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Diversity of chasmophytes in the vascular flora of Greece: floristic analysis and phytogeographical patterns

Maria Panitsa* and Anna Kontopanou

Division of Plant Biology, Department of Biology, University of Patras, GR 26500 Patras, Greece

ABSTRACT: Cliffs are among the environments with the most adverse conditions for living organisms because of the limited availability of soil, moisture, and nutrients, and owing to the harsh conditions of exposure. They constitute shelters for rare, endemic, and range-restricted plant taxa. A main database has been prepared which includes vascular plant taxa that are obligate or facultative chasmophytes and also contains information about their life form, chorology, protection status, occurrence in more than 135 places such as cliffs, gorges, or open rocky habitats, and their geographical distribution in the 13 phytogeographical regions of Greece based on available floristic, vegetation, and phytosociological literature and on the authors' own collections and observations. The paper presents an analysis of the total diversity of cliff plant species, as well as the diversity of obligate chasmophytic plant species, endemics, and range-restricted taxa, in addition to the results of studying the distribution patterns of different subsets of plant taxa in the different phytogeographical regions of Greece. Hemicryptophytes and chamaephytes are the dominant life forms of the chasmophytic taxa. Among 935 species and subspecies registered, 476 are obligate chasmophytes, of which the majority are Greek endemics. Hierarchical cluster analysis of different subsets of plant taxa revealed affinities of the cliff flora of different phytogeographical regions. Additionally, 15 chasmophytic taxa mentioned in Annexes II, IV, and V of EEC Directive 92/43 belong to the cliff flora, of which 10 are obligate chasmophytes and nine have a priority for protection. Eighteen taxa are included in the IUCN Red List of Threatened Species, of which four are critically endangered (CR), seven are vulnerable (VU), and three are endangered (EN). The distinct correlation between endemism and chasmophytic ecology is emphasized, since a detailed understanding of the local distribution and specific habitats of rare plants provides an opportunity for local conservation efforts that can influence biodiversity conservation on a larger scale.

Keywords: cliff flora, chasmophytes, endemic taxa, range-restricted taxa, vascular plants

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INTRODUCTION

The complexity of landscapes in Mediterranean areas and the impressive diversity of habitats there result in a high richness of regional or local endemic plants (Blondel & Aronson 1999). Cliffs, gorges, crevices, and narrow ledges of sheer rocks on mountains are of great botanical interest for supporting a rather sparse vegetation of ecologically specialised taxa, i.e., "chasmophytes", which show phytogeographical significant patterns of variation and distribution and include some palaeoendemics that have survived only in these remote places (Strid & Tan 1997). Davis (1951) described Mediterranean cliffs as biologically closed communities that serve as refugia from unfavourable climatic change, competition with hillside communities, and grazing. The protection provided by the cliff produces ecological opportunities for the flora to undergo natural development, unlike the case of most terrain units, which have been grossly modified by human activity (Larson *et al.* 2000).

*correspondence: mpanitsa@upatras.gr

The diversity of endemic and range-restricted taxa tends to be more distinct in habitat categories more or less isolated, like cliffs and rocky habitats, where 22.9% of the endemic and 20.6% of the range-restricted taxa of the Greek vascular flora have been registered (Dimopoulos *et al.* 2013, 2016).

The high-rank syntaxa of chasmophytic vegetation have been revised and validated in Europe by Mucina *et al.* (2016) and in Greece by Bergmeier *et al.* (2011), Dimopoulos *et al.* (1997, 2012), who showed that this vegetation there is characterised by eight orders and 15 alliances with clear differences in floristic composition mainly due to the very high proportion of endemics, which serve as diagnostic species of the syntaxa.

Snogerup (1985) supposed that chasmophytic ecology is a secondary development for plant taxa that found refuge in the Aegean cliffs, while Kypriotakis & Tzanoudakis (2001) demonstrated the existence of a strong relationship between chasmophytes and regional or local endemics.

Chasmophytes have many functional characteristics in common: they are generally long-lived, woody-based perennials with prolonged and conspicuous flowering, high germinability of seeds, and various long-distance seed dispersal mechanisms that grow in habitats more or less inaccessible to herbivores, exposed to long periods of hot sunshine, and characterised by extremely limited soil moisture conditions (Strid & Tan 1997; Blondel & Aronson 1999; Larson *et al.* 2000). A significant number of plant species in Annexes II, IV and V of EEC Directive 92/43, several of which have a priority for protection due to their very limited geographical distribution, are specialised on this habitat type from an ecological viewpoint, as they are adapted to extreme conditions of exposure, moisture, and nutrients.

The aims of this study are to reveal the species diversity of the cliff flora of Greece; to analyse the biological and chorological characteristics of endemic and range-restricted chasmophytic species; and to describe the phytogeographical patterns of chasmophytic taxa in Greece.

MATERIALS AND METHODS

Within the framework of the authors' research on the floristic diversity of endemic, rare, and protected plant taxa on cliffs and rocky slopes, a database has been created including plant taxa that are obligate, mainly, or occasionally chasmophytes and containing information about their occurrence in more than 135 different places such as cliffs, gorges, or open rocky habitats, as well as their distribution in the 13 phytogeographical regions of Greece as defined by Strid & Tan (1997). These 13 phytogeographical regions are as follows: North East Greece (NE), North Central Greece (NC), East Central Greece (EC), the Northern Pindus Mountains (NPi), the Southern Pindus Mountains (SPi), Sterea Ellas (StE), Peloponnesus (Pe), the Ionian islands (IoI), the North Aegean Islands (NAe), the West Aegean Islands (WAe), the East Aegean Islands (EAe), the Kikladhes (Cylades) (Kik), and Kriti (Crete)-Karpathos (KK).

All available information included in several floristic studies of different areas of Greece, in vegetation rélévés, in phytosociological studies, in authors' collections, and in observations from field work since 2014 has been added to this database.

Kypriotakis & Tzanoudakis (2001) distinguish the following three categories of plant taxa: "obligate" chasmophytes, occurring almost exclusively on cliff's and in crevices; plants that are "mainly" chasmophytes, occurring for the most part on vertical cliffs, but with clearly lower frequency in other kinds of habitats as well; and plants that are "partially or occasionally" chasmophytes, which are very often encountered on cliffs, but frequently also occur in other habitats.

However, plant taxa are relegated to two categories in other publications, viz., "obligate" chasmophytes and "facultative" ones (ex. Cellinese *et al.* 2009). In the present study, the analysis refers to "obligate" chasmophytes (OCh) and the total cliff flora (TCh) (comprising "obligate" and "facultative" taxa).

