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The world's easternmost natural stands of *Cupressus sempervirens* L. (Cupressaceae) in the Hyrcanian forests of Iran

Tayebeh Amini[1], Hamid Ejtehadi[2*], Morteza Djamali[3], Frederic Guibal[3]

[1]*PhD candidate, Quantitative Plant Ecology and Biodiversity Research Lab., Department of Biology, Faculty of Science, Ferdowsi University of Mashhad, Mashhad, Iran*
[2]*Quantitative Plant Ecology and Biodiversity Research Lab., Department of Biology, Faculty of Science, Ferdowsi University of Mashhad, Mashhad, Iran*
[3]*Institut Méditerranéen de Biodiversité et d'Ecologie, Aix-Marseille Université, CNRS, Université d'Avignon, France.*
[*]*corresponding author: hejtehadi@um.ac.ir*

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Abstract

Mediterranean cypress (*Cupressus sempervirens* L.) is naturally distributed in the eastern Mediterranean (from Crete Island to Saudi Arabia) and parts of Iran. So far, habitats of this species have not been thoroughly studied in Iran. The main objective of this study is to document the state of the knowledge on the chorology of *Cupressus sempervirens* populations in Iran and to introduce new populations discovered by the authors. Floristic studies and comparisons between habitats have been performed in this research. Our study, done in the eastern parts of Golestan province harboring the eastern end of Hyrcanian forests, has revealed five new discontinuous habitats of Mediterranean cypress and characterized their ecological and conservational values. A total of 685 species belonging to 357 genera and 85 plant families were also identified in the area.

Introduction

Mediterranean cypress (*Cupressus sempervirens* L.) is a prominent floristic element in the Mediterranean climate that has many economic, ethno botanical and ecological values in its natural propagation zone. Mediterranean cypress is naturally distributed in the eastern Mediterranean (from Crete Island to Saudi Arabia) and parts of Iran (disjunct population), especially in the forests located south of the Caspian Sea and it seems to be the only cypress species naturally growing in Iran (Rield, 1968; Klein, 1994). It is a pioneer species, growing quickly when young on most types of soils, including rocky and compact ones, adapted to the Mediterranean climate with dry and hot summers and rainy winters. (Caudullo & amp; de Rigo, 2016). Existence of *Cupressus* forests in Iran and their natural distribution range are one of the mysteries of Iran vegetation history. Basically, the placement of real Mediterranean forests in the Euro-Siberian vegetation is not expected. The presence of these forests, scattered and isolated, assumes that these populations are considered to be relicts (Zohary, 1973). Although these ancient forests are separated from other habitats, they present bioclimatic, ecological and phytosociological similarities. Previously, eight sites have been mentioned in the Hyrcanian area, the most western of which is being located in Harzevil, Rudbar (Gilan province) and the most eastern in the Hosseina, Minoodasht (Golestan province) (Fig. 1).

There are still many ambiguities about the Mediterranean characters of the flora and continental bioclimate of Southwest Asia and in particular in Iran. Throughout the northern slopes of the Alborz mountains and in

