. subsp. *lithophila* (Schischk.) Tutin [H-ES (Euxino-Hyr), IT, M-3014]; *Sanicula europaea* L. [H-PL-3015]; *Seseli libanotis* (L.) W. Koch [H-ES, IT, (INDIA)-3016]
- Apocynaceae: *Vincetoxicum funebre* Boiss. & Ky. [H-ES (Euxino-Hyr), IT-3017]; *Vincetoxicum scandens* Sommier & Levier [H-ES, IT, M-3018]
- Aquifoliaceae: *Ilex spinigera* (Loes.) Loes. [P-ES (End-Hyr)-3019]
- Araliaceae: *Hedera pastuchovii* Woron. ex Grossh. [P-ES (Euxino-Hyr)-3020]
- Asteraceae: *Achillea millefolium* L. subsp. *millefolium* [H-ES, IT-3021]; *Anthemis triumfettii* (L.) All. subsp. *khorsanica* (Rech. f.) Iranshahr [H-ES (Hyr), IT-3022]; *Artemisia absinthium* L. [H-ES, IT, M-3023]; *Artemisia chamaemelifolia* Vill. [H-ES, IT-3024]; *Aster alpinus* L. [GR-ES, IT-3025]; *Carduus onopordioides* Fisch. ex M. B. [H-ES (Euxino-Hyr), IT-3026]; *Carduus seminudus* M. B. [H-ES (Euxino-Hyr), IT-3027]; *Carlina vulgaris* L. [H-ES, IT-3028]; *Carpesium abrotanoides* L. [H-PL-3029]; *Centaurea elbrusensis* Boiss. & Buhse [H-ES (End-Hyr)-3030]; *Centaurea hyrcanica* Bornm. [H-ES (Hyr), IT-3031]; *Centaurea zuvandica* (Sosn.) Sosn. [GR-ES (Hyr), IT-3032]; *Cirsium lappaceum* M. B. var. *ferox* Boiss. [H-ES (Hyr), IT-3033]; *Conyza bonariensis* (L.) Cronq. [T-COS-3034]; *Cousinia pterocaulos* (C. A. Mey.) Rech. f. [H-ES (End-Hyr)-3035]; *Crepis sancta* (L.) Babcock subsp. *azerbaijanica* Rech. f. [T-IT-3036]; *Crepis sancta* (L.) Babcock subsp. *nemausensis* (Gouan) Babcock [T-ES (Hyr), IT, M-3037]; *Dolichorrhiza persica* (Boiss.) B. Nord. [GR-IT (End)-3038]; *Echinops koelzii* Rech. f. [H-IT (End)-3039]; *Erigeron acer* L. subsp. *pycnotrichus* (Vierh.) Grierson [H-IT-3040]; *Gnaphalium sylvaticum* L. [GR-ES, IT-3041]; *Iranecio othonnae* (M. B.) B. Nord. [H-ES, IT, M-3042]; *Lapsana communis* L. [H-ES, IT-3043]; *Leontodon hispidus* L. [GR-ES, IT, M-3044]; *Petasites hybridus* (L.) P. Gaertn., B. Meyer & Scherbius [GR-PL-3045]; *Prenanthes cacaliifolia* (M. B.) Beauverd [H-ES (Euxino-Hyr)-3046]; *Senecio glaucus* L. [T-PL-3047]; *Senecio vulcanicus* Boiss. [T-ES (End-Hyr)-3048]; *Serratula quinquefolia* M. B. ex Willd. [H-ES (Euxino-Hyr), IT-3049]; *Solidago virga-aurea* L. [H-ES, IT, M-3050]; *Tanacetum parthenium* (L.) Schultz [H-COS-3051]; *Taraxacum* sp. [H-\* -3052]; *Tripleurospermum sevanense* (Manden.) Pobed. [T-ES-3053]
- Berberidaceae: *Berberis integerrima* Bunge [P-ES (Euxino-Hyr), IT, SINA-3054]; *Berberis orthobotrys* Bienert ex C.K. Schneider [P-ES (Hyr), IT-3055]; *Epimedium pinnatum* Fisch. [GR-ES (Hyr)-3056]