Following Dimopoulos *et al.* (2013), taxa are defined as (1) subspecies and (2) species that have no subspecies, i.e., when a species has subspecies, then only its subspecies are counted. The database has been enriched with information about the biological and chorological types of the taxa, their geographical distribution, the elevation range of their occurrence, some of their functional traits, their habitat preferences (for taxa occurring mainly, partially, or occasionally on cliffs and rocky slopes), and their protection status according to Annexes II, IV, and V of EEC Directive 92/43, the Red List categories according to the European Red List (Bilz *et al.* 2011), the IUCN Red List, and the Red Data Book of Rare and Threatened Plants of Greece (Phitos *et al.* 1995; 2009a,b).

For life forms, chorological types, and the habitats and distribution of taxa in the phytogeographical regions of Greece (Strid & Tan 1997), we followed Dimopoulos *et al.* (2013, 2016). The frequency (F) of every taxon in the 13 phytogeographical regions in which a taxon occurs was calculated, and taxa present in all 13 regions have $F = 1$, while taxa present in one of them have $F = 1/13 = 0.077$.

Four different subsets of data, viz., data pertaining to the total cliff flora (TCh), the obligate chasmophytic flora (OCh), Greek endemic taxa (EN), and range-restricted (RR) taxa, were used for the analysis. Greek endemic taxa have a geographical distribution restricted to one or more of the 13 phytogeographical regions of Greece. According to Dimopoulos *et al.* (2013), range-restricted taxa are characterised by a restricted distribution and populations occurring along a linear distance not exceeding 500 km and can be shared by Greece and one or more countries.

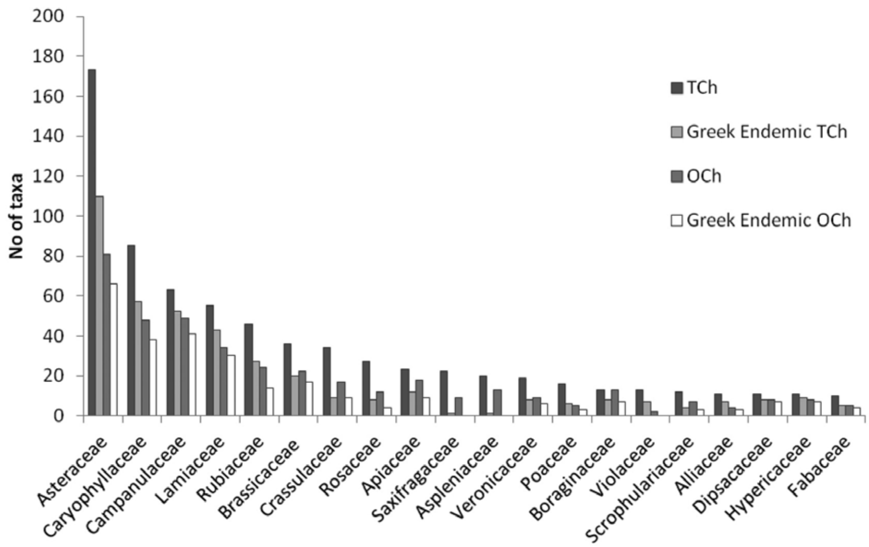


Figure 1. Taxon-richest families in the total cliff flora (TCh), the Greek endemic TCh, the obligate chasmophytic flora (OCh), and the Greek endemic OCh.

Tomović *et al.* (2014) discuss in detail terminological problems related to endemism and endemic taxa on the Balkan Peninsula. They consider as Balkan endemics taxa solely restricted to territory of the Balkan Peninsula. In the present study, we followed the annotated checklist of the vascular flora of Greece (Dimopoulos *et al.* 2013) and consider as Balkan endemics taxa restricted to Balkan countries, occasionally extending to adjacent parts of SE Europe.

For floristic comparisons among the different phytogeographical regions, we used R programming to perform hierarchical cluster analysis, the Sørensen index as the coefficient of similarity, and the Wards criterion as a combined index.

RESULTS

The database on the total floristic richness of rocky cliffs (facultative and obligate chasmophytes) contains 935 species and subspecies representing 790 taxa in all (TCh), which are classified into 54 families and 188 genera. A total of 476 species and subspecies, representing 426 taxa, are obligate chasmophytes (OCh) belonging to 38 families and 125 genera.

The most extensively represented family of the total flora of rocky cliffs (TCh) is Asteraceae with 173 taxa, followed by the families Caryophyllaceae with 85 taxa and Campanulaceae with 63 taxa (Fig. 1). Among representatives of the obligate chasmophytic flora (OCh) recorded in our database, the families richest in taxa are Asteraceae with 81 taxa, Campanulaceae with 49 taxa, and Caryophyllaceae with 48 taxa. Figure 2 shows representation of the taxon-richest families in TCh and OCh in the 13 phytogeographical regions of Greece.

Figure 3 presents the life-form spectra of tTCh and OCh, the endemic flora, and the range-restricted flora. Hemicryptophytes are the dominant life form (59% in TCh and 62% in OCh). Chamaephytes are the second most suitable life form enabling plant taxa to colonise rocky formations for all subsets of taxa studied. The percentages of different life form categories of TCh and OCh for the 13 phytogeographical regions of Greece are shown in Fig. 4, from which can also be seen the dominance of hemicryptophytes, followed by chamaephytes.

From the conducted chorological analysis, it appears that the majority of taxa belong to the category of Greek endemics (53.8% of TCh and 65.8% of OCh) (Fig. 5), followed by Balkan endemics (17.3% of TCh and 13.3% of OC) and Mediterranean elements (21.5 and 16.6%, respectively). Range-restricted taxa constitute 64.3% of TCh and 75.3% of OCh. Greek endemics represent 81% (415 out of 508 taxa) of the range-restricted taxa of TCh and 85.3% (274 out of 321 taxa) of the range-restricted taxa of OCh (Fig. 6).

Figure 7 presents the number of taxa of the general chorological types of TCh and OCh in the 13 phytogeographical regions of Greece. Larger numbers of Greek endemics occur in the phytogeographical regions KK, with a percentage representation of 50.0% of TCh (127 out of 254 taxa) and 64.7% of OCh (90 out of 139 taxa); and Pe, with a percentage representation of 43.4% (132 out of 304 taxa) and 56.8% (75 out of 132 taxa), respectively. Greek endemics among representatives of TCh and OCh also have significant proportions in WAe (33.5 and 52.7%, respectively), StE (32.3 and 43.3%), and Kik (31.9 and 45.8%). Balkan endemics represent high proportions of TCh and OCh in the continental areas of NPi (40.3 and 43.1%, respectively), NC (37.4 and 35.3%), NE (34.3 and 35.9%), and SPi (27.9 and 25.4%). Figure 8 shows that the taxon-richest families also show very high percentages of Greek endemic taxa among representatives of the total cliff flora (TCh) and the flora of obligate chasmophytes (OCh).