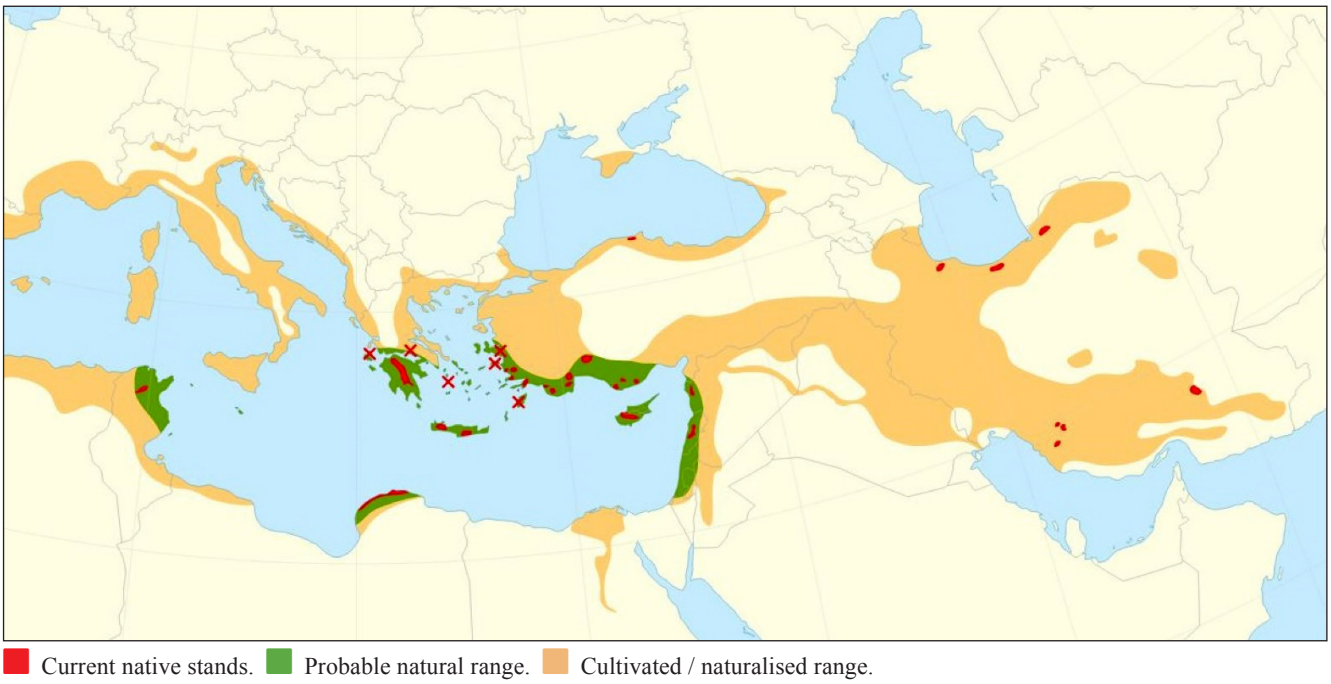

Fig. 1. Distribution of Mediterranean cypress (*Cupressus sempervirens* L.), a prominent plant element in the Mediterranean climate: Red (small areas): Residual natural stands, Green: probable natural range in the Mediterranean Basin, Orange: range including human introductions (Caudullo et al., 2017).

more remote areas from the Caspian Sea shores, where marine influence is diminishing, there are a number of isolated discrete mountains with a particular geology mostly composed of marls, marlstones, limestones, and shales (Vahdati Daneshmand et al., 2001) extended from the western (Harzevill, Roodbar, Rostamabad in Sefidrood valley) to the central (Pole Zoghal, Hassanabad, and Dashte Nazir in Nowshahr) far to the eastern Hyrcanian (Zarrin Gol in Aliabad Katul and from there to Ramian and Hosseina in Minoodasht) (Fig. 1). The amount of annual rainfall in these areas is significantly lower than the rest of the Hyrcanian zone and northern slopes of Alborz (Djamali et al., 2011). The specific topographic configuration including the presence of natural defiles connecting the central Iranian plateau to Caspian lowlands creating the zone of confrontation of continental and marine climates, has created typical Mediterranean microclimatic areas with annual rainfall usually less than 400 mm (Klein, 1994; Khalili, 1973, Zohary, 1973; Alijani and Harman, 1985; Djamali et al., 2011). In the geological times, the palaeogeography and palaeoclimate of Iran has undergone fundamental changes likewise other parts of the world (Berberian and King, 1981; Ballato et al., 2010) causing fundamental changes in vegetation and flora of this region (e.g. Djamali et al., 2008).

During the Tertiary time, it is likely that conifers had more significant distribution due to a more suitable bioclimatic condition for the development of different coniferous elements and lack of severe climatic changes and milder glaciations. Later glacial-interglacial cycles, however, would have extirpated most of these conifers and particularly those of the Pinaceae family which are almost absent from the Flora Iranica (Assadi, 1988; Zare, 2001). The existence of high Alborz Mountains as a natural geographical barrier would have impeded the boreal conifers to migrate and develop on the northern slopes of the Alborz. On the contrary, local Mediterranean bioclimatic niches have been locally provided and remained intact in some isolated places for the development and diffusion of Mediterranean elements including cypress trees. The particular persistent geological and geographical conditions in some isolated valleys of the Alborz Mountains such as Harzevill, Roudbar, Rostamabad, Eshkevar, Hassanabad, Aliabad Katul, Ramian and Minoodasht would have provided suitable ecoclimatic niches which were occupied by the Mediterranean elements such as cypress trees which were extirpated from more continental areas of Iranian Plateau.

