

## **Flora and factors affecting species diversity in the islet groups of the protected “Natura 2000” sites of the Amvrakikos Gulf and Mesolongi Lagoon (Ionian area, Greece)**

Authors: Iliadou, Eleni, Panitsa, Maria, Raus, Thomas, and Dimopoulos, Panayotis

Source: Willdenowia, 44(3) : 439-450

Published By: Botanic Garden and Botanical Museum Berlin (BGBM)

URL: <https://doi.org/10.3372/wi.44.44315>

---

The BioOne Digital Library (<https://bioone.org/>) provides worldwide distribution for more than 580 journals and eBooks from BioOne's community of over 150 nonprofit societies, research institutions, and university presses in the biological, ecological, and environmental sciences. The BioOne Digital Library encompasses the flagship aggregation BioOne Complete (<https://bioone.org/subscribe>), the BioOne Complete Archive (<https://bioone.org/archive>), and the BioOne eBooks program offerings ESA eBook Collection (<https://bioone.org/esa-ebooks>) and CSIRO Publishing BioSelect Collection (<https://bioone.org/csiro-ebooks>).

Your use of this PDF, the BioOne Digital Library, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](http://www.bioone.org/terms-of-use).

Usage of BioOne Digital Library content is strictly limited to personal, educational, and non-commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne is an innovative nonprofit that sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

ELENI ILIADOU<sup>1,2</sup>, MARIA PANITSA<sup>2\*</sup>, THOMAS RAUS<sup>3</sup> & PANAYOTIS DIMOPOULOS<sup>2</sup>

## Flora and factors affecting species diversity in the islet groups of the protected “Natura 2000” sites of the Amvrakikos Gulf and Mesolongi Lagoon (Ionian area, Greece)

### Abstract

Iliadou E., Panitsa M., Raus Th. & Dimopoulos P.: Flora and factors affecting species diversity in the islet groups of the protected “Natura 2000” sites of the Amvrakikos Gulf and Mesolongi Lagoon (Ionian area, Greece). – Willdenowia 44: 439–450. 2014. – Version of record first published online on 18 November 2014 ahead of inclusion in December 2014 issue; ISSN 1868-6397; © 2014 BGBM Berlin-Dahlem.

DOI: <http://dx.doi.org/10.3372/wi.44.44315>

The vascular plant species diversity of the islet groups in the Amvrakikos Gulf and Mesolongi Lagoon, hitherto unexplored, is documented by an inventory of vascular plants, filling gaps in the floristic information available for the two National Parks to which these islet groups belong, as well as for the Ionian land-bridge island system for which detailed studies concerning floristic and phytogeographical relationships were available before. The total vascular flora of the two islet groups comprises 226 plant taxa. Spectra of life-form and chorological elements are presented and discussed. Floristic cross-correlations (beta-diversity) show that the individual islet floras differ from each other from 39 % to 91 %. Concerning the role of eco-geographical variables as influencing plant species diversity in the area, regression analyses indicate island area as the major predictor variable of species richness.

Additional key words: island biogeography, land-bridge islands, phytogeography, Mediterranean region, vascular plants, beta-diversity

### Introduction

Plant species richness and distribution patterns on oceanic versus chersogenous islands have been extensively studied in island biogeography. An important point is to determine factors affecting species richness and repartition on islands. This becomes critical when the islands concerned are protected by law and conservation efforts are claimed.

The ecological importance of the Ionian area from a nature conservation point of view was mentioned by Iliadou & al. (2014). The designation of two national parks and Ramsar Convention sites of international importance for birds on the border of W mainland Greece and the Ionian archipelago makes it important to elucidate the biogeographical relationship of the Ionian area to the adjacent parts of the Greek mainland.

Plant species diversity of some larger Ionian islands and islet groups has been studied already, but there is still a large number of small islands and islets that have not been investigated at all and have remained completely unexplored floristically, such as the islet groups in the marginal seas of the Amvrakikos Gulf and the Mesolongi Lagoon (Fig. 1).

The islet group in the Amvrakikos Gulf belongs to the Natura 2000 Site of Community Importance GR2110001, “Amvrakikos Gulf, Louros and Arachthos Delta”, which also includes the Special Protection Area GR2110004, “Amvrakikos Gulf, Katafourko lagoon and Korakonia”. Both sites belong to the “Amvrakikos Wetlands National Park”. The islet group in the Mesolongi Lagoon is part of two overlapping Natura 2000 sites, a Special Protection Area (GR2310015) and a Site of European

1 Department of Environmental and Natural Resources Management, University of Ioannina, 30100 Agrinio, Greece.

2 Current address: Department of Environmental and Natural Resources Management, University of Patras, 30100 Agrinio, Greece; \*e-mail: [mpanitsa@upatras.gr](mailto:mpanitsa@upatras.gr) (author for correspondence).

