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Abstract

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The local endemic element in the flora of the W Aegean island of Evvia comprises 39 taxa (2.1 % of an estimated total of 1833 taxa). The three centres of endemism on the island are the ophiolitic areas of N Evvia, Mt Dirphis in central Evvia and Mt Ochi and the Cape Kafireas area in S Evvia. The majority of the endemic taxa inhabit limestone and ophiolitic habitats. Schizoendemics (80.8 %) form the largest category, followed by apoendemics (11.5 %) and palaeoendemics (7.7 %). Taxonomical comments on selected taxa are provided. The chromosome number of ten taxa is given for the first time.

Key words: island biogeography, taxonomy, vascular plants, serpentine, chromosome numbers.

Introduction

The Aegean area is an important centre of Mediterranean plant endemism, floristically pioneered by Rechinger (1943, 1944, 1949). In the W Aegean, the flora of the island of Evvia was studied in detail (Rechinger 1961, partly based on Phitos 1960). Much floristic and biosystematic work has subsequently been carried out in Evvia and adjacent regions (e.g. Künkele & Paysan 1981, Akeroyd & Preston 1987, Boratyński & al. 1988, Trigas & Iatrou 2000) and many taxa have been described from the island in the last decades (Phitos 1964, 1965, 1981, Ehrendorfer & Schönbeck-Temesy 1975, Georgiadis 1980, Phitos & Georgiadis 1981, Phitos & Tzanoudakis 1981, Papanikolaou & Kokkini 1982, Tiniakou 1991, Brullo & al. 1997, 2003, Trigas & Tzanoudakis 2000, Trigas & Iatrou 2003, 2005). Endemism in the local flora was analysed by the first author only recently (Trigas 2003). Actually, 1833 taxa (species and subspecies) are known to occur in Evvia. The Greek endemic element includes 178 taxa (9.7 %). Of these, 39 taxa (2.1 % of the total flora) are island endemics of Evvia, discussed in the present paper as to their taxonomy, estimated origin and evolution. For topographical, geological, climatic and edaphic properties of the investigated area (Fig. 1) the reader is referred to Rechinger (1961), Trigas & Iatrou (2000) and Trigas (2003), for paleogeography in particular to Creutzburg (1966), Greuter (1970), Dermitzakis (1990) and Andel & Tzedakis (1996).



Fig. 1. Topographic map of Evvia with the northern (EN), central (EC) and southern (ES) divisions according to Rechingher (1961).

Material and methods

This paper is based on field studies carried out from 1995 to 2003, studies of herbarium specimens (ATH, C, UPA, W), and evaluation of the literature. The collection of plant material and field observations were made in different seasons of the year to fully cover different altitudinal belts and representative types of habitats. Nomenclature follows Tutin & al. (1968-80, 1993), Greuter & al. (1984-89), Strid (1986) and Strid & Tan (1991, 1997, 2002). The classification by cytotaxonomic criteria of the local endemic taxa of Evvia follows Favarger & Contandriopoulos (1961). The karyological studies are based on material collected in nature and cultivated in pots outdoors in the experimental botanical garden of the University of Patras (for laboratory methods applied, see Trigas & Iatrou 2005).

Results and discussion

The endemic flora of Evvia consists of 39 taxa (32 species and 7 subspecies; Table 1) in 14 families and 23 genera. Highly diverse genera with many endemics in the Greek flora (e.g., *Allium*, *Centaurea*, *Silene*, *Verbascum*, *Viola*) are also represented in the endemic flora of Evvia. The chromosome number is known for 27 taxa but not yet studied in the remaining 11 taxa. Of the endemic taxa of Evvia 20 are chamaephytes, 12 hemicryptophytes, 5 geophytes (*Allium* spp., *Geocaryum euboicum*), 1 therophyte (*Ammi topalii*), and 1 phanerophyte (*Quercus trojana* subsp. *euboica*). When referring to age of taxa and times of speciation processes, either taken from liter-

ature or derived from own observations, the present authors are aware of the fact that conclusive evaluations may point towards plausibilities rather than proved evidence.

1. Geographical distribution of the endemics

The local endemic taxa of Evvia are not evenly distributed. The highest concentration is observed in central Evvia (21 taxa), followed by N Evvia (18 taxa) and S Evvia (9 taxa). Three centers of endemism can be observed:

a) The ophiolitic regions of N Evvia with 12 local endemics; eight exclusively on serpentine and four on both serpentine and limestone at low altitudes, plus six on limestone or on calcareous quaternary sediments at higher altitudes of Mt Kandili and its surroundings.

b) Mt Dirphis and the nearby mountainous areas of central Evvia with 18 local endemics; ten at medium and higher altitudes, five (*Allium dirphianum*, *Asperula suffruticosa*, *Cruciata taurica* subsp. *euboea*, *Minuartia dirphya*, *Silene dirphya*) restricted to the highest peak (Delphi) of Mt Dirphis, plus three (*Allium calamarophilon*, *Campanula cymaea*, *Ammi topalii*) at low altitudes and along the coast.

c) Mt Ochi (five taxa at medium and high altitudes) and Cape Kafiareas in S Evvia (four taxa at low altitude, partly coastal).

Most (i.e. 30) of the insular endemics of Evvia occur in only one of the three geographical divisions of the island (Fig. 1). Twelve taxa are confined to N Evvia, twelve to central Evvia and six to S Evvia. The distribution of these taxa is limited to very small areas on the mountains or in the lowland. The remaining nine endemics are distributed in two of the three geographical divisions, none expanding from N through S Evvia.