**Table 4** continued

- Betulaceae: *Alnus subcordata* C. A. Mey. var. *villosa* (Regel) H. Winkl. [P-ES (Hyr)-3057]; *Carpinus betulus* L. var. *betulus* [P-ES-3058]; *Carpinus orientalis* Miller subsp. *orientalis* [P-ES, SYRIA-3059]
- Boraginaceae: *Echium amoenum* Fisch. & C. A. Mey. [H-ES (Euxino-Hyr)-3060]; *Myosotis asiatica* Schischk. & Serg [H-PL-3061]; *Myosotis lithospermifolia* (Willd.) Hornem. [H-ES (Euxino-Hyr), IT-3062]; *Nonnea lutea* (Desr.) Reichenb. ex DC. [H-ES-3063]; *Solenanthes stamineus* (Desf.) Wettst. [H-ES, IT, M-3064]
- Brassicaceae: *Alliaria petiolata* (M. B.) Cavara & Grande [H-ES, IT, M-3065]; *Alyssopsis mollis* (Jacq.) O. E. Schulz [H-ES (Hyr)-3066]; *Alyssum desertorum* Stapf var. *desertorum* [T-IT, M-3067]; *Alyssum* sp. [H-\*-3068]; *Arabis caucasica* Willd. subsp. *caucasica* [H-ES, IT, M-3069]; *Arabis nova* Vill. [T-ES, IT, M-3070]; *Arabis sagittata* (Bertol.) DC. [H-ES, IT, M-3071]; *Capsella bursa-pastoris* (L.) Medicus [H-COS-3072]; *Cardamine bulbifera* (L.) Crantz [GR-ES-3073]; *Cardamine impatiens* L. var. *pectinata* (Pall.) Trautv. [T-ES (Euxino-Hyr), M-3074]; *Draba nemorosa* L. [T-PL-3075]; *Erysimum cuspidatum* (M. B.) DC. [H-ES, M-3076]; *Hesperis hyrcana* Bornm. & Gauba [H-ES (Euxino-Hyr), IT-3077]; *Thlaspi hastulatum* (Stev. ex) DC. [T-ES (Euxino-Hyr), IT-3078]; *Thlaspi umbellatum* (Stev. ex) DC. [T-ES (Euxino-Hyr)-3079]
- Buxaceae: *Buxus hyrcana* Pojark. [P-ES (Hyr), TUR-3080]
- Campanulaceae: *Campanula eo-cervicaria* Nab. [H-ES (Euxino-Hyr), IT-3081]; *Campanula glomerata* L. [H-ES, IT-3082]; *Campanula latifolia* L. [H-ES, M-3083]; *Campanula odontosepala* Boiss. [H-ES (Hyr), IT,3084]; *Campanula rapunculoides* L. subsp. *lambertiana* (DC.) Rech. f. [H-ES (Euxino-Hyr), IT-3085]
- Cannabaceae: *Celtis caucasica* Willd. [P-ES, IT, NEPAL-3291]
- Caprifoliaceae: *Dipsacus pilosus* L. [H-ES-3086]; *Lonicera caucasica* Pall. [P-ES, IT-3087]; *Lonicera floribunda* Boiss. & Buhse [P-ES (Hyr), TUR-3088]; *Scabiosa columbaria* L. subsp. *caespitosa* Jamzad [H-ES (End-Hyr)-3089]; *Scabiosa hyrcana* Stev. [H-ES (Euxino-Hyr)-3090]
- Caryophyllaceae: *Arenaria serpyllifolia* L. var. *macrosepala* Rech. f. [T-ES (End-Hyr)-3091]; *Arenaria serpyllifolia* L. var. *serpyllifolia* [T-COS-3092]; *Cerastium glomeratum* Thuill. [T-COS-3093]; *Dianthus* sp. [H-\*-3094]; *Minuartia lineata* Bornm. [H-ES (Hyr)-3095]; *Minuartia recurva* (All.) Schinz & Thellung subsp. *oreina* (Mattf.) McNeill [H-ES (Euxino-Hyr), IT-3096]; *Moehringia trinervia* (L.) Clairv. [T-ES, IT-3097]; *Petrorhagia saxifraga* (L.) Link [H-ES, IT, M-3098]; *Saponaria cerastioides* Fisch. ex C. A. Mey. [T-ES (Euxino-Hyr)-3099]; *Scleranthus orientalis* Rossler [H-ES (Euxino-Hyr), IT, M-3100]; *Silene latifolia* Poir. subsp. *ericalcynica* (Boiss.) Greuter & Burdet [H-ES, IT-3101]; *Silene marschallii* C. A. Mey. subsp. *sahendica* (Boiss. & Buhse) Melzh. [H-IT-3102]; *Silene palinotricha* Fenzl ex Boiss. [H-IT (End)-3103]; *Silene schafta* Gmel. Jun. ex Hohen [H-ES (Hyr)-3104]; *Stellaria holostea* L. [GR-ES, IT-3105]; *Stellaria media* (L.) Vill. [T-COS-3106]; *Stellaria pallida* (Dumort.) Pire [T-ES, IT, M-3107]
- Celastraceae: *Evonymus latifolia* (L.) Mill. [P-ES, M-3108]; *Evonymus velutina* (C. A. Mey.) Fisch. & C. A. Mey. [P-ES (Hyr), IT-3109]
- Cistaceae: *Helianthemum nummularium* (L.) Miller [C-ES, IT-3110]
- Convolvulaceae: *Calystegia sylvestris* (Willd.) Roem. et Schult. [GR-ES, M-3111]
- Cornaceae: *Cornus australis* C. A. Mey. [P-ES, IT, M-3112]
- Crassulaceae: *Sedum gracile* C. A. Mey. [H-ES (Euxino-Hyr)-3113]; *Sedum hispanicum* L. [T-IT, M-3114]; *Sedum lenkoranicum* Grosse. [H-ES (Euxino-Hyr)-3115]; *Sedum pallidum* M. B. [H-ES, IT-3116]; *Sedum stoloniferum* S. G. Gmel. [H-ES-3117]; *Sempervivum iranicum* Bornm. & Gauba [H-ES (End-Hyr)-3118]
- Ebenaceae: *Diospyros lotus* L. [P-PL-3119]
- Ericaceae: *Monotropa hypopithys* L. [GP-COS-3120]; *Vaccinium arctostaphylos* L. [P-ES (Euxino-Hyr)-3121]
- Euphorbiaceae: *Euphorbia amygdaloides* L. [GR-ES, M-3122]; *Euphorbia condylocarpa* M. B. [H-ES (Euxino-Hyr), IT-3123]; *Euphorbia helioscopia* L. [T-PL-3124]; *Euphorbia iberica* Boiss. [H-ES, IT-3125]; *Euphorbia stricta* L. [T-ES, IT-3126]; *Mercurialis perennis* L. [GR-ES, M-3127]
- Fabaceae: *Albizzia julibrissin* Durazz [P-PL-3128]; *Anthyllis boissieri* Sagorski [H-ES, M-3129]; *Astragalus aureus* Willd. [C-ES (Euxino-Hyr), IT-3130]; *Astragalus nurensis* Boiss. & Buhse [H-ES (End-Hyr)-3131]; *Astragalus vereskensis* Maassoumi & Podlech [H-IT (End)-3132]; *Colutea buhsei* (Boiss.) Shap. [P-IT-3133]; *Coronilla orientalis* Miller [C-ES, M-3134]; *Coronilla varia* L. subsp. *hirta* (Bunge ex Boiss.) Rech. f. [H-IT-3135]; *Gleditsia caspica* Desf. [P-ES (Hyr), TUR-3136]; *Lathyrus laxiflorus* (Desf.) O. Kuntze [GR-ES, M-3137]; *Lathyrus pratensis* L. [GR-ES, IT, M-3138]; *Lathyrus rotundifolius* Willd. subsp. *miniatus* (M. B. ex Stev.) P. H. Davis [H-ES, IT-3139]; *Medicago lupulina* L. [H-COS-3140]; *Medicago polymorpha* L. [T-COS-3141]; *Medicago rigidula* (L.) All. var. *submitis* (Boiss.) Heyn [T-PL-3142]; *Onobrychis bungei* Boiss. [H-ES (Euxino-Hyr)-3143]; *Onobrychis cornuta* L. subsp. *cornuta* [P-PL-3144]; *Trifolium pratense* L. var. *pretense* [H-PL-3145]; *Trifolium repens* L. var. *repens* [H-PL-3146]; *Trifolium tumens* Stev. ex M. B. var. *tumens* [GR-ES (Euxino-Hyr), IT-3147]; *Trigonella calliceras* Fisch. [T-ES (Euxino-Hyr), TUR-3148]; *Vicia crocea* (Desf.) B. Fedtsch. [H-ES-3149]; *Vicia hirsuta* (L.) S. F. Gray [T-COS-3150]; *Vicia hybrida* L. [T-IT, M-3151]
- Fagaceae: *Fagus orientalis* Lipsky [P-ES, M-3152]; *Quercus castaneifolia* C. A. Mey. subsp. *castaneifolia* [P-ES (Hyr), IT-3153]; *Quercus macranthera* Fisch. & C. A. Mey. ex Hohen. [P-ES (Euxino-Hyr)-3154]
- Gentianaceae: *Gentiana septemfida* Pall. [H-ES (Euxino-Hyr), IT-3155]; *Gentiana* sp. [H-\*-3156]
- Geraniaceae: *Erodium cicutarium* (L.) ĽHér. ex Aiton [H-PL-3157]; *Geranium columbinum* L. [H-ES, M-3158]; *Geranium dissectum* L. [T-ES, IT-3159]; *Geranium gracile* Ledeb. ex Nordm. [GR-ES-3160]; *Geranium purpureum* Vill. [H-ES, IT, M-3161]; *Geranium pusillum* L. [T-ES, IT, M-3162]; *Geranium pyrenaicum* Burm. f. [H-ES, IT, M-3163]
- Hamamelidaceae: *Parrotia persica* (DC) C. A. Mey. [P-ES (Hyr)-3164]

**Table 4** continued

- Hypericaceae: *Hypericum androsaemum* L. [P-ES, IT, M-3165]; *Hypericum armenum* Jaub. & Spach [H-IT-3166]; *Hypericum perforatum* L. [H-COS-3167]
- Juglandaceae: *Pterocarya fraxinifolia* (Poir.) Spach [P-ES-3168]
- Lamiaceae: *Ajuga reptans* L. [GS-ES, M-3169]; *Clinopodium umbrosum* (M. B.) C. Koch [H-PL-3170]; *Clinopodium vulgare* L. subsp. *vulgare* [H-ES, IT-3171]; *Dracocephalum thymiflorum* L. [T-ES, IT-3172]; *Lamium album* L. subsp. *album* [GR-ES, IT-3173]; *Lamium album* L. subsp. *crinitum* (Montbr. & Auch. ex Benth.) Mennema [GR-PL-3174]; *Lamium galeobdolon* (L.) (L.) L. subsp. *montanum* (Pers.) Hayek [GR-ES, M-3175]; *Melissa officinalis* L. [H-ES, IT, M-3176]; *Nepeta sintenisii* Bornm. [H-IT-3177]; *Origanum vulgare* L. subsp. *viride* (Boiss.) Hayek [H-PL-3178]; *Phlomis anisodonta* Boiss. [H-IT-3179]; *Prunella vulgaris* L. [GR-PL-3180]; *Salvia glutinosa* L. [H-ES, IT, M-3181]; *Scutellaria tournefortii* Benth. [GR-ES (Hyr)-3182]; *Stachys byzantina* C. Koch [H-ES, IT-3183]; *Stachys sylvatica* L. [H-ES-3184]; *Teucrium chamaedrys* L. subsp. *sinuatum* (Čelak.) Rech. f. [H-IT-3185]; *Teucrium chamaedrys* L. subsp. *syspirense* (C. Koch) Rech. f. [H-ES (Euxino-Hyr), IT-3186]; *Teucrium hyrcanicum* L. [GR-ES (Euxino-Hyr)-3187]; *Thymus pubescens* Boiss. & Kotschy ex Čelak. [C-IT-3188]; *Thymus transcaspicus* Klokov [C-IT-3189]