3 Botanischer Garten und Botanisches Museum Berlin-Dahlem, Freie Universität Berlin, Königin-Luise-Str. 6–8, 14195 Berlin, Germany.

Community Importance (GR2310001), which compose the “National Park of Mesolongi – Aitoliko lagoons, estuaries of Acheloos and Evinos River and Echinades islet group”. These two national parks are of the most diverse and complex sites of the Natura 2000 ecological network in Greece and also represent two of Greece’s 11 Ramsar Convention wetlands, which are of international importance for the conservation of their avifauna (Dimopoulos & al. 2005).

The floristic composition of the two islet groups under discussion here (Fig. 1) was hitherto unknown, and for this reason the main objectives of the present study are: (1) to provide for the first time a floristic inventory of the protected islet groups, thus continuing current studies of the plant species diversity of the Ionian islets (Iliadou & al. 2014); (2) to investigate the floristic similarities among the individual islets; and (3) to explore the main factors affecting plant species richness in the two islet groups in order to highlight the role of geographical variables in shaping their flora. In the given conservation context, factors determining plant species richness and habitat composition may also directly or indirectly influence animal and especially bird species richness (Kissling & al. 2008).

**Material and methods**

**1. Study area**

The survey of the two investigated islet groups covers six islets of the Amvrakikos Gulf and four islets of the Mesolongi Lagoon with areas ranging from 0.41 ha to 65.9 ha, very low elevation ranging from 1 m to 8 m a.s.l. and distance from the nearest mainland coastline ranging from 10 m to 5.7 km (Table 1). The low hilly and coastal slopes are generally gentle. The names of the constituting islets and their geographical data are provided in Fig. 1 and Table 1. The islets are uninhabited, but there are one or two small houses for people working in the fish farms that are the main human activity in the surrounding sea. Grazing has been observed on the larger islets. The Amvrakikos Gulf islets belong to the prefecture of Preveza, except the islet of Kefalos, which belongs to the prefecture of Aitolokarnania as

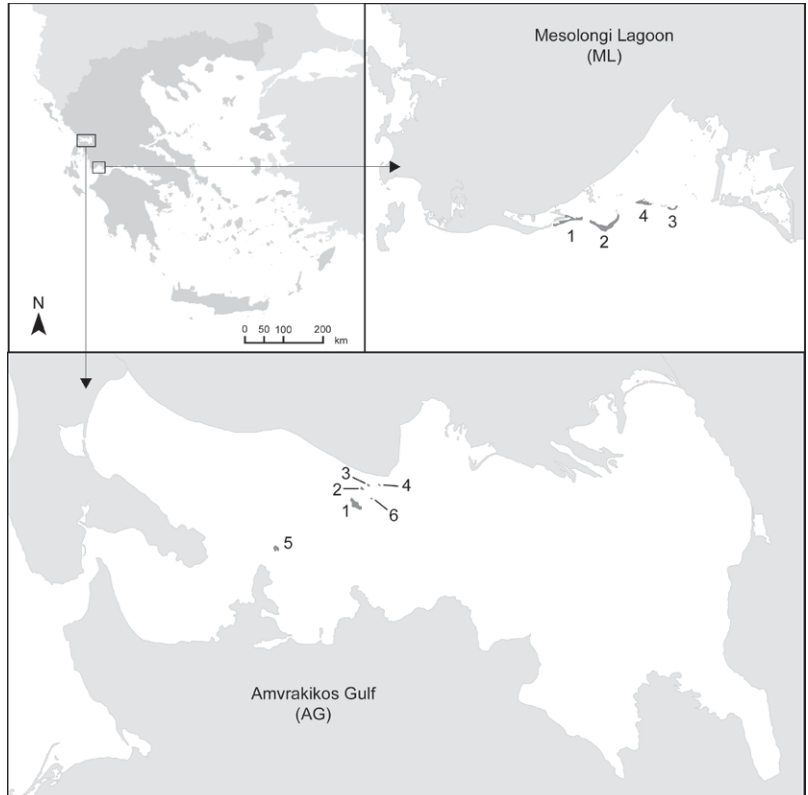


Fig. 1. Map of the two studied islet groups. The numbers correspond to the islet codes in Table 1.

Table 1. Geographical and ecological information about the two studied islet groups. – S = number of taxa; A = surface area [ha]; E = highest elevation [m]; Dm = minimum distance to nearest mainland [km].