As many as 26 of the insular endemics of Evvia are lowland taxa occurring below 1000 m, eight taxa grow only above 1000 m and 5 taxa are distributed over both altitudinal ranges. A similar altitudinal distribution pattern has been observed in the endemic flora of Peloponnisos (Iatrou 1986, Tan & Iatrou 2001).

2. Edaphic endemism – distribution according to substrate

The strong link of taxa to a specific geological substrate is one of the most important characteristics of the endemic flora of Evvia. The majority of the local endemic taxa (17 taxa or 43.6 %) are exclusively distributed on limestone, viz. *Allium dirphianum*, *A. calamarophilon*, *Asperula euboea*, *A. suffruticosa*, *Campanula constantini*, *C. cymaea*, *Chaerophyllum euboicum*, *Cruciata taurica* subsp. *euboea*, *Geocaryum euboicum*, *Hypericum fragile*, *Linum goulimy*, *Nepeta argolica* subsp. *dirphya*, *Senecio eubaeus*, *Silene dirphya*, *Verbascum euboicum*, *Verbascum zuccarini*, *Viola dirphya*. Nine local endemics (23.1%) grow exclusively on ultramafic rock (serpentine), viz. *Alyssum euboicum*, *Asperula ophiolithica*, *Centaurea ebenoides*, *C. euboica* subsp. *euboica*, *C. euboica* subsp. *intermedia*, *C. mantoudii*, *Minuartia dirphya*, *Quercus trojana* subsp. *euboica*, *Silene oligantha* subsp. *pseudoradicosa*. Four local endemics grow equally well on serpentine and limestone (*Alyssum densistellatum*, *Bolanthus intermedius*, *Campanula goulimy*, *Scutellaria goulimy*), another four occur exclusively on schist in S Evvia (*Allium karistanum*, *A. runemarkii*, *Armeria johnsenii*, *Campanula celsii* subsp. *carystea*). *Sideritis euboea* and *Viola euboea* grow on both limestone and schist. *Inula subfloccosa* is confined to cipolin and marbles, whereas *Asperula brachyphylla* grows on both schist and cipolin. Finally one species, *Ammi topalii*, inhabits coastal sands.

The influence of serpentines in speciation processes in plants is well known (Kruckeberg 1951, 1954, 1967, Proctor & Woodell 1975). The serpentines of Evvia, concentrated in the north while being only scattered in the central and southern divisions, are of special interest in terms of phytogeography, in particular with respect to their position at the southeastern periphery of the whole system of serpentine areas in the Balkans, and their insular isolation. The serpentine areas of the Balkan Peninsula represent an ancient core of speciation and act likewise as an important refugial habitat for relict elements. Numerous relict and endemic taxa on various taxonomic levels, predominantly or facultatively found on serpentine, support this view (Stevanović & al.

Table 1. The endemic vascular plant taxa of Evvia, with geographical distribution in the three geographical divisions of Evvia as defined in Fig. 1, altitudinal range, substrate preference and chromosome number. Previously unpublished chromosome numbers are marked with an asterisk.

Taxon	EN	EC	ES	Altitude (m)	Substrate	2n
<i>Allium diriphanium</i> Brullo & al.		+		1400-1500	Limestone	32
<i>A. calamarophilum</i> Phitos & Tzanoud.		+		20-30	Limestone	16
<i>A. karistanum</i> Brullo & al.			+	5-30	Schist	16
<i>A. runemarkii</i> Trigas & Tzanoud.			+	5-20	Schist	16
<i>Alyssum densistellatum</i> T. R. Dudley	+	+		50-700	Limestone-Ophiolite	-
<i>A. euboicum</i> Halácsy	+	+		30-600	Ophiolite	16
<i>Ammi topalii</i> Beauverd		+		0-20	? Sand	-
<i>Armeria johnsenii</i> Papan. & Kokkini			+	5-20	Schist	18*
<i>Asperula brachyphylla</i> Trigas & Iatrou			+	1100-1300	Schist-Cipolin	-
<i>A. euboica</i> (Ehrend.) Trigas		+	+	300-800	Limestone	22*
<i>A. ophiolithica</i> Ehrend.	+			50-450	Ophiolite	44*
<i>A. suffruticosa</i> Boiss. & Heldr.		+		1000-1700	Limestone	44*
<i>Bolanthus intermedius</i> Phitos	+			0-50	Limestone-Ophiolite	-
<i>Campanula celsii</i> subsp. <i>carystea</i> Phitos			+	0-600	Schist	34*
<i>C. constantini</i> Beauverd & Topali		+		450-1600	Limestone	34
<i>C. cymaea</i> Phitos		+		0-750	Limestone	34
<i>C. goulimyi</i> Turrill	+			0-450	Limestone-Ophiolite	34
<i>Centaurea ebenoides</i> Heldr.	+			0-700	Ophiolite	20
<i>C. euboica</i> Rech. f. subsp. <i>euboica</i>	+			200-700	Ophiolite	22
<i>C. euboica</i> subsp. <i>intermedia</i> Phitos & Georgiadis	+			200-700	Ophiolite	22
<i>C. mantoudii</i> Georgiadis	+			30-400	Ophiolite	36
<i>Chaerophyllum euboicum</i> Halácsy		+		1000-1200	Limestone	-
<i>Cruciata taurica</i> subsp. <i>euboica</i> (Ehrend.) Ehrend.		+		1000-1700	Limestone	-
<i>Geocaryum euboicum</i> (Rech. f.) Engstrand	+			600-1200	Limestone	-
<i>Hypericum fragile</i> Boiss..	+	+		0-500	Limestone	18*
<i>Inula subfloccosa</i> Rech. f.			+	150-600	Cipolin	16 (+0-1B)*
<i>Linum goulimyi</i> Rech. f.	+			200-400	Limestone	-
<i>Minuartia dirphyia</i> Trigas & Iatrou		+		900-1000	Ophiolite	26
<i>Nepeta argolica</i> subsp. <i>dirphyia</i> (Boiss.) Strid & Kit Tan		+		400-1600	Limestone	16
<i>Quercus trojana</i> subsp. <i>euboica</i> (Papaioannou) K. I. Chr.	+			100-600	Ophiolite	-
<i>Scutellaria goulimyi</i> Rech. f.	+			250-700	Limestone-Ophiolite	34
<i>Senecio eubaeus</i> Boiss. & Heldr.	+	+		1000-1400	Limestone	40*
<i>Sideritis euboica</i> Heldr.		+	+	600-1700	Limestone-Schist	32*
<i>Silene dirphyia</i> Greuter & Burdet		+		1550-1740	Limestone	24*
<i>S. oligantha</i> subsp. <i>pseudoradicosa</i> (Rech. f.) Greuter	+			50-700	Ophiolite	24
<i>Verbascum euboicum</i> Murb. & Rech. f.	+	+		400-900	Limestone	-
<i>V. zuccarinii</i> (Boiss.) I. K. Ferguson	+			50-400	Limestone	-
<i>Viola dirphyia</i> Tiniakou		+		1000-1300	Limestone	40
<i>V. euboica</i> (Halácsy) Halácsy		+	+	800-1700	Limestone-Schist	40