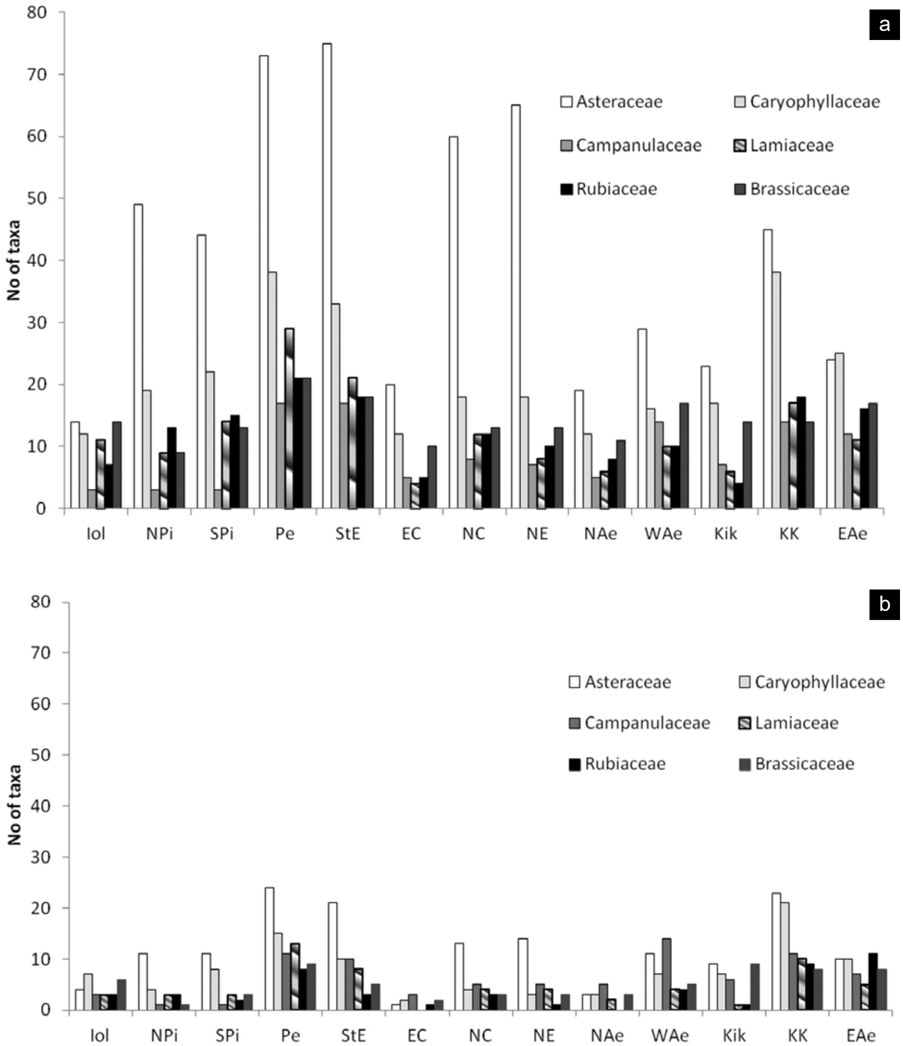


Figure 2. Taxon-richest families in the total cliff flora (TCh) (**a**) and the obligate chasmophytic flora (OCh) (**b**), and their representation in the 13 phytogeographical regions of Greece.

Occurring in all 13 regions of Greece and thus having a frequency rate (F) equal to 1, the most common TCh taxa number 27 taxonomic units (3.4%). On the other hand, most of the taxa of all subsets are registered in one of the phytogeographical regions and have an F value equal to 0.077 (Fig. 9). They represent 52.5% of TCh, 62.7% of OCh, 72% of endemic TCh, 76.1% of endemic OCh, 69.7% of range-restricted TCh, and 73.8% of range-restricted OCh.

Floristic similarity of the 13 phytogeographical regions of Greece was examined using hierarchical cluster analysis of TCh, OCh, total Greek endemics, endemic OCh, and range-restricted TCh and OCh taxa (Fig. 10). Dissimilarity among the different phytogeographical areas increases and is revealed when the analysis is conducted using endemic and range-restricted taxa. When endemic OCh taxa are examined (Fig. 10d), two groups of phytogeographical areas are formed. The first one includes the continental NC, EC, and NE phytogeographical areas and the insular areas EAe, WAe, Kik, and KK, while the second includes four continental phytogeographical areas (StE, Pe, NPi, and SPi) and IoI. When range-restricted OCh taxa are examined, there are three main groups (Fig. 10d-f). The first one is insular and includes EAe, WAe, Kik, and KK, the second includes five continental areas and IoI, and the third includes SPi, NC, and NAe. WAe - KK, Kik - EAe, NC – Nae, and EC - NE are grouped together in cluster analysis of OCh endemics, and the first three pairs are also grouped together in cluster analysis of range-restricted OCh taxa.

With respect to the question of protection status, 15 chasmophytic taxa mentioned in Annexes II, IV, and V of EEC Directive 92/43 (Council of Europe 1992) belong to the cliff flora. Ten of them are obligate chasmophytes and nine have a priority for protection. Eighteen taxa are included in the IUCN Red List of Threatened Species (IUCN 2016). Four of those taxa are critically endangered (CR), seven are vulnerable (VU), three are endangered (EN), eight are of least concern (LC), and one is considered as near threatened (NT). Seventy endemic chasmophytic taxa are included in Phitos *et al.* (1995; 2009a, b), of which seven are considered as critically endangered (CR), nine as endangered (EN), and 41 as vulnerable (VU).