Islet name	Islet code	Latitude [N]	Longitude [E]	S	A	E	Dm
<b>Amvrakikos Gulf islets</b>							
Vouvalos	AG1	38°59'11"	20°55'00"	109	13.48	8	1.75
Vlaxos	AG2	38°59'40"	20°55'14"	48	1.36	4	1.05
Diapori	AG3	38°59'45"	20°55'29"	34	0.79	5	0.9
Vouzvara	AG4	38°59'22"	20°55'35"	23	0.41	4	1.7
Kefalos	AG5	38°57'53"	20°52'19"	79	4.3	4	0.95
Agios Antonios	AG6	38°59'58"	20°55'50"	14	0.53	5	0.78
<b>Mesolongi Lagoon islets</b>							
Tholi	ML1	38°18'34"	21°16'17"	113	17.6	3	0.01
Prokopanistos	ML2	38°18'16"	21°18'23"	96	65.9	1	3.16
Agios Sostis	ML3	38°19'14"	21°22'14"	65	8.8	1	3.53
Shinias	ML4	38°19'28"	21°20'33"	56	17.1	1	5.7

also do the islets of the Mesolongi Lagoon. All the islets are owned by the Greek state.

The Amvrakikos Gulf is also a semi-closed sea, watered by plenty of fresh water with sediments. Vött & al. (2007) showed geomorphological, sedimentological and geoarchaeological evidence of multiple tsunami impacts on the Aktio headland (the entrance of the Amvrakikos Gulf). May & al. (2012), studying the Lefkada–Preveza

coastal zone, which is characterized by an active barrier system and related extensive beachrock sequences protecting the entrance to the gulf, concluded that tsunami events in particular have induced sudden impulses of coastal evolution in the study area contributing to coastal and environmental changes involving a recurrent reorganization of the coastal system by gradual, long-term, steadily acting processes such as longshore drift, tending to the establishment of a state of renewed coastal balance. The islets in the Amvrakikos Gulf are composed of Triassic/Lower Jurassic or Jurassic limestones (IGME 1989).

The Mesolongi Lagoon is connected to the Gulf of Patras, which forms a part of the Ionian Sea. The lagoon lies behind a fragmented sandy coastal ridge that separates it from the open sea. It is semi-closed and shallow (the depth ranges from a few cm in the interior regions up to roughly 2.5 m, with a mean depth of approximately 0.5 m) and the circulation is dominated by the tide entering through the Gulf of Patras, at least for ordinary wind conditions (Leftheriotis & al. 2013). The islets in the Mesolongi Lagoon are composed of post-tectonic and late-tectonic sediments of the Holocene (alluvium) in valleys, plains and coastal deposits (IGME 1989). They form a kind of barrier islets (Fig. 1).

Based on the climatic diagram of Emberger (1952), the study area belongs to a subhumid bioclimate characterized by mild winters. The xerothermic index (Bagnouls & Gaussen 1953) and the ombrothermic diagram (UNESCO-FAO 1963) characterize the study area as thermo-Mediterranean with a dry period from early May to mid-October.

Three habitat types of Annex I of the Directive 92/43/EU have been recognized in the study area of the Amvrakikos Gulf islets: vegetated sea cliffs of the Mediterranean coasts (habitat type code 1240), Mediterranean and thermo-Atlantic halophilous scrub (*Sarcocornietea fruticosi*) (1420) and *Olea europaea* – *Pistacia lentiscus* scrub (9320). Five habitat types of Annex I have been recognized on the islets of the Mesolongi Lagoon: habitat type 1420, as in the Amvrakikos Gulf islets, *Salicornia* and other annuals colonizing mud and sand (1310), Mediterranean salt meadows (*Juncetalia maritimi*) (1410), embryonic shifting dunes (2110) and coastal dunes with *Juniperus* species (2250\*); plus one more habitat type not included in Annex I: reedbeds (72A0).

## 2. Annotated floristic inventory

The floristic inventory presented here (see Appendix) includes species and subspecies, with their life-form and chorological categories, of the flora of the individual islets of the two groups. Repeated field trips were carried out between 2007 and 2012 in different seasons of the year, in order to acquire an integrated knowledge of the flora of the islets.

Families, genera, species and subspecies are given in an alphabetic order within the higher groups gymno-

sperms and angiosperms. For simplicity, “taxa” is statistically used hereafter for both species and subspecies (the latter in case a species has more than one subspecies in the area). The plant collections are deposited in Agrinio (W Greece) in the herbarium of the Department of Environmental and Natural Resources Management, Laboratory of Ecology and Nature Conservation.

Nomenclature, life-form and chorological categories follow Dimopoulos & al. (2013) except for *Spergularia marina*, the correct name for *S. salina* (see Buttler & Thieme 2013, the latter designation erroneously accepted in Dimopoulos & al. 2013: 83). For the determination of the plant material, Tutin & al. (1968–1980, 1993), Pignatti (1982) and Strid & Tan (1997, 2002) were used.