- Linaceae: *Linum catharticum* L. [T-ES, IT-3190]
- Loranthaceae: *Viscum album* L. [P-PL-3191]
- Malvaceae: *Tilia platyphyllos* Scop. subsp. *caucasica* (Rupr.) Loria [P-ES-3192]
- Moraceae: *Ficus carica* L. [P-ES, IT, M-3193]
- Oleaceae: *Fraxinus excelsior* L. subsp. *coriariifolia* (Scheele) E. Murray [P-ES (Hyr), IT-3194]
- Onagraceae: *Circaea lutetiana* L. [GR-ES, IT, M-3195]; *Epilobium montanum* L. [GR-PL-3196]
- Orobanchaceae: *Orobanche hederæ* Duby [GP-ES, M-3197]; *Orobanche major* L. [GP-ES, IT, INDIA-3198]; *Orobanche oxyloba* (Reut.) G. Beck [GP-ES, IT, M-3199]; *Orobanche vulgaris* Poir. [GP-ES, IT-3200]
- Oxalidaceae: *Oxalis corniculata* L. [T-COS-3201]
- Paeoniaceae: *Paeonia wittmanniana* Hartw. ex Lindl. var. *nudicarpa* Schipcz. [H-ES-3202]; *Paeonia wittmanniana* Hartw. ex Lindl. var. *wittmanniana* [H-ES (Euxino-Hyr)-3203]
- Papaveraceae: *Chelidonium majus* L. [H-ES, M-3204]; *Corydalis verticillaris* DC. subsp. *verticillaris* [GC-IT-3205]; *Papaver rhoeas* L. [H-ES, IT, M-3206]
- Plantaginaceae: *Digitalis nervosa* Steud. & Hochst. ex Benth. [H-ES (Euxino-Hyr)-3276]; *Plantago atrata* Hoppe subsp. *saxatilis* (M. B.) Pilger [H-ES (Euxino-Hyr)-3207]; *Plantago lanceolata* L. [H-PL-3208]; *Veronica mazanderanae* Wendelbo [T-ES (End-Hyr)-3285]; *Veronica persica* Poir. [T-COS-3286]; *Veronica polita* Fries [T-COS-3287]; *Veronica rechingeri* M. A. Fischer [H-ES (End-Hyr)-3288]
- Polygalaceae: *Polygala platyptera* Bornm. & Gauba [H-ES (End-Hyr)-3209]; *Polygala anatolica* Boiss. & Heldr. [H-ES, IT, M-3210]
- Polygonaceae: *Polygonum cf. hydropiper* L. subsp. *hydropiper* [T-ES, IT-3211]; *Polygonum convolvulus* L. [T-PL-3212]; *Polygonum patulum* M. B. [T-ES, IT, M-3213]; *Rumex sanguineus* L. [H-ES, M-3214]
- Primulaceae: *Androsace maxima* L. [T-ES, IT, M-3215]; *Cyclamen coum* Miller subsp. *caucasicum* (K. Koch) O. Schwarz [GC-ES-3216]; *Primula heterochroma* Stapf [H-ES (Hyr), IT-3217]; *Primula macrocalyx* Bge. [H-ES, M-3218]
- Ranunculaceae: *Anemone caucasica* Willd. ex Rupr. [GB-ES (Hyr), IT-3219]; *Ficaria kochii* (Ledeb.) Iranshahr & Rech. f. [H-ES, IT-3220]; *Ranunculus amblylobus* Boiss & Hohen. [GR-IT (End)-3221]; *Ranunculus brutius* Ten. [GR-ES, M-3222]; *Ranunculus caucasicus* M. B. [GR-ES, M-3223]; *Ranunculus constantinopolitanus* (DC.) d'Urv. [H-IT, M-3224]; *Ranunculus oxyspermus* Willd. [H-ES, IT, M-3225]; *Thalictrum foetidum* L. [H-PL-3226]
- Rhamnaceae: *Rhamnus cathartica* L. var. *cathartica* [P-ES, IT, M-3227]; *Rhamnus cathartica* L. var. *caucasica* Kusn. [P-ES (Euxino-Hyr)-3228]; *Rhamnus cf. minuta* Grub. [P-IT-3229]