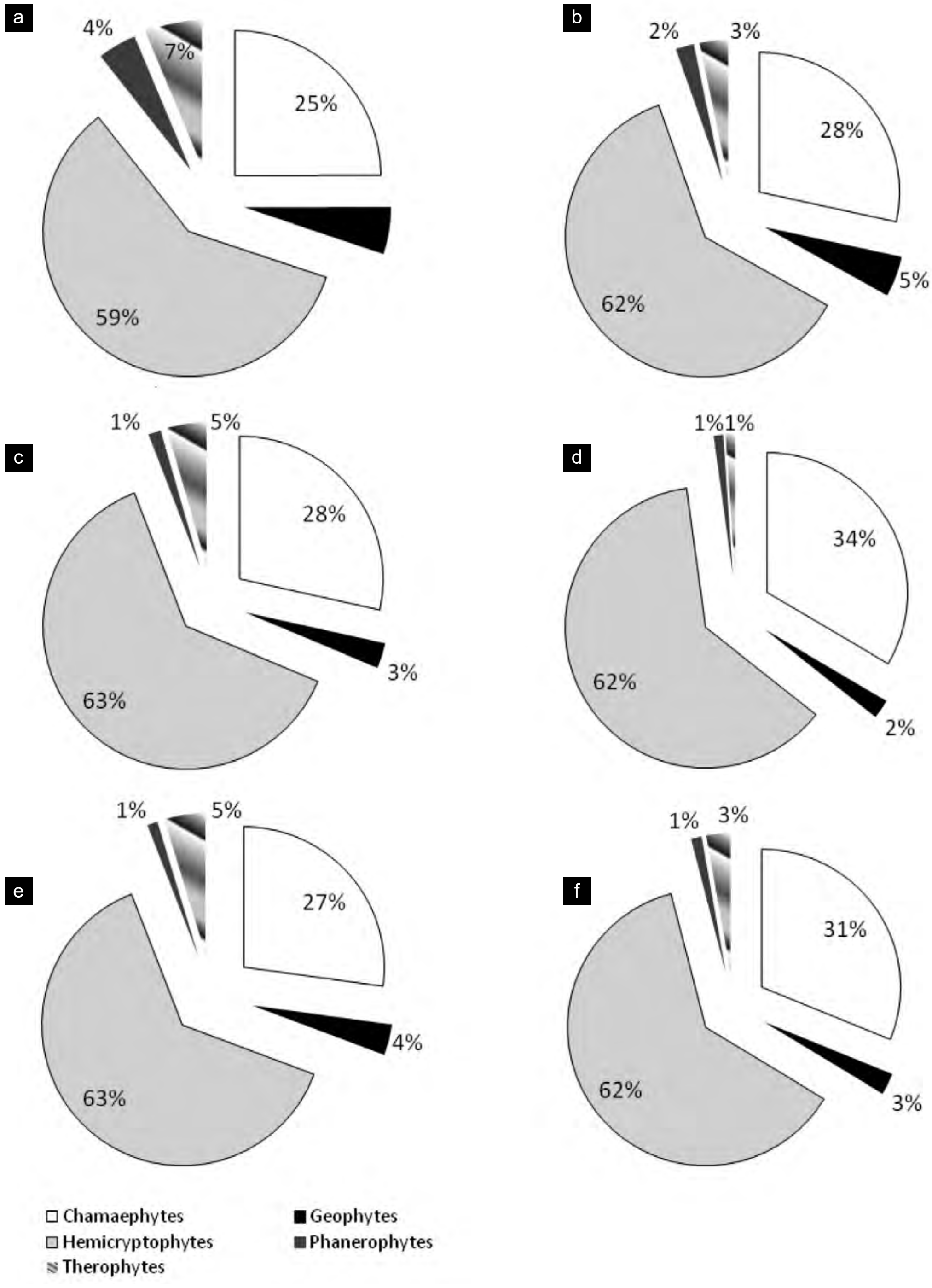


Figure 3. Life form spectrum of:taxa of the total cliff flora (TCh) **(a)**, obligate chasmophytic taxa (OCh) **(b)**, Greek endemics of TC **(c)** and OCh **(d)**, and range-restricted taxa of TCh **(e)** and OCh **(f)**.

DISCUSSION

Extreme for the majority of plants, cliffs have provided refuges for adequately specialised but weakly competitive species which have been eliminated elsewhere (Strid & Tan 1997). The occurrence of these rare species on cliffs reflects both their tolerance of harsh environmental conditions and their intolerance of human disturbance (Larson *et al.* 2000). Lavergne *et al.* (2003) concluded that in cliff and rocky habitats the factor limiting establishment and growth is not that there are not enough resources, but rather the very small number of micro-sites favourable for installation. Obligate chasmophytes are restricted to crevices or more or less

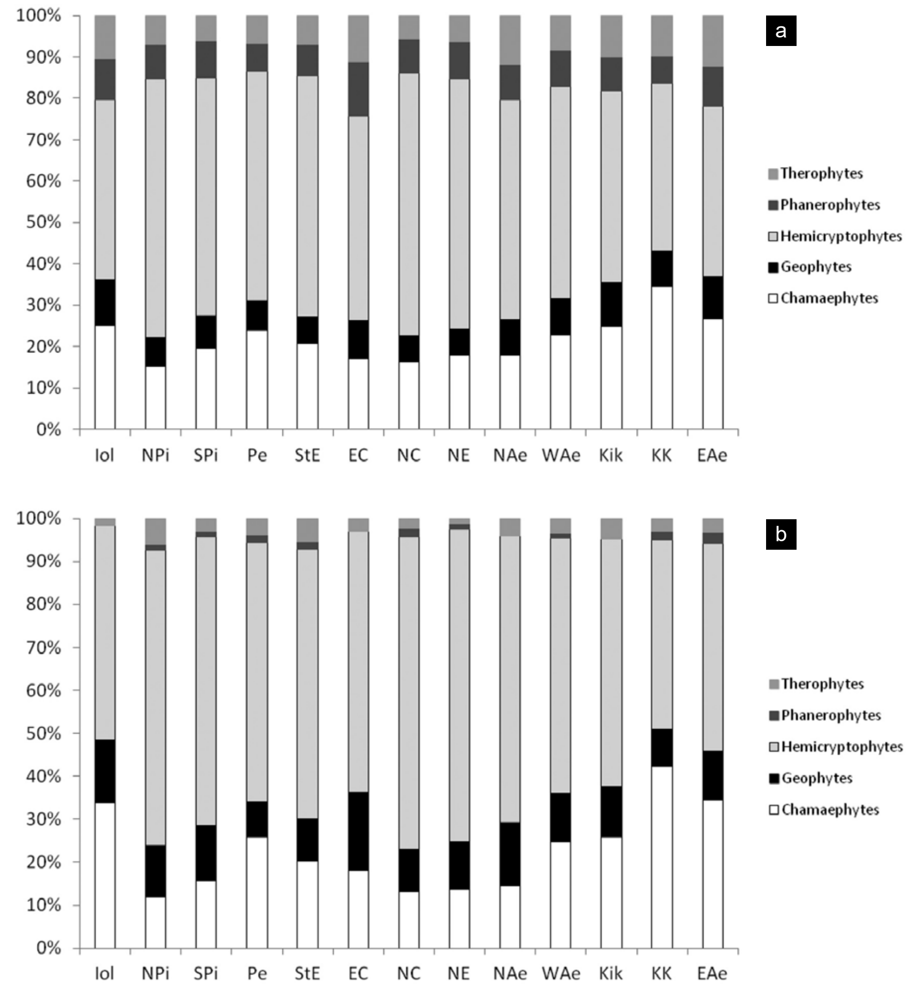


Figure 4. Percentages of different life form categories in the 13 phytogeographical regions of Greece: **a**) for taxa of the total cliff flora (TCh); **b**) for obligate chasmophytes (OCh).

vertical cliffs, whereas facultative chasmophytes may also invade road cuttings and phrygana communities (Strid & Tan 1997).