## 3. Floristic similarity analysis

Floristic similarity of the islets per pair (beta-diversity) was calculated using the Sørensen similarity coefficient (Sørensen 1948):  $Cs=2j/(a+b)/C$ , where  $j$  = the number of taxa common to both islets compared,  $a$  = the number of taxa recorded from islet 1, and  $b$  = the number of taxa recorded from islet 2. In addition, the proportion of islets on which a taxon occurs was calculated. The dendrogram presenting floristic relations between the islets studied (Fig. 2) is based on the hierarchical cluster analysis using Statistica 6 (StatSoft, Inc. 2001).

## 4. Statistical analysis of the factors affecting plant species richness

Geographical data concerning surface area (A), highest elevation (E) and maximum distance to the nearest mainland (Dm) were determined by open-access digital topographic maps (1:50 000 scale) of the Hellenic Military Geographical Service.

The relationships between plant species richness and the geographical variables affecting it were tested using simple and multiple linear regression analyses and the Spearman correlation coefficient. All regressions and the estimations of parameters were carried out with Statistica 6 (StatSoft, Inc. 2001).

## Results

### 1. Floristic inventory and analysis

There is no previous literature information at all concerning plant species richness of the islets studied. Our pioneer field investigations on all of the ten islets revealed the occurrence of 226 plant taxa.

The vascular plant diversity of the six Amvrakikos Gulf islets comprises 142 plant taxa, belonging to 45 families, 117 genera, 130 species and 12 subspecies, while the vascular plant diversity of the four Mesolongi Lagoon islets comprises 164 plant taxa, belonging to 46 families, 126 genera, 155 species and nine subspe-

cies (Table 2). Except for two gymnosperms, all of the taxa are angiosperms. Vascular cryptogams have not yet been found.

In both island groups a high percentage (c. 43%) of the taxa belongs to three families: *Poaceae* (23 taxa), *Asteraceae* and *Fabaceae* (19 taxa each). Therophytes predominate (52.1%–53%) and Mediterranean plant taxa represent 75.2% of the Amvrakikos Gulf islets flora and 66.7% of the Mesolongi Lagoon islets flora. For the life-form spectrum see Table 3; for the chorological spectrum see Table 4.

Four alien taxa, according to Arianoutsou & al. (2010), are present in the flora of the islets studied, viz.: *Erigeron bonariensis*, *Phalaris canariensis*, *Symphotrichum squamatum* and *Xanthium orientale* subsp. *italicum*.

Eleven of the taxa recorded are included in the IUCN Red List of Threatened Species (IUCN 2013) and three are included in the European Red List of Vascular Plants (Bilz & al. 2011), all of characterized as Least Concern (LC); 27 taxa are included in the list of UNEP (2014) (see Table 5).

## 2. Floristic similarity among the studied islets

Floristic cross-correlations (beta-diversity) between the studied islets by means of the Sørensen similarity coefficient revealed values (0.09–0.61) showing that the floras of each of the studied islets differ from each other from 39% to 91% (Fig. 2). The hierarchical cluster analysis showed that the island of Vouvalos (AG1), highest and largest of the Amvrakikos Gulf islets group, has a very different floristic composition as also does the medium-sized islet of Kefalos (AG5), when compared to all the other islets (Fig. 2). The other four, smaller Amvrakikos Gulf islets group together, as also do the four Mesolongi Lagoon islets (Fig. 2).

Concerning the number of islets on which each taxon occurs, 33.2% of the taxa occur on only one of the ten studied islets, 23.5% on only two of them and 15.9% on only three of them. Only 1.3% of the taxa were found to be common to all ten islets, and 0.4% common to nine

Table 2. Numbers of vascular plant taxa in the flora of the two studied islet groups. – AG = Amvrakikos Gulf islets; ML = Mesolongi Lagoon islets.

	Area	Families	Genera	Species	Subspecies	Taxa	%
Gymnosperms	AG	2	2	2	0	2	1.4
	ML	1	1	1	0	1	0.6
Angiosperms	AG	43	115	128	12	140	98.6
	ML	45	125	154	9	163	99.4
<b>Total</b>	AG	<b>45</b>	<b>117</b>	<b>130</b>	<b>12</b>	<b>142</b>	<b>100</b>
	ML	<b>46</b>	<b>126</b>	<b>155</b>	<b>9</b>	<b>164</b>	<b>100</b>

Table 3. Life-form spectrum of the flora of the two studied islet groups.

Life-form category	Amvrakikos Gulf islets		Mesolongi Lagoon islets	
	Number of taxa	%	Number of taxa	%
Phanerophytes	15	10.6	18	11
Chamaephytes	12	8.4	11	6.7
Hemicryptophytes	24	16.9	31	18.9
Geophytes	17	12	17	10.4
Therophytes	74	52.1	87	53
<b>Total</b>	<b>142</b>	<b>100</b>	<b>164</b>	<b>100</b>

Table 4. Chorological spectrum of the flora of the two studied islet groups.