However, all the above arguments are more hypothetical. The current state of knowledge on Tertiary-Quaternary changes in flora and vegetation is not enough to give any robust scenario about the presence of the relict-like populations of *Cupressus sempervirens* L. in Iran. These populations might, indeed, display the

relicts of once more widespread coniferous forests or mixed broad-leaved and coniferous forests found in the Hyrcanian region. Apart from cypress, other coniferous trees including *Taxus baccata* L. (Mosadegh, 1975) and *Thuja orientalis* L. are also isolated relict populations in the eastern Hyrcanian forests. Together with relict populations of *Betula*, these conifers may thus suggest that the colder and drier long glacial periods may have favoured the expansion of these forests. By contrast, the shorter but warmer interglacial climates have been more suitable for temperate/subtropical broad-leaved trees and have made them more superior in competition over the conifers. Further palaeobotanical data for the Tertiary and Quaternary periods are needed to back such a hypothesis. The main objective of the study is documenting the state of knowledge on the chorology of *Cupressus sempervirens* populations in Iran and to introduce new populations discovered by the authors.

Materials and Methods

The study area is located *in Hyrcanian region in northern Iran (Gilan, Mazandaran and Golestan provinces),* in this study, all available habitats were carefully examined. Existing plants were collected and identified in all seasons. The condition of the habitats was considered and compared. The whole Hyrcanian region was searched for more Cypress habitats, and after finding these habitats, they were also carefully studied floristically and ecologically.

Results and discussion

Floristic studies have shown similarities and differences between the areas in which the Cypress is living, located in northern parts of Iran. If we compare the floristic composition of these habitats, we will reach to some interesting results.In the westernmost part of Gilan (Sefidrud valley), wherever Cypress habitat is further away from the Hyrcanian forests, there are Mediterranean elements with it (Nos. 1-3) and the further we go from the west to the east, the Cypresses are surrounded by native broadleaves and are located in cliffs and steep slopes, to the point where they gradually fade away from the Hyrcanian habitats.

In the east of Gilan province, in the Eshkevar valley, the cypresses are again observed in the rocky outcrops and steep slopes of the valleys and on both sides of the Polerud river. But in this habitat (No. 4) no trace of Mediterranean species can be seen and cypress is completely mixed with Hyrcanian species. Perhaps due to the higher humidity, there is more rainfall in the Eshkevar valley. In Mazandaran province, cypress only exists in the valley of Chalous river (Hassanabad) (No. 5). This habitat, with an area of more than 7000 hectares is the largest natural habitat of Cypress in northern Iran. The soil is calcareous and very poor in nutrients. The steep slopes in the mountains, with elevation of 350 to 1,100 meters, have limited the growth of plants. In the margins of these areas, where the growth conditions have changed both in terms of soil and slope, broadleaves dominate. In fact, in the Hassanabad region of Chalous, cypresses have won competing with other broadleaves, and they have dominated this habitat for hundreds of years (Fig. 2).

Fig. 2. *Cupressus sempervirens* stands in Hassanabad, Chalous valley.

Cypress habitat in the east of Golestan province is also limited to the valleys of Chehelchay, Zarrin Gol and Qarasu rivers (6, 7 and 8), and other areas are occupied by the broad leaves. Nearly 50 healthy trees were found inside the Golestan National Park (number 9), which has not been reported so far. Habitats, Ghorchecheshmeh Paeen, Savare -Bala Zav-Koh, Qezel otagh (Numbers 9 to 12) are located in the easternmost part of Hyrcania. In these areas, the diversity of Hyrcanian forests is reduced, and oak deciduous forests have been pushed to steep slopes in valleys and areas that are unsuitable for agriculture. Talented and fertile lands that used to be covered with native deciduous trees are now cultivated and used by the local people for agriculture and animal husbandry. Now, with the harsh conditions created for agriculture by the broad leaves, the cypresses are in a worse and more difficult situation and are seen in poor and unsuitable habitats. Figure 5 shows a *C. sempervirens* stand in Qezel Otagh habitat.