Specialist plants of cliffs represent a low proportion (9%) of the whole Greek flora (Dimopoulos *et al.* 2013), but considering the small areas occupied by cliffs, the chasmophytic flora is remarkably rich. Of the total cliff flora registered, 54% are obligate chasmophytic taxa, 54% are Greek endemics, and 64.3% are range-restricted taxa.

These results were expected since there is a close relationship between chasmophytic ecology and endemism, and the majority of endemic species are chasmophytes (Snogerup 1971; Kypriotakis & Tzanoudakis 2001; Cattaneo & Grano 2015; etc.). Chasmophytic plant communities are characterised by the participation of species of high biogeographical interest, as the number of endemic taxa is particularly important, while the degree of vegetation cover is always very weak. There is a strong ecological and biological differentiation between endemic and widely distributed taxa in the Mediterranean area, since endemic taxa occupy rocky habitats with steeper slopes, where edaphic constraints are severe and biotic interactions are reduced because of low vegetation cover and low diversity (Lavergne *et al.* 2004).

The families richest in endemic chasmophytes follow in general terms the pattern of families of the total Greek flora (as indicated by several floristic studies), with the exceptions of the families Poaceae and Fabaceae, which are among the richest and most diverse families in Greece, but which have a much lower representation in the endemic flora (Georghiou & Delipetrou 2010). Asteraceae has the highest representation in the endemic chasmophytic flora, although this is not usually the case with endemics (Stevanović *et al.* 2007; Georgiou & Delipetrou 2010). According to Wagenitz (1986) and Hellwig (2004), the Mediterranean Basin can be considered the centre of species diversity for the sub-tribe Centaureinae of Asteraceae. The Mediterranean Basin is considered a refugium for many of these species (Greuter1979), and several endemic taxa of *Centaurea* are very narrowly distributed in the region (Pisanu *et al.* 2011). About 14% (111 taxa) of the total cliff flora of Greece and 12.2% of the obligate chasmophytes are represented by the two genera *Centaurea* and *Hieracium*. These two

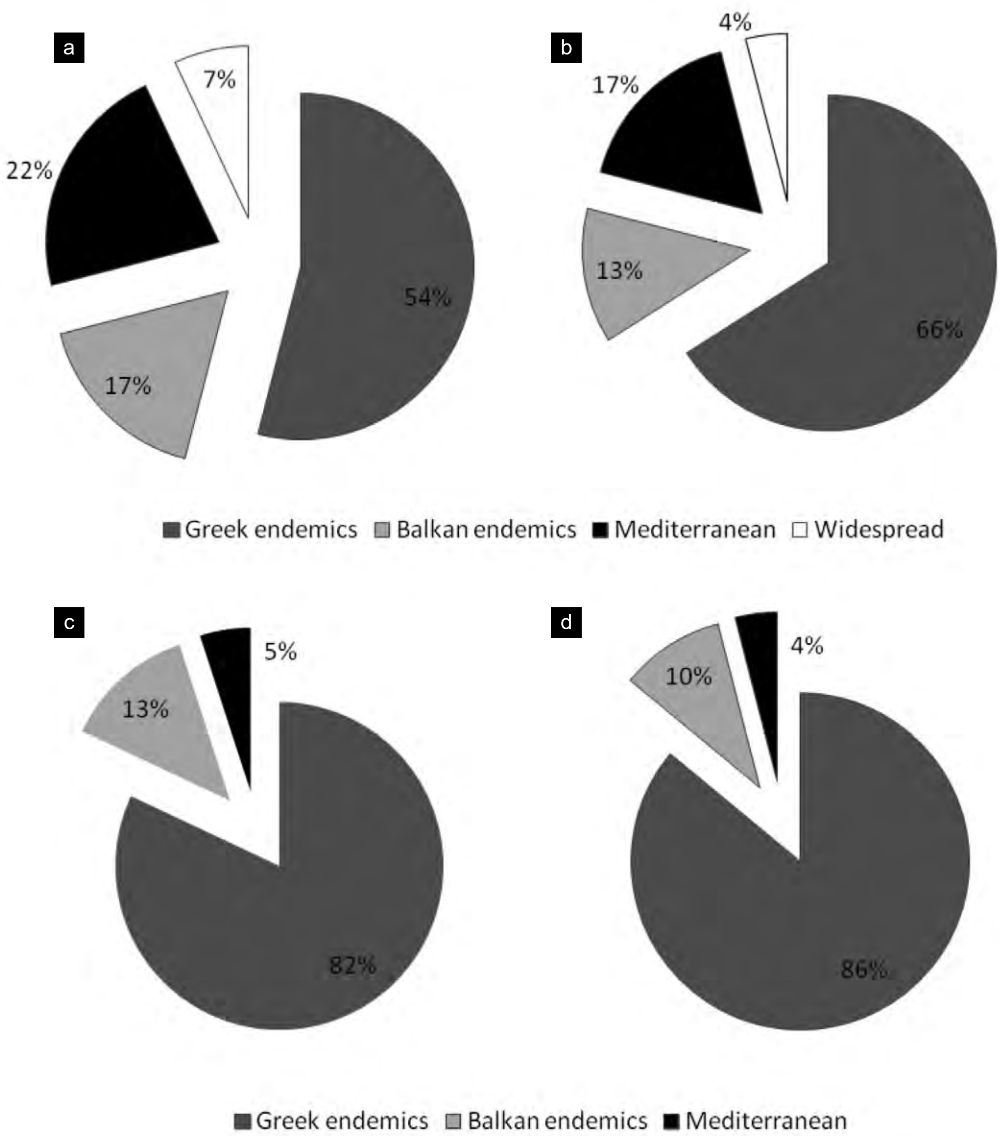


Figure 5. Chorological spectrum of the total cliff flora (TCh) (**a**), obligate chasmophytes (OCh) (**b**), range-restricted taxa of TCh (**c**), and range-restricted taxa of OCh (**d**).

genera represent 17.6% of the total endemic cliff flora of Greece and 16.4% of obligately chasmophytic Greek endemics.