Chorological category	Amvrakikos Gulf islets		Mesolongi Lagoon islets	
	Number of taxa	%	Number of taxa	%
<b>1. Widespread taxa</b>	<b>34</b>	<b>24.1</b>	<b>51</b>	<b>31.5</b>
Cosmopolitan	7	5	12	7.4
Subtropical-tropical	3	2.1	4	2.5
Euro-Siberian	2	1.4	3	1.8
European-SW Asian	13	9.2	20	12.4
Paleotemperate	9	6.4	12	7.4
<b>2. Mediterranean taxa</b>	<b>106</b>	<b>75.2</b>	<b>108</b>	<b>66.7</b>
East Mediterranean	5	3.5	5	3.1
Mediterranean	69	49	61	37.7
Mediterranean-Atlantic	7	5	12	7.4
Mediterranean-European	15	10.6	14	8.6
Mediterranean-SW Asian	10	7.1	16	9.9
<b>3. Alien taxa</b>	<b>1</b>	<b>0.7</b>	<b>3</b>	<b>1.8</b>
<b>Total</b>	<b>141</b>	<b>100</b>	<b>162</b>	<b>100</b>

of them. The most widespread plant taxa recorded on the studied islets are *Asparagus acutifolius*, *Limbarda crithmoides* and *Pistacia lentiscus* (on all ten studied islets), *Smilax aspera* (on nine islets) and *Asphodelus ramosus*, *Elytrigia juncea* and *Rubia peregrina* (on eight islets). Except the above-mentioned taxa, there are others found on five or all six islets of the Amvrakikos Gulf, such as *Lonicera implexa*, *Myrtus communis* and *Olea euro-*

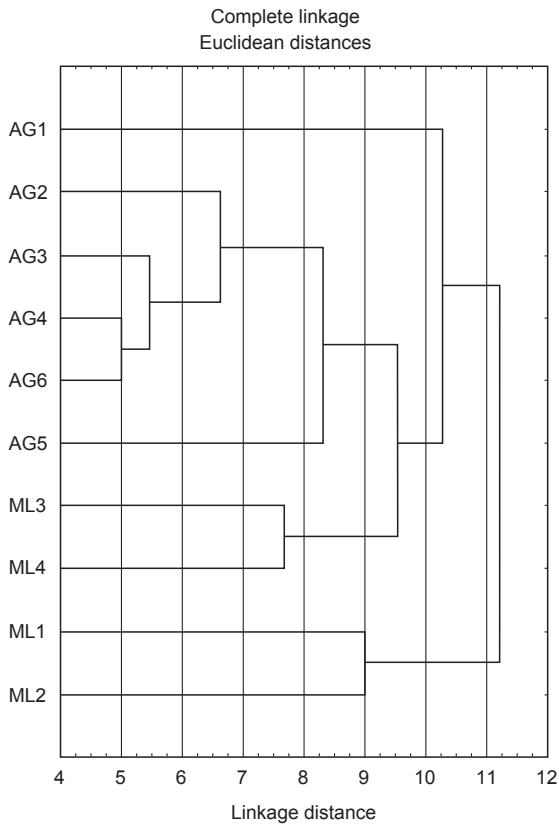


Fig. 2. Hierarchical cluster analysis showing floristic relations between the studied islets (linkage method: complete linkage, Euclidean distances). – For islet codes see Table 1.

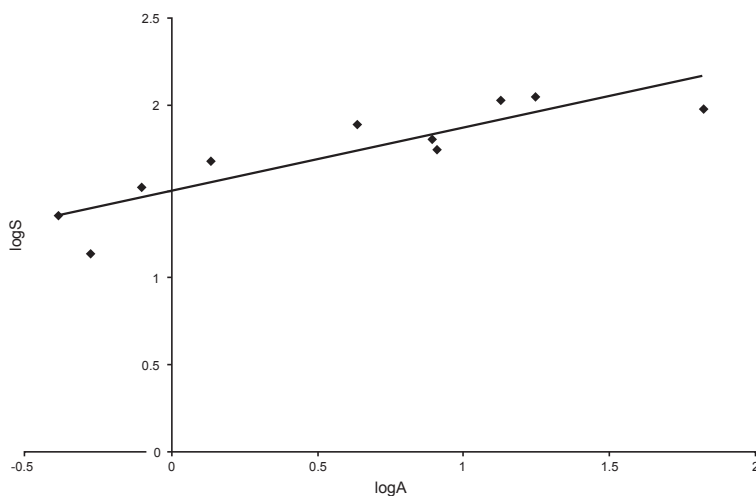


Fig. 3. Plant species-area relationship (SAR) of the studied islets ( $\log S = 1.507 + 0.343 \log A$ ,  $R^2 = 0.741$ ,  $R = 0.861$ ).