- Rosaceae: *Alchemilla amardica* Rothm. [GR-ES (End-Hyr)-3230]; *Alchemilla hyrcana* (Buser) Juz. [GR-ES (Hyr)-3231]; *Alchemilla melancholica* Fröhner [GR-ES (End-Hyr)-3232]; *Alchemilla microscopica* Fröhner [GR-ES (End-Hyr)-3233]; *Alchemilla rigida* Buser [GR-ES-3234]; *Alchemilla sericata* Reichenb. [GR-ES (Euxino-Hyr)-3235]; *Alchemilla surculosa* Fröhner [GR-ES (End-Hyr)-3236]; *Aremonia agrimonoides* (L.) DC. [H-ES-3237]; *Aruncus vulgaris* Rafin. [GR-ES-3238]; *Cotoneaster nummularia* Fisch. & C. A. Mey. [P-ES, IT-3239]; *Crataegus microphylla* C. Koch [P-ES, IT, M-3240]; *Crataegus* sp. [P-\*, 3241]; *Fragaria vesca* L. [GS-ES, IT-3242]; *Geum urbanum* L. [H-ES, IT, M-3243]; *Laurocerasus officinalis* Roemer [P-ES, M-3244]; *Malus orientalis* Ugl. [P-ES (Euxino-Hyr), IT-3245]; *Mespilus germanica* L. [P-ES, IT, M-3246]; *Potentilla adscharica* Sommier & Levier ex Keller [H-ES (Euxino-Hyr), IT-3247]; *Potentilla argentea* L. [H-ES, IT, M-3248]; *Potentilla bungei* Boiss. [H-ES (Euxino-Hyr)-3249]; *Potentilla micrantha* Ramond [H-ES, IT, M-3250]; *Potentilla pannosa* Boiss. & Hausskn. [H-IT-3251]; *Prunus divaricata* Ledeb. subsp. *divaricata* [P-ES, IT, M-3252]; *Pyrus boissieriana* Buhse [P-ES (Hyr), IT-3253]; *Rosa canina* L. [P-ES, IT, M-3254]; *Rosa iberica* Stev. [P-ES, IT-3255]; *Rubus caesius* L. [P-ES, IT-3256]; *Rubus hirtus* Waldst. & Kit. [P-ES-3257]; *Rubus hyrcanus* Juz. [P-ES (Hyr)-3258]; *Rubus persicus* Boiss. [P-ES (Hyr)-3259]; *Sanguisorba minor* Scop. subsp. *minor* [H-ES, IT, M-3260]; *Sorbus torminalis* (L.) Crantz [P-ES, IT, M-3261]
- Rubiaceae: *Crucianella gilanic* Trin. subsp. *demavendensis* Ehrend. & Schönb.-Tem. [H-IT (End)-3262]; *Cruciata laevipes* Opiz [H-ES, IT-3263]; *Galium odoratum* (L.) Scop. [GR-PL-3264]; *Galium rotundifolium* L. [GR-ES, M-3265]; *Phuopsis stylosa* (Trin.) Hook. f. [GR-ES (Hyr)-3266]
- Sapindaceae: *Acer campestre* L. [P-ES, M-3267]; *Acer cappadocicum* Gled. [P-ES, IT-3268]; *Acer hyrcanum* Fisch. & C. A. Mey. [P-ES, M-3269]; *Acer platanoides* L. [P-ES-3270]; *Acer velutinum* Boiss. var. *glabrescens* (Boiss. & Buhse) E. Murray [P-ES (Hyr), IT-3271]; *Acer velutinum* Boiss. var. *velutinum* [P-ES (Hyr)-3272]

**Table 4** continued

- Saxifragaceae: *Saxifraga cymbalaria* L. var. *cymbalaria* [H-ES, IT, M-3273]; *Saxifraga paniculata* Miller subsp. *cartilaginea* (Willd. ex Sternb.) D. A. Webb. [H-ES-3274]; *Saxifraga ramsarica* Jamzad [H-ES (End-Hyr)-3275]