Members of the family Caryophyllaceae show a high level of active endemism in Greece (Trigas *et al.* 2007), well reflecting past and present features of the area's phytogeography, since it represents a mixture of ancient taxa conserved mainly on the islands and in the high mountains in direct association with historical factors, and taxa of recent origin that continue their evolution in some cases, under the influence of adaptive radiation and genetic drift (Trigas *et al.* 2007; Augustinos *et al.* 2014). The family Campanulaceae presents the highest degree of endemism (49% of its taxa), and *Campanula* shows a high degree of species richness and endemism (Georgiou & Delipetrou 2010). Jones *et al.* (2017) focus on the

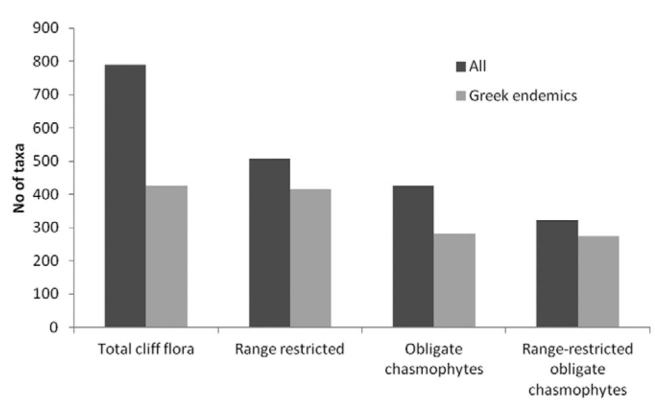
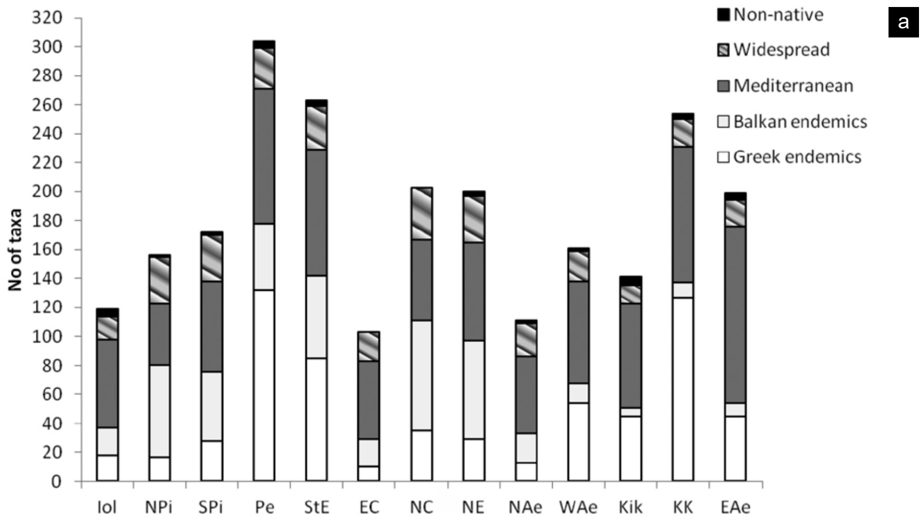


Figure 6. Number of Greek endemic taxa of the total cliff flora, among obligate chasmophytes, and among range-restricted taxa.



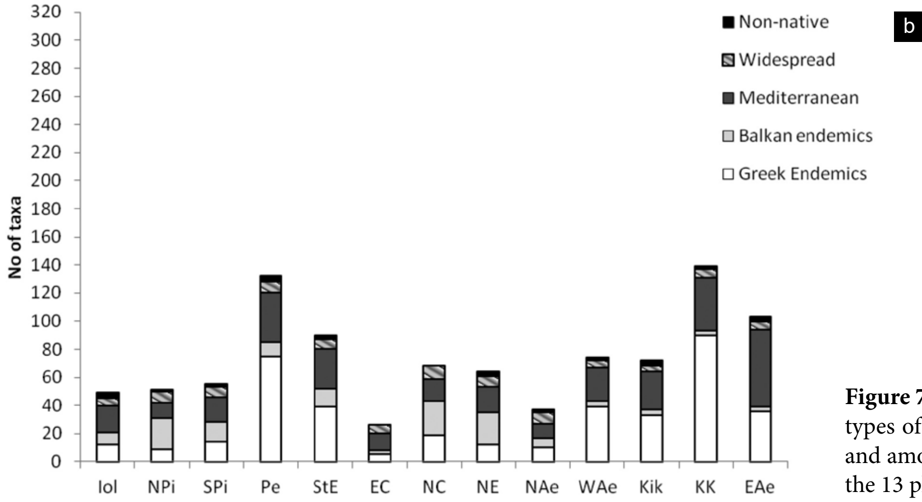


Figure 7. Representation of general chorological types of the total plant taxa recorded (TCh) (**a**) and among obligate chasmophytes (OCh) (**b**) in the 13 phytogeographical regions of Greece.

dynamic diversification history of *Campanula* and the inferred rate shifts in a geo-historical context. Cellinese *et al.* (2009) asserted that endemism is probably driven by loss of species on the mainland after island isolation and surmised that several Cretan endemic Campanulaceae species may have been more widespread in the past, but are now restricted to often inaccessible areas such as cliffs, probably as a result of human pressure.

Life form is an important functional attribute of investigated endemic species (Georghiou & Delipetrou 2010), and this is confirmed by the dominance of hemicryptophytes and chamaephytes in TC and OC endemics. Kypriotakis (1998), Kypriotakis & Tzanoudakis (2001), Tzanoudakis *et al.* (2006), and Tsakiri *et al.* (2016) also showed that most of the endemic plants are chamaephytes and hemicryptophytes scattered on numerous steep calcareous cliffs and in crevices. Having in mind the extreme conditions prevailing on cliffs, Georghiou & Delipetrou (2010) speculated that the taproots and ligneous underground or slightly aboveground parts of hemicryptophytes and chamaephytes may effectively enable them to withstand wind blowdowns and help in their recovery from such events.

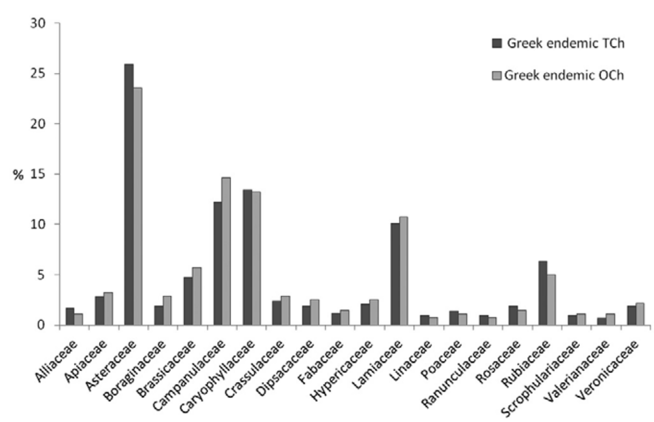


Figure 8. Percentages of Greek endemic taxa in the taxon-richest families of the total cliff flora (TCh) and among obligate chasmophytes (OCh).