Mediterranean cypress is a protected species and its natural habitats are considered to be part of important forest reserves of Iran, but due to lack of

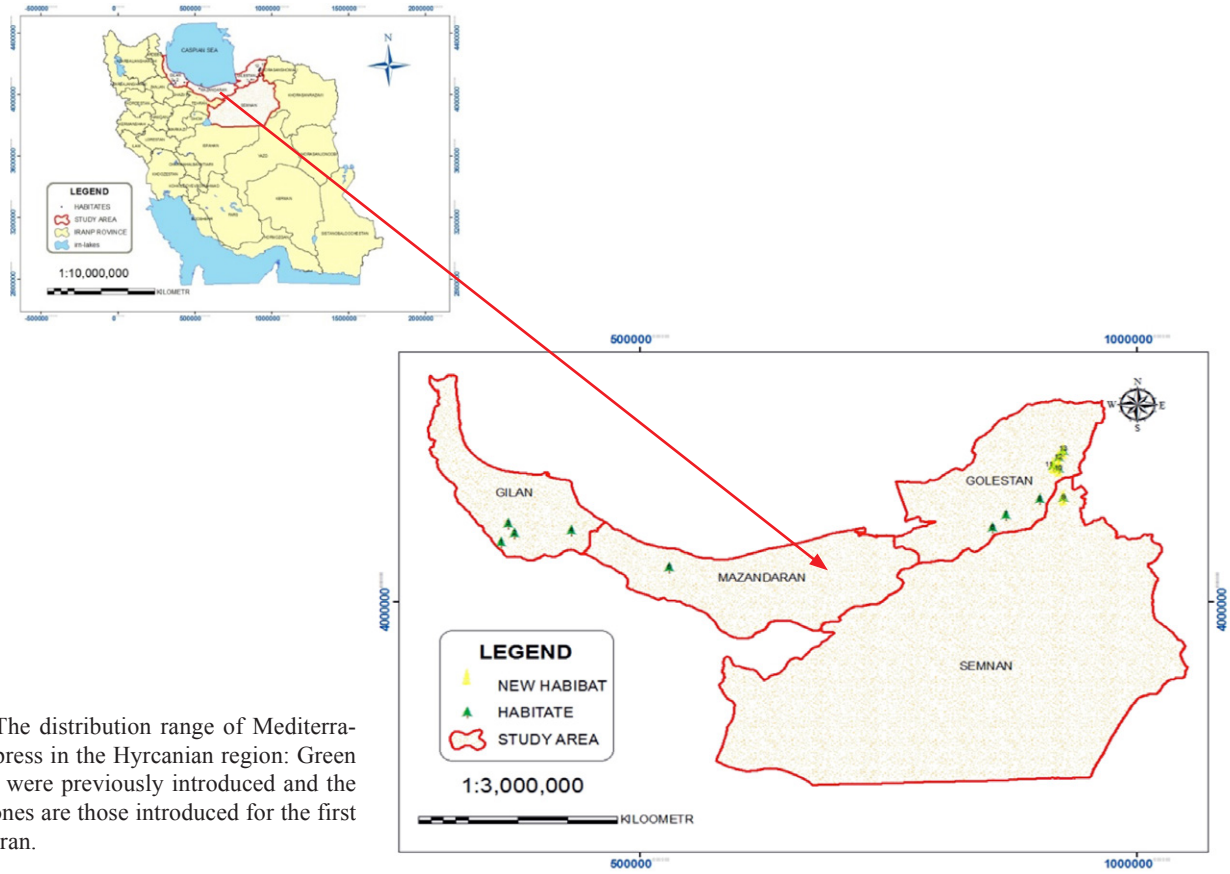

Fig. 3. The distribution range of Mediterranean cypress in the Hyrcanian region: Green symbols were previously introduced and the yellow ones are those introduced for the first time in Iran.

Fig. 4. The old trees and sites of *Cupressus sempervirens* L. in Sarve Bala, Eastenmost of Golestan province (Left). Dispersed Cypress trees in the Oak forests of Golestan National Park. As shown in the figure, trees with a trunk diameter above 120 cm are abundant (Right).

detailed studies on its habitats, no proper conservation management has been applied to them so far. A detailed review has been done in Hyrcanian habitats of Mediterranean cypress during the project entitled "An ecological, floristic and dendrochronological study of *Cupressus sempervirens* L. stands in the South Caspian (Hyrcanian) region: implications for conservation ", the study area includes Golestan, Mazandaran and Gilan provinces in the north of Iran which is the subject matter of the PhD thesis of the first author, and so far, it is the only floristic and ecological research on the *C. sempervirens* localities in Iran. According to our assessments harvesting the wood of this unique species has been lowered, but never reached zero in any of the habitats. In habitats of Gilan and Mazandaran provinces, protection has

increased in the last two decades, and subsequent cutting of Mediterranean cypress have been reduced but the presence of old stands has been limited to shrine sites. Perhaps, if there were no religious beliefs in these parts, these few numbers of thousands year old trees would have not survived until today.