2003). Of the local serpentine endemics of Evvia, four taxa belong to the genus *Centaurea* and two to *Alyssum*. Both genera are among the richest in obligate serpentine endemics in the Balkan Peninsula (Stevanović & al. 2003). The endemism related to ultramafic substrate on Evvia exhibits a mixture of evolutionary recent and older taxa which can be grouped into certain categories with respect to their origin (see also Table 2).

The first category includes endemics the taxonomic relatives of which are distributed in adjacent non-ophiolitic (usually calcareous) areas (*Centaurea euboica*, *C. mantoudii*, *Quercus trojana* subsp. *euboica*, *Silene oligantha* subsp. *pseudoradicosa*). *Alyssum densistellatum*, *Bolanthus intermedius* and *Scutellaria goulimyi* which grow on both ophiolite and limestone also belong here. This category is considered to include neoendemics and may represent the result of adaptation of older populations to the special ecological conditions of the ophiolitic substrate. Their differentiation probably took place in recent geological eras or may still be in progress.

The second category includes serpentine taxa the relatives of which are distributed quite far away, mostly in northern regions. *Centaurea ebenoides* and *Campanula goulimyi* belong here, the latter growing on both ophiolitic and calcareous substrates. These taxa seem to have reached Evvia from the north, probably during colder periods.

The third category includes taxa that are taxonomically isolated, or their relatives geographically disjunct, such as *Alyssum euboicum*, *Asperula ophiolithica* and *Minuartia dirphyia*. Given the palaeogeography of the region, they seem to have evolved in the distant past, at least during Pliocene. The ophiolitic areas of Evvia, apart from contributing to the evolution of new taxa,

Table 2. Classification of the local endemic taxa of Evvia into categories using cytotoxic criteria, including corresponding relatives with their distribution ranges. S = schizoendemic, P = palaeoendemic, A = apoendemic; after Favarger & Contandriopoulos (1961).