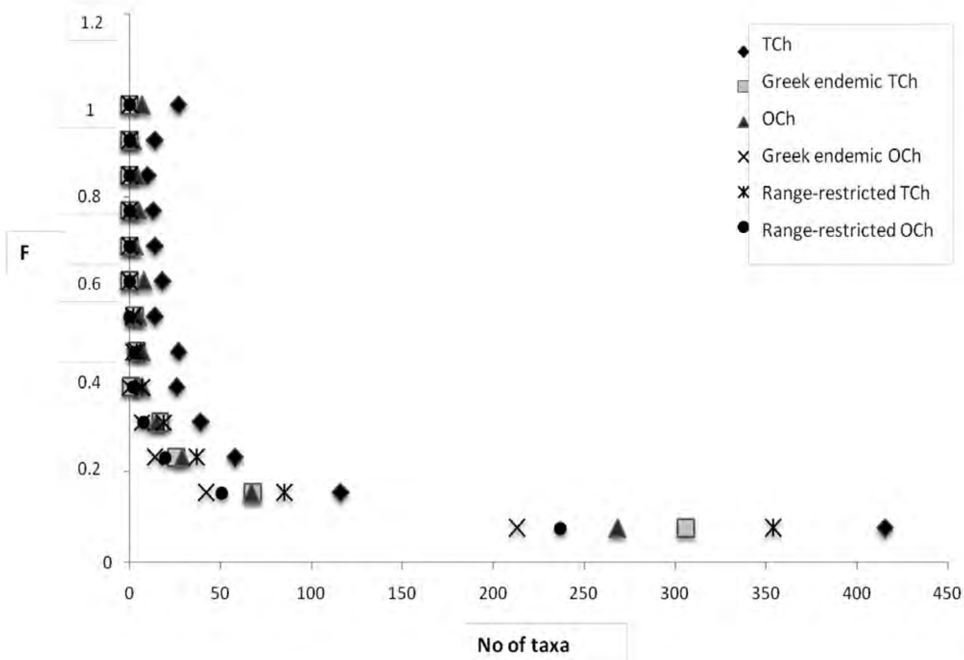


Figure 9. Frequency of presence (F) of all taxa, endemic taxa, and range-restricted (RR) taxa of the total cliff flora (TCh) and among obligate chasmophytes (OCh) in the 13 phytogeographical regions of Greece.

Cattaneo & Grano (2015, 2016) and Sarika *et al.* (2016) studied aspects of the chasmophytic flora and vegetation of some Aegean islands, focusing on chasmophytic species endemic to the Aegean district, which in most cases are also rare and often characterised by quite restricted areas of distribution. The distribution of endemics is characterised by a high frequency of narrowly distributed species and by a north-to-south and a west-to-east increase of local endemism (Strid 1986; Georghiou & Delipetrou 2010).

The most prominent features of endemic and range-restricted obligate chasmophytes are as follows: (1) in the case of endemic obligate chasmophytes, there is great affinity between the continental phytogeographical areas StE, Pe, NPi, and SPi together with the neighbouring IoI insular area,, as well as between all insular Aegean areas together with the Cretan area and between the continental areas NE, EC, and NC; and (2) in the case of the endemic and range-restricted taxa of TC, all Aegean insular phytogeographical areas (except the NAe area for range-restricted taxa) are grouped together and all continental phytogeographical areas constitute a second group together with IoI.

Stevanović *et al.* (2007) showed the strong phytogeographical connection of StE to Pe, SPi and NPi. In so doing, they focused on the large number of endemic taxa from the mountains of Peloponnesus (Pe) and the S and N Pindus Mountains (SPi and NPi) that have their northern and southern distribution limits, respectively, in the area of the mountainous region of Parnassos and Giona (StE). For this reason and additionally for the high number of local endemics, Stevanović *et al.* (2007) characterised the central StE as a hotspot of endemism in the whole of Europe. Petrova & Vladimirov (2010) mentioned the high number of Balkan endemics (194) shared by Greece and Bulgaria. According to our results, 98 of them are included in the total cliff flora (TCh) of Greece and 41 are obligate chasmophytes (OCh).

Since higher-elevation areas on islands and continental mountains are separated by long distances, topography-driven isolation increases speciation rates in mountainous areas across all elevations and results in the globally consistent pattern of higher endemism at higher elevations (Steinbauer *et al.* 2016). Insularity and mountainous terrain play a key role in the presence of endemic plants (Georghiou & Delipetrou 2010), and this correlation is stronger when chasmophytic ecology is also considered (Snogerup 1971; Kypriotakis & Tzanoudakis 2001; Cattaneo & Grano 2015, 2016). Trigas *et al.* (2013) discussed elevational patterns governing the species richness of endemic vascular plants on the long-isolated continental island of Crete (belonging to the KK phytogeographical area), which has experienced extensive post-isolation mountain uplift. Trigas & Iatrou (2006) mentioned edaphic endemism, since the majority of local endemic taxa on the island of Evvia (belonging to the StE phytogeographical area) are exclusively distributed on limestone. They showed that the patterns of altitudinal distribution of endemic species on Evvia Island and on Peloponnesus (Pe) (Iatrou 1986; Tan & Iatrou 2001) are similar. Trigas *et al.* (2012) also focused on the importance of plants endemic to Peloponnesus (Pe) [of which 56.8% (75 taxa) are obligate chasmophytes (OCh) and 43.4% (132 taxa) belong to the total cliff flora (TCh)] for conservation of the Mediterranean and European floras. The great