- Scrophulariaceae: *Euphrasia hirtella* Jordan ex Reut. [T-ES-3277]; *Pedicularis caucasica* M. B. [H-ES (Euxino-Hyr), IT-3278]; *Pedicularis sibthorpii* Boiss. [H-ES (Euxino-Hyr), IT-3279]; *Rhynchosycorys maxima* C. Richter [H-ES (Hyr), IT-3280]; *Scrophularia rostrata* Boiss. & Buhse [H-ES (End-Hyr)-3281]; *Scrophularia vernalis* L. subsp. *clausii* (Boiss. & Buhse) Grau [H-ES (Euxino-Hyr), IT-3282]; *Verbascum* sp. [H\*-3283]; *Verbascum stachydiforme* Boiss. & Buhse [H-ES (Hyr)-3284]
- Solanaceae: *Atropa acuminata* Royle ex Miens [GR-IT-3289]; *Solanum kieseritzkii* C. A. Mey. [C-ES (Hyr)-3290]
- Ulmaceae: *Ulmus glabra* Hudson [P-ES-3292]
- Urticaceae: *Parietaria officinalis* L. [GR-ES, M-3293]; *Urtica dioica* L. subsp. *dioica* [GR-COS-3294]
- Violaceae: *Viola ignobilis* Rupr. [GR-ES (Euxino-Hyr)-3295]; *Viola occulta* Lehmann [T-ES, IT, M-3296]; *Viola rupestris* F. W. Schmidt [GR-ES, IT, M-3297]; *Viola sieheana* W. Becker [GR-ES, IT, M-3298]; *Viola suavis* M. B. [GR-ES, IT, M-3299];
- Monocots**
- Amaryllidaceae: *Allium erubescens* C. Koch [GB-ES (Euxino-Hyr), M-3300]
- Araceae: *Arum rupicola* Boiss. [GC-ES, M-3301]; *Arum* sp. [GC\*-3302]
- Asparagaceae: *Muscari neglectum* Guss. [GB-ES, IT, M-3303]; *Ornithogalum bungei* Boiss. [GB-ES (Hyr)-3304]; *Ornithogalum orthophyllum* Ten. [GB-ES, IT, M-3305]; *Ornithogalum sintenisii* Freyn [GB-ES (End-Hyr), M-3306]; *Danae racemosa* (L.) Moench [P-ES (Euxino-Hyr), M-3307]; *Polygonatum orientale* Desf. [GR-ES, IT, M-3308]; *Polygonatum sewerzowii* Regel [GR-IT-3309]; *Ruscus hyrcanus* Woron. [P-ES (Hyr)-3310]
- Colchicaceae: *Colchicum speciosum* Steven [GC-ES-3311]
- Cyperaceae: *Carex depressa* Link subsp. *transilvanica* (Schur) Egor. [GR-ES, M-3312]; *Carex diluta* M. B. [GR-ES, M-3313]; *Carex divisa* Huds. [GR-COS-3314]; *Carex divulsa* Stokes subsp. *divulsa* [GS-ES, IT, M-3315]; *Carex divulsa* Stokes subsp. *leersii* (Kneuck.) W. Koch [GS-ES, IT, M-3316]; *Carex grioletii* Roemer [GR-ES, M-3317]; *Carex humilis* Leyss. [GR-ES-3318]; *Carex melanostachya* M. B. ex Willd. [GR-ES, IT, M-3319]; *Carex otrubae* Podpera [GR-ES, IT-3320]; *Carex pallescens* L. [H-PL-3321]; *Carex pendula* Huds. [GR-ES, M-3322]; *Carex phyllostachys* C. A. Mey. [H-ES-3323]; *Carex remota* L. subsp. *remota* [GR-ES, M-3324]; *Carex strigosa* Huds. [GS-ES-3325]; *Carex sylvatica* Huds. [GR-ES, M-3326]
- Dioscoreaceae: *Dioscorea communis* L. [GC-ES, IT, M-3327]
- Iridaceae: *Iris reticulata* M. B. var. *reticulata* [GB-ES (Euxino-Hyr), IT-3328]
- Juncaceae: *Luzula forsteri* (Smith) DC. [H-PL-3329]; *Luzula multiflora* (Retz.) Lej. [H-PL-3330]