Taxon	Category	Corresponding relatives	Distribution range of relatives
<i>Allium calamarophilon</i>	S	<i>A. thessalicum</i> <i>A. erythraeum</i> <i>A. runemarkii</i>	Thessalia, Is. Sciathos Chalkidiki S Evvia
<i>A. dirphianum</i>	–	<i>A. savii</i>	Mediterranean
<i>A. karistanum</i>	S	<i>A. peroninianum</i> <i>A. callidictyon</i> <i>A. pentadactyli</i> <i>A. greuteri</i>	SW Anatolia E & C Anatolia, Iran S Italy Cyrenaica
<i>A. runemarkii</i>	S	<i>A. thessalicum</i> <i>A. erythraeum</i> <i>A. calamarophilon</i>	Thessalia, Is. Sciathos Chalkidiki C Evvia
<i>Alyssum densistellatum</i>	–	<i>A. montanum</i> subsp. <i>montanum</i>	E Europe, W Asia
<i>A. euboicum</i>	P	– [isolated]	–
<i>Ammi topalii</i>	–	<i>A. majus</i>	Mediterranean
<i>Armeria johnsenii</i>	S	<i>A. canescens</i> <i>A. abbreviata</i>	C & E Mediterranean Is. Naxos, Is. Amorgos
<i>Asperula brachyphylla</i>	–	<i>A. pinifolia</i> <i>A. nitida</i> s.l.	Stereia Ellas, S Pindos Anatolia, Is. Lesvos
<i>A. euboica</i>	S	<i>A. mungieri</i> <i>A. lutea</i>	S Peloponnisos Stereia Ellas, N Peloponnisos
<i>A. ophiolithica</i>	–	<i>A. tenuifolia</i>	SW Anatolia, Is. Samos
<i>A. suffruticosa</i>	–	<i>A. suberosa</i> <i>A. idaea</i>	Mt. Athos Kriti
<i>Bolanthus intermedius</i>	–	<i>B. graecus</i> <i>B. thymifolius</i>	E Sterea Ellas, Evvia, Is. Naxos E Sterea Ellas, Evvia, E Thessalia, N Greece
<i>Campanula celsii</i> subsp. <i>carystea</i>	S	<i>C. celsii</i> aggr.	S Greece, W Aegean, Mt Athos
<i>C. cymaea</i>	S	<i>C. rupestris</i> aggr.	Thessalia, Sterea Ellas, W Aegean
<i>C. constantini</i>	S	<i>C. rupestris</i> aggr.	Thessalia, Sterea Ellas, W Aegean
<i>C. goulimyii</i>	S	<i>C. celsii</i> aggr.	S Greece, W Aegean, Mt Athos
<i>Centaurea ehenoides</i>	S	<i>C. immanuelis-loewii</i> <i>C. grhavacensis</i>	Bulgaria, N Greece Yugoslavia, N Greece
<i>C. euboica</i>	S	<i>C. achaia</i> <i>C. corinthiaca</i> <i>C. aetolica</i>	Peloponnisos, E Sterea Ellas, Thessalia NE Peloponnisos W Sterea Ellas
<i>C. mantoudii</i>	A	<i>C. pelia</i>	Stereia Ellas, Thessalia, NE Greece
<i>Chaerophyllum euboicum</i>	–	<i>C. aromaticum</i>	C & E Europe, Balkan Peninsula
<i>Cruciata taurica</i> subsp. <i>euboica</i>	–	<i>C. taurica</i> s.l.	Is. Samos, Anatolia to Iran, Caucasus
<i>Geocaryum euboicum</i>	–	<i>G. divaricatum</i> <i>G. parnassicum</i>	Mt Killini Peloponnisos, Sterea Ellas, N Evvia
<i>Hypericum fragile</i>	S	<i>H. taygeteum</i>	Mt Taygetos
<i>Inula subfloccosa</i>	S	<i>I. verbascofolia</i> subsp. <i>methanea</i> <i>I. verbascofolia</i> subsp. <i>parnassica</i>	E Peloponnisos, Attica N Peloponnisos, Sterea Ellas, N Evvia
<i>Linum goulimyii</i>	–	<i>L. leucanthum</i> <i>L. gyaricum</i> <i>L. phitosianum</i>	E Sterea Ellas, C Evvia Is. Yioura, Is. Ikaria S Peloponnisos
<i>Mimuartia dirphyia</i>	S	<i>M. wettsteinii</i> <i>M. parnonia</i>	E Kriti Mt Parnon
<i>Nepeta argolica</i> subsp. <i>dirphyia</i>	S	<i>N. argolica</i> subsp. <i>argolica</i> <i>N. argolica</i> subsp. <i>malacotrichos</i> <i>N. argolica</i> subsp. <i>vourinensis</i>	NE Peloponnisos, E Sterea Ellas N Greece N Greece
<i>Quercus trojana</i> subsp. <i>euboica</i>	?S	<i>Q. trojana</i> subsp. <i>trojana</i>	S Italy, Balkan Peninsula, Anatolia
<i>Scutellaria goulimyii</i>	S	<i>S. albida</i> s.l.	N Italy to Iran
<i>Senecio eubaeus</i>	S	<i>S. macedonicus</i> <i>S. castagneanus</i>	Balkan Peninsula Turkey, W & S Anatolia
<i>Sideritis euboica</i>	S	<i>S. syriaca</i> <i>S. raeseri</i>	Italy to Anatolia, Crimea and Amanus Balkan Peninsula
<i>Silene dirphyia</i>	S	<i>S. saxifraga</i>	S Europe
<i>S. oligantha</i> subsp. <i>pseudoradicosa</i>	S	<i>S. oligantha</i> subsp. <i>oligantha</i> <i>S. oligantha</i> subsp. <i>parnesia</i>	Mt Olimbos Mt Parnis
<i>Verbascum euboicum</i>	–	<i>V. epixanthinum</i> <i>V. apentulium</i>	Peloponnisos, Sterea Ellas, N & S Pindos, Evvia E Thessalia
<i>V. zuccarinii</i>	P	– [isolated]	–
<i>Viola dirphyia</i>	A	<i>V. reichenbachiana</i>	Europe, NW Africa, SW Asia
<i>V. euboica</i>	A	<i>V. cephalonica</i> <i>V. athois</i> <i>V. graeca</i> aggr.	Is. Kephallinia Mt Athos Continental Greece

may have permitted the conservation and survival of some relicts, which have become extinct in adjacent, non-ophiolitic regions.

The serpentinophytes of Evvia show intense phytogeographical connections with the neighbouring ophiolitic regions of adjacent continental Greece. Several serpentine endemics are distributed to the serpentine areas of northern Evvia, eastern Sterea Ellas and/or eastern Central Greece (e.g. *Allium euboicum*, *Daphne euboica*, *Ferulago serpentinica*, *Onosma euboica*, *Scorzonera serpentinica*). The phytogeographical connection with the extensive ophiolitic regions of N Greece is evidently weaker.

Besides ophiolitic substrate the presence of marble and cipolin strips within the extensive schist areas of S Evvia is as well a case of ecological isolation concerning *Inula subfloccosa* and *Stachys euboica* (the latter, considered endemic to S Evvia, has recently been discovered in the Meteora area of Thessaly, according to Kamari & al. 2003).