Fortunately, our study undertaken in the eastern parts of Golestan province harboring the eastern end of Hyrcanian forests, has revealed five new discontinuous habitats of Mediterranean cypress (as shown on Fig. 3) and characterized their ecological and conservational values.

According to vegetation map of this species provided in Caudullo et al. (2017), the easternmost habitat of the Hyrcanian region is in the city of Minoodasht (Hosseina habitat). Based on the review of available sources and information and new data collected during our extensive field investigations we present here, the easternmost habitats of *C. sempervirens* in its global distribution area have not been officially reported previously and the details of new habitats and the previous ones are given in Table 1.

Table 1: Information of the previously known habitats and the new ones (Numbers 9 to13) in the Hyrcanian area (Gilan, Mazandaran and Golestan provinces).

Habitat quality	Altitude (m)	Geographical coordinates	Habitat area (ha.)	Name of habitat	Nearest city	Province	No
Previously, many trees were cut down and their habitats were destroyed and old trees can only be found in Graveyards	350-900	36° 44' 41"N 49° 25' 38" E	680	Harzevil	Rudbar	Gilan	1
	300-600	36° 48' 52"N 49° 25' 39 " E	2260	Nesfii-Rudbar	Rudbar	Gilan	2
	300-900	36° 50' 50.85"N 49° 35' 21 " E	2047	Seydan& Poshtahan	Rostamabad	Gilan	3
	350-450	36° 56' 13.27'N 49° 30' 42.73" E	400	Aminabad Aghapir&			
	400-700	36° 52' 50.85"N 50° 13' 31" E	1000	Eshkevar	Rudsar	Gilan	4
Although these trees were cut down in the previous years, old trees can still be seen	300-1100	36° 29' 56.27"N 51° 21' 21" E	7397 (2266 Pure habitat)	Hassanabad	Nowshahr	Mazandaran	5
Although these trees have been cut down in the recent years, there still exists old and very old ones. Dryness and fires have also caused some problems in the recent years	400-530	36° 50' 01.9"N 54° 58' 41.3" E	115	Zarren gol	Aliabad	Golestan	6
	300-400	36° 59' 11"N 55° 07' 24" E	520	Ramiyan	Ramiyan	Golestan	7
	500-680	37° 07' 43"N 55° 29' 40" E	80	Hosseyna	Minodasht	Golestan	8
These habitats have not been introduced yet and no management work has been done on them and they are being destroyed and disturbed by local human activity	850-900	37° 27' 4.3"N 55° 43 26" E	28	Golestan National Park	Tangerah	Golestan	9
	650-800	37° 26' 16.3"N 55° 44 7" E	190	Ghorche-cheshmeh Paeen	Kalaleh	Golestan	10
	650-900	37° 27' 01.2"N 55° 43 27.7" E	76	Savare -Bala	Kalaleh	Golestan	11
	500-700	37° 31' 35.6"N 55° 45 49" E	300	Zav-Koh	Kalaleh	Golestan	12
	700-850	37° 35' 4.7"N 55° 49 41.2" E	140	Qezel otagh	Golidaghi	Golestan	13

There are three reasons for lack of any acceptable report of these habitats. First, *C. sempervirens* is an unknown species to most of the people. Second, some people may recognize it but they are not aware of its high botanical value. Third, some may think they are planted and are not grown naturally. Plants were collected and identified from these five habitats. They are very similar to other resorts in Golestan province. There is a main difference between these five habitats and other Cypress habitats in that, these areas are surrounded by agricultural lands whereas the other habitats in Gilan and Mazandaran provinces are surrounded by Hyrcanian deciduous forests. For this reason, more trees are being destroyed and cut down. These newly discovered habitats are not in good conservation conditions and further protective measures are urgently needed upon further study and introduction. All of the Cypress habitats in northern Iran are surrounded by deciduous forests. Wherever a significant well developed population is observed, the growth conditions are certainly difficult for the broad-leaved species, otherwise cypress, without exception, can only be seen in very steep slopes, rocky and rocky beds, and unfavorable soils for growth.

Fig. 5. Residual forest of *Cupressus sempervirens* in Qezel otagh habitat.

Conclusion

The results of this study shows that *Cupressus sempervirens* was present in all Hyrcanian regions from the easternmost to the westernmost point, but in each of these habitats, depending on the conditions and adjacent species, had a different behavior and it always has taken refuge in difficult habitats in competition with other species. Maybe it can be said that it has taken refuge in a place where other species do not have the strength to grow.

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