- Liliaceae: *Gagea alexeenkoana* Misch. [GB-ES (Euxino-Hyr), IT-3331]; *Gagea confusa* A. Terr. [GB-ES (Euxino-Hyr), IT-3332]; *Gagea fragifera* (Villars) E. Bayer & G. López [GB-ES, IT, M-3333]; *Tulipa* sp. [GB\*-3334]
- Orchidaceae: *Cephalanthera caucasica* Kranzl. [GR-ES (Hyr)-3335]; *Cephalanthera rubra* (L.) L. C. Rich. [GR-ES, IT, M-3336]; *Epipactis microphylla* (Ehrh.) Swartz [GR-ES, M-3337]; *Epipactis persica* (Soó) Nannfeldt [GR-ES, IT-3338]; *Listera ovata* (L.) R. Br. [GR-PL-3339]; *Neottia nidus-avis* (L.) L. C. Rich. [GP-ES, M-3340]; *Orchis mascula* L. subsp. *mascula* [GC-ES, M-3341]; *Orchis mascula* L. subsp. *pinetorum* (Boiss. & Ky.) Camus [GC-ES, IT-3342]; *Platanthera bifolia* (L.) L. C. Rich. [GC-PL-3343]
- Poaceae: *Agropyron* sp. [T-PL-3344]; *Agrostis stolonifera* L. [GS-PL-3345]; *Brachypodium pinnatum* (L.) P. Beauv. [GR-PL-3346]; *Brachypodium sylvaticum* (Hudson) P. Beauv. [H-PL-3347]; *Bromus benekenii* (Lange) Trimen [GR-ES, IT, M-3348]; *Bromus briziformis* Fisch. & C. A. Mey. [T-ES (Euxino-Hyr)-3349]; *Bromus* sp. [H\*-3350]; *Bromus sterilis* L. [H-PL-3351]; *Bromus tomentellus* Boiss. [H-ES, IT-3352]; *Dactylis glomerata* L. subsp. *glomerata* [H-PL-3353]; *Elymus caucasicus* (C. Koch) Tzvelev [GR-IT-3354]; *Festuca drymeia* Mert. & Koch [GR-ES (Euxino-Hyr)-3355]; *Festuca ovina* L. [H-PL-3356]; *Festuca pinifolia* (Hack.) Bornm. [H-IT, M-3357]; *Festuca rubra* L. [GR-PL-3358]; *Helictotrichon pratense* (L.) Pilger [H-PL-3359]; *Koeleria glaucovirens* Domin [GR-IT, M-3360]; *Melica uniflora* Retz. [GR-ES, IT-3361]; *Microstegium vimineum* (Trin.) A. Camus [H-PL-3362]; *Oplismenus undulatifolius* (Ard.) P. Beauv. [H-ES, M-3363]; *Phleum alpinum* L. [GR-COS-3364]; *Phleum paniculatum* Hudson var. *ciliatum* (Boiss.) Bor [T-ES (Euxino-Hyr), M-3365]; *Poa angustifolia* L. [GR-COS-3366]; *Poa bulbosa* L. [GB-ES, IT, M-3367]; *Poa nemoralis* L. [GS-ES, IT-3368]; *Poa pratensis* L. [GR-PL-3369]; *Poa* sp. [H\*-3370]; *Poa timoleontis* Heldr. ex Boiss. [H-ES, IT, M-3371]; *Sesleria phleoides* Stev. ex Roemer & Schultes [H-ES-3372]; *Trisetum flavescens* (L.) P. Beauv. [H-PL-3373]
- Smilacaceae: *Smilax excelsa* L. [P-ES, M-3374]

*Life forms* C chamaephyte; GB bulbiferous geophyte; GC geophyte with corm; GP parasituous geophyte; GR rhizomatous geophyte; GS stoloniferous geophyte; H hemicryptophyte; P phanerophyte and T therophyte. *Chorotypes* COS cosmopolitan; End endemism; ES Euro-Siberian; Hyr hyrcanian; IT Irano-Turanian; M mediterranean; PL pluriregional

\* Unknown

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