3. Classification of the endemics after cytotaxonomic criteria

Favarger & Contandriopoulos (1961) systematized the cytotaxonomic study of endemic taxa and their vicarious congeners in order to better understand their evolutionary history and distinguish "passive" endemism of palaeo- and patroendemics from "active" endemism of schizo- and apoendemics. Our karyological data allow such a classification for 27 of the 39 local endemic taxa of Evvia (Table 2). The majority represents schizoendemics (80.8 %) while the categories of apoendemics (11.5 %) and palaeoendemics (7.7 %) follow by distance (patroendemics absent). The dominance of schizoendemics and apoendemics in the endemic flora of Evvia shows that endemism has originated in Evvia mainly in an "active" way. The cytotaxonomic classification of the endemic plants of Peloponnisos (Iatrou 1986) gained similar results (palaeoendemics 7.8 %, patroendemics 0.0 %, schizoendemics 86.3 %, apoendemics 5.9 %).

In Evvia, the category of palaeoendemics is represented by *Alyssum euboicum* and *Verbascum zuccarinii*. As compared to other Aegean areas rich in palaeoendemics (e.g. the S Aegean area; Greuter 1972, 1975), this is only a very small number, possibly caused by the relatively recent isolation of Evvia from continental Greece, and the immigration and successful competition of northern taxa during the glacial periods. Palaeoendemics are ancient taxa showing little variation and a distribution often of a relictual type, corresponding to the remains of a once larger area (Cardona & Contandriopoulos 1979). *V. zuccarinii* belongs to this category as its population presents low morphological diversity and is taxonomically isolated, without close relatives in the Balkan Peninsula and Anatolia, its closest relative being *V. pyramidatum* M.Bieb. from the Caucasus. *A. euboicum* is a possibly palaeoendemic species well adapted to the harsh environmental conditions of the ophiolitic rocks and is locally common, although scattered and restricted in distribution. Its morphological variability is remarkable and seems to depend, to some extent, on different composition of the ophiolitic rocks it colonizes. It has no close relatives in *Alyssum* sect. *Odontarrhena* (C. A. Mey.) W. D. J. Koch in the Balkans, and an Anatolian origin seems more probable for this species, supported by morphological similarities with *A. condensatum* Boiss. & Hausskn. s.l. from Anatolia, Syria, Lebanon and N Iraq.

Patroendemics constitute, together with palaeoendemics, the ancient element of a flora. Despite the existence of some patroendemics in the Aegean there is none among the local endemic taxa of Evvia that can safely be classified as such using cytotaxonomic criteria. Patroendemics were also not reported in the endemic flora of Peloponnisos (Iatrou 1986).

With 21 taxa, schizoendemics form the largest group in the endemic flora of Evvia. Some of them are taxa of recent origin and their evolution is still in progress. Others, similarly to palaeoendemics, have an old origin.

Allium karistanum and *Minuartia dirphyia* are considered to be schizoendemic taxa of an old origin (relictual schizoendemics), and probably *Hypericum fragile*, *Sideritis euboea*, *Asperula euboea* and *Centaurea ebenoides* are also to be included in this category. *Allium karistanum*, together with *A. callidictyon*, *A. peroninianum*, *A. greuteri* and *A. pentadactyli*, form a group of species with a remarkable disjunction over the Mediterranean (see distribution map in Brullo &

al. 1997). Their ecological preferences and some of their morphological features indicate that they are probably relics of a xerothermic flora linked with the Messinian period (5–6 m.y. B.P.) when the Mediterranean climate was uniformly xeric and these geophytes probably had a wide distribution (Brullo & al. 1997). The geographical distribution of *Minuartia dirphyia* and its corresponding species, *M. wettsteinii* and *M. parnonia* is less scattered (Trigas & Iatrou 2005). This pattern indicates that the origin of these species goes back at least to Pliocene, characterising them as palaeo-schizoendemics. *Hypericum fragile* belongs to *Hypericum* sect. *Taeniocarpium* Jaub. & Spach which has a wide distribution range throughout Europe eastwards to Israel and E Siberia. The representatives of this section in Greece, *H. fragile* and *H. taygeteum*, have very restricted distribution ranges, indicating a relictual status. *Sideritis euboica* and *S. raeseri*, although distributed in neighbouring areas (Fig. 2), show morphological differences that indicate long isolation. *S. syriaca* subsp. *syriaca*, endemic to Crete, appears to be the closest relative of *S. euboica* at least morphologically. The distribution ranges of both latter species also indicate an old origin. The species related to *Centaurea ebenoides* (Table 2) are distributed in the central part of the Balkan Peninsula, hence it has probably a northern origin. However, striking morphological differences of *C. ebenoides* from its corresponding species indicate long isolation.

Schizoendemics the corresponding taxa of which are distributed in closely neighbouring areas are supposed to have a relatively recent origin (neoschizoendemics). Their morphological differentiation is usually weak and they are often classified at subspecific level. The majority of the endemics of Evvia belong here (*Allium calamarophilum*, *A. runemarkii*, *Armeria johnsenii*, *Campanula celsii* subsp. *carystea*, *C. constantini*, *C. cymaea*, *C. goulimy*, *Centaurea euboica*, *Inula subfloccosa*, *Nepeta argolica* subsp. *dirphyia*, *Scutellaria goulimy*, *Senecio eubaeus*, *Silene oligantha* subsp. *pseudoradicosa*, *Quercus trojana* subsp. *euboica* and *Silene dirphyia*). Their corresponding taxa (Table 2) usually have restricted distribution ranges. The subspecific differentiation of *Centaurea euboica* subsp. *euboica* and *C. euboica* subsp. *intermedia*, both growing on serpentine in N Evvia, was presumably triggered by fragmentation of the ophiolitic areas of N Evvia by intercalary calcareous rocks and by differences in their chemical composition.