### 3. Statistical analysis of the factors affecting plant species richness

The Spearman correlation coefficient was calculated among biogeographical factors to evaluate multi-collinearity of these predictor variables. Surface area (A), elevation (E) and distance to the mainland (Dm) are not correlated to each other.

The results of simple regression analyses (log-log) of plant species richness indicated island surface area as a predictor variable of species richness since they are strongly correlated ( $R^2 = 0.741$ ). Elevation and distance to the mainland do not show a significant effect on species richness. Fig. 3 presents the logarithmic species-area relationship (SAR) for the islets studied with the equation  $\log S = 1.507 + 0.343 \log A$ . Stepwise multiple regression analyses were conducted among the number of plant taxa and the set of the studied biogeographical factors. Only the surface area (A) is a strong predictor variable of plant species richness since plant species richness is not significantly correlated with elevation (E) and distance to the adjacent species pool (Dm).

### Discussion

There has been a complete gap so far concerning plant species richness of the islets studied, which are included in the protected areas of the “Amvrakikos Wetlands National Park” and the “National Park of Mesolongi – Aitoliko lagoons, estuaries of Acheloos and Evinos River and Echinades islet group”. During our field investigations on the six islets in the Amvrakikos Gulf and the four islets in the

Mesolongi Lagoon, 226 plant taxa were registered representing 11.1 % of the total flora of the Ionian area (2027 taxa) as recorded by Dimopoulos & al. (2013). A large proportion of these taxa belong to the families *Asteraceae*, *Fabaceae* and *Poaceae*, which are among the families adapted best to the ecological conditions of the Mediterranean area as is also confirmed by many floristic studies of Greek insular areas (Panitsa & Tzanoudakis 2001, 2010; Kougioumoutzis & al. 2012; etc.). The Mediterranean character of the flora of the studied islet groups is reflected also by the high proportions of the Mediterranean plant taxa, in conjunction with the high percentage of therophytes.

Floristic cross-correlations of the studied islets (beta-diversity) according to the Sørensen similarity coefficient revealed values from 0.09, indicating high floristic heterogeneity, to 0.61, showing significant floristic similarity. Hierarchical cluster analyses divided the islets studied into three subgroups mainly based on surface area and the geographical position.

*paea* subsp. *europaea*, and also on all four islets of the Mesolongi Lagoon, such as *Juncus maritimus*, *Limonium narbonense*, *L. virgatum*, *Salsola tragus*, *Scirpoides holoschoenus* and *Tamarix hampeana*.

Table 5. Plant taxa on the two studied islet groups that are registered under a protection status. – AG = Amvrakikos Gulf islets; ML = Mesolongi Lagoon islets.

Taxon	AG	ML	Presidential Decree 67/1981	CITES	IUCN	European Red List	UNEP WCMC
<i>Achillea maritima</i>	–	×	–	–	–	–	×
<i>Aegilops biuncialis</i>	–	×	–	–	–	–	×
<i>Aeluropus litoralis</i>	–	×	–	–	–	–	×
<i>Alkanna tinctoria</i>	–	×	–	–	–	–	×
<i>Arthrocnemum macrostachyum</i>	×	×	–	–	–	–	×
<i>Calystegia soldanella</i>	–	×	–	–	–	–	×
<i>Centaureum erythraea</i>	×	×	–	–	LC	–	–
<i>Cyclamen hederifolium</i>	×	–	–	×	–	–	×
<i>Ephedra foeminea</i>	×	–	–	–	LC	–	–
<i>Euphorbia dendroides</i>	–	×	–	×	–	–	×
<i>Euphorbia paralias</i>	×	×	–	–	–	–	×
<i>Euphorbia pepalis</i>	–	×	–	–	–	–	×
<i>Geranium purpureum</i>	–	×	–	–	–	–	×
<i>Glaucium flavum</i>	–	×	–	–	–	–	×
<i>Juncus inflexus</i>	×	×	–	–	LC	–	–
<i>Juniperus phoenicea</i>	×	×	–	–	LC	–	×
<i>Lagurus ovatus</i>	×	×	–	–	–	–	×
<i>Medicago marina</i>	–	×	–	–	–	LC	×
<i>Nerium oleander</i>	–	×	–	–	LC	–	–
<i>Ononis reclinata</i>	–	×	–	–	–	–	×
<i>Ophrys scolopax</i> subsp. <i>cornuta</i>	×	–	×	×	–	–	–
<i>Orobanche minor</i>	–	×	–	–	–	–	×
<i>Pancratium maritimum</i>	–	×	–	–	–	–	×
<i>Parapholis incurva</i>	×	×	–	–	–	–	×
<i>Phragmites australis</i>	×	×	–	–	LC	LC	–
<i>Pistacia lentiscus</i>	×	×	–	–	–	–	×
<i>Prasium majus</i>	×	×	–	–	–	–	×
<i>Ranunculus chius</i>	–	×	–	–	–	–	×
<i>Reichardia picroides</i>	×	×	–	–	–	–	×
<i>Schoenus nigricans</i>	–	×	–	–	LC	–	–
<i>Scirpoides holoschoenus</i>	–	×	–	–	LC	–	–
<i>Serapias vomeracea</i>	×	–	×	×	–	LC	×
<i>Tamarix hampeana</i>	×	×	–	–	–	–	×
<i>Tetragonolobus purpureus</i>	×	–	–	–	LC	–	–
<i>Trifolium angustifolium</i>	×	×	–	–	LC	–	–
<i>Trifolium scabrum</i>	–	×	–	–	LC	–	–
<i>Trifolium tomentosum</i>	–	×	–	–	–	–	×
<i>Vulpia fasciculata</i>	–	×	–	–	–	–	×