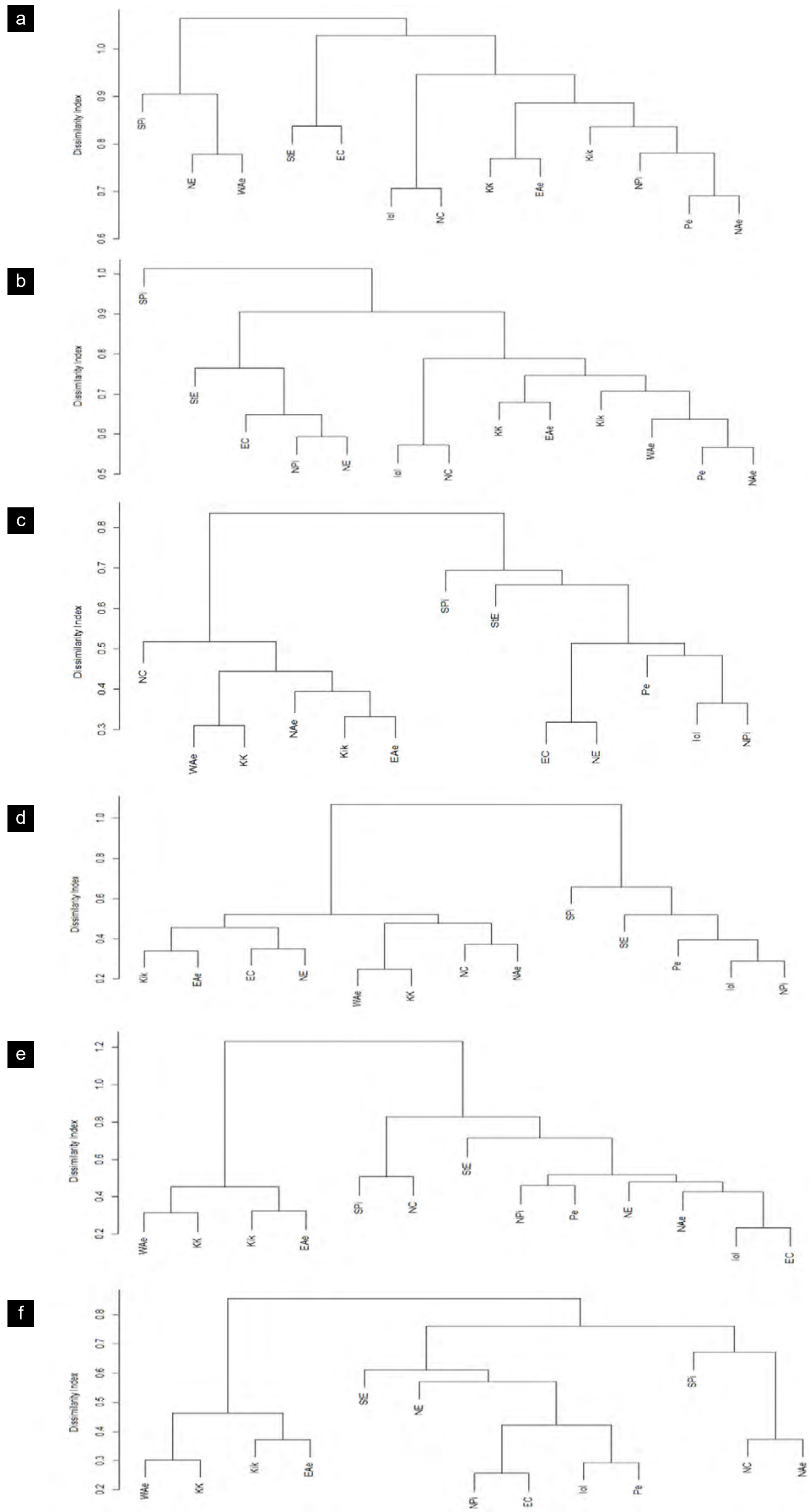


Figure 10. Hierarchical cluster analysis of the total cliff flora (TCh) (**a**), obligate chasmophytic taxa (OCh) (**b**), endemics of TCh (**c**), endemics of OCh (**d**), range-restricted taxa of TCh (**e**), and range-restricted taxa of OCh (**f**).

biogeographical importance of the above-mentioned areas is underlined by the characterisation of Central and Southern Greece (StE and Pe) and the island of Crete (the main part of the KK phytogeographical area) as two of 10 hotspots based on plant endemism and richness of the Mediterranean region (Medail & Quezel 1997, 1999).

Rare species increase the potential breadth of ecosystem functions across spatial scales (Mouillot *et al.* 2013), so in the light of climate change and increasing human interference detailed research needs to be continued in order to understand the importance of rarity for vulnerability in ecosystem structure and functions.

CONCLUSIONS

The Greek chasmophytic flora is very rich in endemic plant taxa, most of which are range-restricted. Our results underline the remarkable correlation between endemism and chasmophytic ecology. A complete knowledge of the distribution of rare chasmophytes, their adaptations to extreme environmental conditions, their functional traits, their specialised ecological preferences, and their specific habitats could constitute the basis for effective planning of measures aiming to ensure conservation of their populations, on a local level at first and then on a national or higher level. It is important to focus on the ecology of populations of rare plants, examine in detail the factors determining their conservation in situ, and in this way confront the effects of global changes.

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Botanica SERBICA

REZIME

Diverzitet hazmofita u vaskularnoj flori Grčke: florističke analize i fitogeografski obrasci

Maria Panitsa i Anna Kontopanou

Litice spadaju u okruženja sa najnepovoljnijim uslovima za žive organizme usled ograničene dostupnosti zemljišta, vlage, hranljivih materija i nepovoljne izloženosti. One predstavljaju skloništa retkih, endemičnih, kao i biljaka ograničenih areala. Glavna baza podataka je pripremljena tako da uključuje vaskularne biljke koje su obligatne ili fakultativne hazmofite, i sadrži podatke o njihovim životnim formama, horologiji, statusu zaštite. Takođe, ona sadrži podatke o njihovoj distribuciji u okviru više od 135 litica, kanjona ili otvorenih kamenjara, kao i njihovoj geografskoj distribuciji unutar 13 fitogeografskih regiona Grčke, na osnovu dostupne florističko-vegetacijske literature i autorskih kolekcija i zapažanja. Urađene su analize ukupnog diverziteta flore litica, obligatnih hazmofitskih biljnih vrsta, endemita i vrsta ograničenog rasprostranjenja, kao i studija obrazaca distribucije različitih podgrupa biljnih vrsta u različitim fitogeografskim regionima Grčke. Hemikriptofite i hamefite predstavljaju dominatne životne forme među analiziranim hazmofitama. U okviru 935 konstatovanih taksona ranga vrste i podvrste, 476 su hazmofite, među kojima se nalazi većina grčkih endemita. Hijerarhijska klaster analiza različitih podgrupa biljnih vrsta pokazali su afinitet flore litica ka različitim fitogeografskim regionima. Dodatno, 15 hazmofitskih taksona koji se nalaze u Aneksima II, IV i V Direktive 92/43/ EEC, pripadaju flori litica, od čega su njih 10 obligatne hazmofite i 9 imaju prioritet zaštite. Osamnaest taksona je uključeno u IUCN Crvenu listu ugroženih vrsta, od čega su 4 kritično ugrožene (CR), 7 je osetljivo (VU) i 3 su ugrožene (EN). Upadljiva povezanost između endemizma i hazmofitske ekologije je naglašena, s obzirom da detaljno razumevanje lokalne distribucije i specifičnih staništa retkih vrsta pružaju mogućnost za zaštitu na lokalnom nivou, što može uticati na zaštitu biodiverziteta na višem nivou.

Ključne reči: flora litica, hazmofite, endemični taksoni, taksoni ograničenog rasprostranjenja, vaskularne biljke.