The category of apoendemics includes *Centaurea mantoudii*, *Viola dirphyia* and *Viola euboica*. *C. mantoudii* is an auto- or allotetraploid ($2n = 4x = 36$; Georgiadis 1980, Trigas 2003) and it seems to originate from the diploid *C. pelia* ($2n = 2x = 18$) that spreads widely in areas adjacent to the range of *C. mantoudii*. *V. dirphyia* is also tetraploid ($2n = 4x = 40$; Tiniakou 1991), probably originating from the widely distributed diploid *V. reichenbachiana* ($2n = 2x = 20$; Livaniou-Tiniakou 1991) via auto- or allopolyploidy. Both taxa can be considered neopolyploids, according to Favarger (1975) and Greilhuber & Ehrendorfer (1988), with their relative diploid taxa distributed in closely neighbouring areas. *V. euboica* is tetraploid ($2n = 4x = 40$; Erben 1985), of an allopolyploid origin (Erben 1996), and its ancestral taxa are very difficult to identify within the extremely difficult complex of *Viola* sect. *Melanium*. It seems to be a mesopolyploid according to Favarger (1975; see also Table 2).

4. Origin and geographic affinities of the endemic flora of Evvia

The allocation of the regional endemics of Evvia to the present distribution ranges of their related taxa may elucidate their origin and geographic affinities, grouped into different categories.

The first, and largest, category includes taxa that seem to have developed in either continental or insular (Aegean) Greece. The “continental” group includes *Allium calamarophilum*, *A. runemarkii*, *Asperula euboica*, *Bolanthus intermedius*, *Campanula celsii* subsp. *carystea*, *Centaurea ebenoides*, *C. euboica*, *C. mantoudii*, *Geocaryum euboicum*, *Hypericum fragile*, *Inula subfloccosa*, *Nepeta argolica* subsp. *dirphyia*, *Senecio eubaeus*, *Silene oligantha* subsp. *pseudoradicosa*, *Viola euboica* and *Verbascum euboicum*, the “insular” group contains *Asperula suffruticosa*, *Campanula cymaea*, *C. constantini* and *C. goulimy*.

The second category includes endemic taxa that seem to originate from widely distributed taxa, some populations of which underwent speciation in Evvia. *Alyssum densistellatum*, *Ammi topalii*, *Armeria johnsenii*, *Chaerophyllum euboicum*, *Quercus trojana* subsp. *euboica*, *Scutellaria*

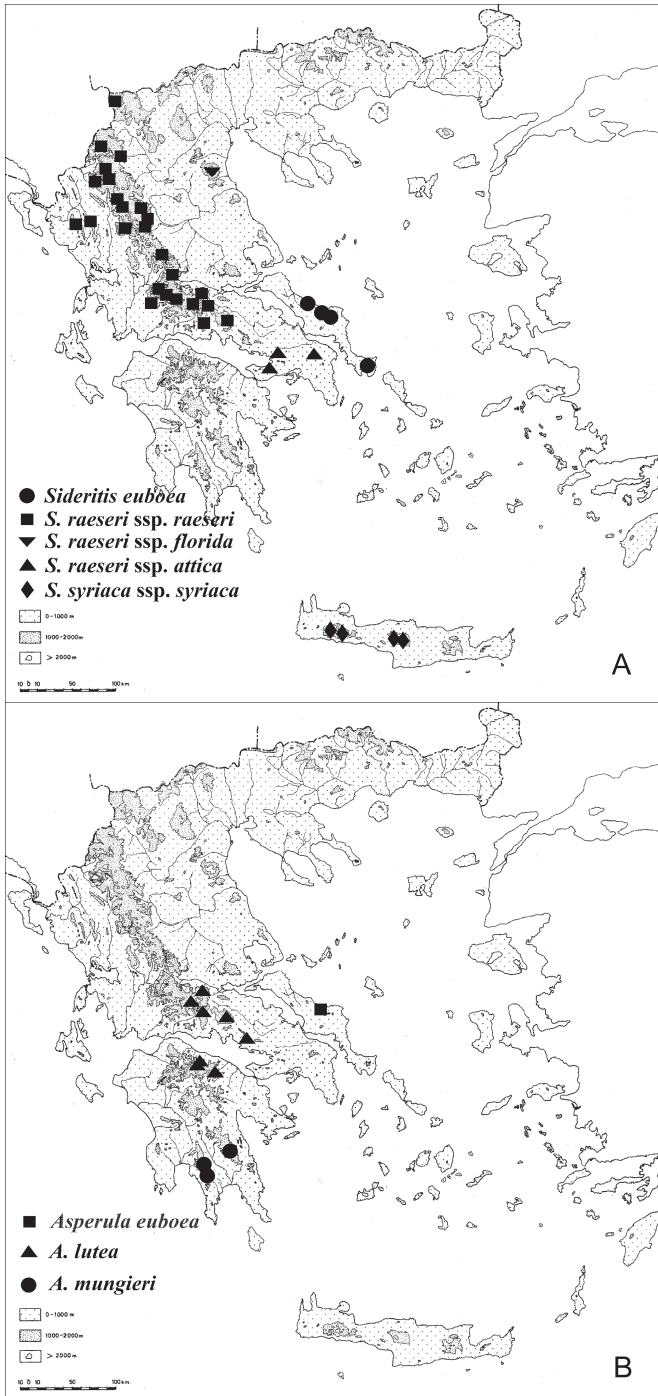


Fig. 2. A: Total range of *Sideritis euboëa*, *S. raeseri* subsp. *florida*, *S. raeseri* subsp. *attica*, *S. syriaca* subsp. *syriaca* and distribution range of *S. raeseri* subsp. *raeseri* in Greece; B: total range of *Asperula euboëa*, *A. lutea* and *A. mungieri*.

goulimy, *Silene dirphy*a and *Viola dirphy*a belong here. In some cases (Fig. 3) the widely distributed related taxa expand to the north of Evvia. In all cases the endemic taxa show strong morphological similarities to their relatives and they should be considered of a relatively recent origin.