Furthermore, the proportion of islets on which a taxon occurs showed that about 20 % of the taxa are frequent on more than half of the islets, while 72.6 % of the taxa are rare or not common in the islet group, being found only on one to three of the islets. Island similarities concerning all native taxa show a significant geographical component, reflecting the spatial autocorrelation of floras before the fragmentation of the mainland – or the effects of intensive post-fragmentation dispersal (Triantis & al. 2008b).

The high occurrence on the studied islets of taxa such as *Myrtus communis*, *Olea europaea* subsp. *europaea* and *Pistacia lentiscus* is a nice example of one of the most outstanding ecological plant-avian frugivore interactions. Panitsa & Tzanoudakis (2010) also mentioned that the

high incidence of *Olea europaea* and *Pistacia lentiscus* represent characteristic examples of plant species introduction via sea birds to islets around the E Aegean island of Leros.

As the islet groups of the Amvrakikos Gulf and Mesolongi Lagoon belong to national parks that are nature reserves under the International Ramsar Convention and designated as Important Bird Areas, it is critical to mention here that the islets studied, as a part of warm lowlands in the Mediterranean, are also important wintering quarters for European frugivorous birds. González-Varo (2010) suggested that, in a conservation context, it may be possible to sustain frugivore animal numbers by promoting succession within extant patches of vegetation

instead of increasing woodland cover (reforestation) at landscape level.

In addition, the role of the Mesolongi Lagoon islets as barrier islets should be noted. Looney & Gibson (1995) noticed that on coastal barrier islands the seed bank of low disturbance, late-succession vegetation types was well developed in contrast to a poorly developed and transient seed bank occurring in more frequently disturbed, early successional dredge-spoil unvegetated areas and strand. Stallins & Parker (2003) outlined the complex interplay between disturbance and environmental gradients (plant species abundances, landform-mediated physical gradients, sediment mobility) that influence biogeographical patterns. This is in accordance with the relatively high plant species richness and the absence of endemic plant taxa on the investigated islets that could additionally be attributed to their low elevation and their relatively recent isolation from the mainland.

The investigation of factors affecting plant species richness showed that, for the islet groups studied here, the total species richness is strongly correlated to island surface area. There is a strong species-area relationship ( $R^2 = 0.741$ ), as was also found for the islands of the S Aegean ( $R^2 = 0.73$ ) by Kagiampaki & al. (2011). This corroborates that, in general, surface area is considered the most influential explanatory variable of species richness in island biogeography (Whittaker & Fernández-Palacios 2007; Triantis & al. 2008a, 2008b).

The logarithmic approach of the power function ( $S = cAz$ ) of Arrhenius's model (1921) explains best the variation in species richness (Willerslev & al. 2002) and shows higher slopes for "island"-like species-area relationships than "mainland" relationships according to Rosenzweig (1995). The slope as expressed by the  $z$ -value of the species-area relationship for the studied islet groups is 0.343. This is not close to the "canonical" value of 0.263 set up by Preston (1962) and MacArthur & Wilson (1967), but it is within the range of 0.2–0.5 proposed by Rosenzweig (1995) for island groups indicating the above-mentioned "mainland" species-area relationship. It should be mentioned that for the neighbouring islet group of Echinades situated in the Ionian open sea, the  $z$ -value is 0.236 (Iliadou & al. 2014). The slope ( $z$ -value) shows the increase rate of species richness with area and it can vary according to the examined geographical unit and the taxonomic group analysed (Duarte & al. 2008; MacArthur & Wilson 1967).