The third category includes taxa which originate E of Evvia, viz. in Anatolia or even further east, including *Asperula brachyphylla*, *A. ophiolithica*, *Cruciata taurica* subsp. *euboea* and probably *Alyssum euboicum*. These are old taxa usually well differentiated from their relatives, which seem to have arrived in Evvia via the central Aegean. The distribution of *A. brachyphylla* and its congeners is the only clear evidence for this migration route (see distribution map in Trigas & Iatrou 2003).

In the S Aegean area, especially in Crete, many eastern species are confined to high altitudes (Carlström 1987), reflecting the climatic conditions of the migration periods. Two insular endemics of Evvia of an eastern origin (*Asperula brachyphylla*, *Cruciata taurica* subsp. *euboea*) are confined to high altitudes, whereas *Asperula ophiolithica* and *Alyssum euboicum* (exclusively on serpentine in N Evvia) are lowland species the relatives of which are usually growing on limestone at moderate and high altitudes (up to 3000 m) in Anatolia. According to Brooks (1987), the serpentines of Evvia, found mostly at low altitude, support a flora that includes plants distributed, outside Evvia, further north or at higher altitudes. This disjunct distribution is a typical character of serpentine floras elsewhere, where competitive pressure restricts some plants either to the edaphically harsh environment of ultramafites, or to the climatically harsh environment of regions further north or at higher altitudes.

Finally, a fourth category is represented by *Allium karistanum* which, with its relative taxa, seem to constitute remnants of an old xerophytic flora widely distributed in the Mediterranean area during the Messinian.

5. Comments on selected taxa

Asperula euboea (Ehrend.) Trigas

The *Asperula* populations that grow on cliffs in central Evvia were originally described as a subspecies of *A. lutea* (*A. lutea* subsp. *euboea* Ehrend. in Rechinger 1961). Ehrendorfer & Krendl (1976) divided *A. lutea* into four subspecies distributed in S Greece, viz. *A. lutea* subsp. *lutea* (Sterea Ellas and N Peloponnisos), *A. lutea* subsp. *euboea* (endemic to central Evvia), *A. lutea* subsp. *rigidula* (E Sterea Ellas, Evvia, Peloponnisos) and *A. lutea* subsp. *mungieri* (endemic to Mts Taigetos and Parnon in S Peloponnisos), both the latter later recognized as independent species (Schönbeck-Temesy & Ehrendorfer 1991, Tan & Iatrou 2001). The *Asperula* populations of Central Evvia, too, belong to a clearly distinct species, *A. euboea* (Ehrend.) Trigas (Trigas 2003), which grows in a specialized habitat (i.e. shady vertical limestone cliffs) and differs from its relative taxa in habit and in several morphological characters. It seems to be more closely related to *A. mungieri* Boiss. & Heldr. than to *A. lutea* Sm. s. str., differing from the former by its dense caespitose habit, shorter stems, longer hyaline apex of leaves and dull yellow corolla (whitish, purple or brownish-purple in *A. mungieri*), and from the latter by its dense caespitose habit, longer, acicular, ± falcate leaves and a shorter inflorescence.

Fumana pinatzii Rech. f.

Fumana pinatzii was described from Evvia (Rechinger 1956); according to the description, it does not show remarkable taxonomic differences in single characters from *F. arabica* (L.) Spach, a widespread species of the Mediterranean region, except the number of seeds in the capsule (6 instead of 12 in *F. arabica*).

In the locus classicus of *Fumana pinatzii* (the Limni area in N Evvia), we collected many specimens of the local *Fumana* populations growing abundantly in the ophiolitic areas. The study of these specimens, and their comparison with the type specimen, confirmed the absence of morphological differences between *F. pinatzii* and *F. arabica* from various places in Greece. The

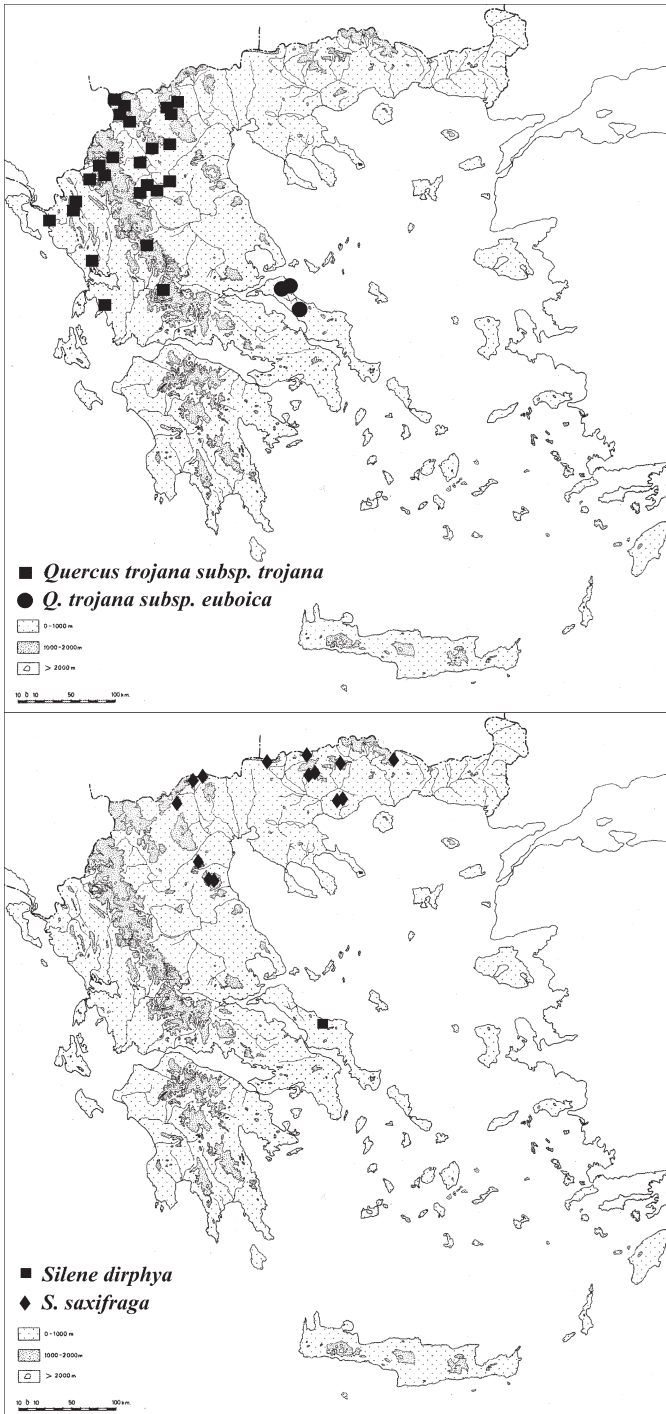


Fig. 3. A: Total range of *Quercus trojana subsp. euboica*, and distribution range of *Q. trojana subsp. trojana* in Greece; B: total range of *Silene dirphyha* and distribution range of *S. saxifraga* in Greece.

specimens from N Evvia were found to contain 6, 9 or 12 seeds per capsule. No morphological differences linked with different number of seeds per capsule were found. According to Heywood (1968), specimens of *F. arabica* from the Kiklades islands have sometimes 6 seeds per capsule, while the number of seeds in *F. arabica* is (6-)8-12. The inclusion of *F. pinatzii* within the variation and as a synonym of *F. arabica* is therefore appropriate.

Colchicum pinatziorum Rech. f.

The description of *Colchicum pinatziorum* (Rechinger 1961) was based on a specimen of Pinatzis collected on Mt Kandili in N Evvia, at an altitude of c. 1000 m. The species, according to the description and the type specimen seen, shows only slight taxonomic differences from *C. boissieri* Orph. which is distributed in Sterea Ellas, the island of Chios and W Anatolia (Tan & Iatrou 2001). The differences of Pinatzis's specimen from specimens of *C. boissieri* collected in Sterea Ellas are confined to the slightly more slender perianth segments and the smaller anthers (c. 2 mm long).

During a visit to Mt Kandili we found large populations of *Colchicum* growing in *Abies cephalonica* woodland at altitudes of 850 to 1050 m. The study of the specimens revealed a considerable variation in the size of the perianth segments (4-12 mm wide) and anthers (2.2-3.6 mm long). These measurements fit well (or only slightly extend beyond) the dimensions given for *C. boissieri*. We did not find any other morphological difference between the specimens of Mt Kandili and genuine *C. boissieri*. This is true also for the leaves, which originally were not described in *C. pinatziorum*. We therefore propose to sink *C. pinatziorum* into synonymy of the more widespread *C. boissieri*.

Crepis dioscoridis subsp. *euboica* Rech. f.

Crepis dioscoridis s.l. is a very polymorphic species distributed in SE Europe. Subspecies were described by Babcock (1947), but these were based on very limited material, and further information is required before their status can be confirmed (Sell 1976).

Crepis dioscoridis subsp. *euboica* was described by Rechinger (1961) from central Evvia and related by him to *C. dioscoridis* subsp. *tubiformis* (Halácsy) Babc. Specimens of *C. dioscoridis* s.l. collected by us in central Evvia do not show stable differences with specimens of *C. dioscoridis* s.l. collected in E Sterea Ellas. Size of leaves and length of stems clearly correspond with modifying ecological parameters of the habitat. Subspecific rank for the populations of *C. dioscoridis* from Evvia is therefore not justified.

Concluding remarks

Restricted distribution ranges, and the strong link to specific geological substrates are important characteristics of the endemic flora of Evvia. The abundance of schizoendemics and the presence of apoendemics emphasize the "active" evolution of endemic taxa on the island. The majority of the endemics belong to groups that seem to have differentiated in situ. Northern and eastern elements, although low in number, have further enriched the local endemic flora.

Endemics form a significant group of taxa for setting conservation priorities. The insular endemics of Evvia, many of them with extremely narrow distribution ranges, are subject to a number of serious threats. Almost 50 % of them are considered facing a high risk of extinction in the wild and therefore fulfill the criteria of inclusion in the categories of "Critically Endangered", "Endangered" or "Vulnerable", according to the IUCN Red List Categories and Criteria (IUCN 2001, Trigas 2003). Their conservation should be of priority in any future environmental plans in the area.

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