In conclusion, the present study shows that the islet groups of the Amvrakikos Gulf and the Mesolongi Lagoon host a significant plant species richness and high overall heterogeneity. The role of geographical position, geological history, palaeogeography and of variables such as island surface area determines the individual islet floras. The inventory of the plant species diversity of the islets in the Amvrakikos Gulf and the Mesolongi Lagoon, the exploration of plant species-richness patterns and of the effects of factors affecting them, fills one more gap

in the floristic information available for both the "Amvrakikos Wetlands National Park" and the "National Park of Mesolongi – Aitoliko lagoons, estuaries of Acheloos and Evinos River and Echinades islet group", thus adding to and complementing the case of the Echinades islets group (Iliadou & al. 2014). In order to propose and implement proper measures for the conservation management of species and habitats in the given protected areas, knowledge of the species diversity basically presented here is of crucial importance.

## Acknowledgements

This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) – Research Funding Program: Heraclitus II. Investing in knowledge society through the European Social Fund. In addition, the authors would like to thank two anonymous reviewers for their valuable comments on an earlier draft of this paper.

## References

- Arianoutsou M., Bazos I., Delipetrou P. & Kokkoris Y. 2010: The alien flora of Greece: taxonomy, life traits and habitat preferences. – *Biol. Invas.* **12**: 3525–3549.
- Arrhenius O. 1921: Species and area. – *J. Ecol.* **9**: 95–99.
- Bagnouls F. & Gaussen H. 1953: Saison sèche et indice xérothermique. – *Doc. Cartes Prod. Vég.* **3**: 1–47.
- Bilz M., Kell S. P., Maxted N. & Lansdown R. V. 2011: European Red List of vascular plants. – Luxembourg: Publications Office of the European Union.
- Buttler K. P. & Thieme M. 2013: Florenliste von Deutschland – Gefäßpflanzen. (Version 5 – Juli 2013). – Published at <http://www.kp-buttler.de/florenliste/index.htm> [accessed 22 Jun 2014].
- Dimopoulos P., Bergmeier E. & Fischer P. 2005: Monitoring and conservation status assessment of habitat types in Greece: Fundamentals and exemplary cases. – *Ann. Bot. (Rome)*, n.s., **5**: 7–20.
- Dimopoulos P., Raus Th., Bergmeier E., Constantinidis Th., Iatrou G., Kokkini S., Strid A. & Tzanoudakis D. 2013: Vascular plants of Greece: an annotated checklist. – Berlin: Botanischer Garten und Botanisches Museum Berlin-Dahlem, Freie Universität Berlin; Athens: Hellenic Botanical Society. – *Englera* **31**.
- Duarte M. C., Rego F., Romeiras M. M. & Moreira I. 2008: Plant species richness in the Cape Verde Islands – Eco-geographical determinants. – *Biodivers. & Conservation* **17**: 453–466.
- Emberger L. 1952: Sur le quotient pluviothermique. – *Compt. Rend. Hebd. Séances Acad. Sci.* **234**: 2508–2510.



- González-Varo, J. P. 2010: Fragmentation, habitat composition and the dispersal/predation balance in interactions between the Mediterranean myrtle and avian frugivores. – *Ecography* **33**: 185–197.
- IGME (ed.) 1989: Geological map of Greece, 1: 50 000, Messolongion, Vonitsa and Arta Sheets. – Athens: Institute of Geology and Mineral Exploration [IGME].
- Iliadou E., Panitsa M., Raus Th. & Dimopoulos P. 2014: Flora and factors affecting species diversity in protected “Natura 2000” sites of the Ionian area: the Echinades islet group (Greece). – *Willdenowia* **44**: 121–136.
- IUCN 2013: The IUCN Red List of threatened species. Version 2013.2. – Published at <http://www.iucnredlist.org> [accessed 21 Nov 2013].
- Kagiampaki A., Triantis K., Vardinoyannis K. & Mylonas M. 2011: Factors affecting plant species richness and endemism in the South Aegean (Greece). – *J. Biol. Res.* **16**: 282–295.
- Kissling W. D., Field R. & Böhning-Gaese K. 2008: Spatial patterns of woody plant and bird diversity: functional relationships or environmental effects? – *Global Ecol. Biogeogr.* **17**: 327–339.
- Kouglioumoutzis K., Tiniakou A., Georgiou O. & Georgiadis T. 2012: Contribution to the flora of the South Aegean volcanic arc: Anafi island (Kiklades, Greece). – *Willdenowia* **42**: 127–141.
- Leftheriotis, G. A., Horsch, G. M. and Fourniotis, N. Th. 2013: A numerical study of the hydrodynamic circulation of the Messolonghi-Aetoliko lagoonal system. – Pp. 1061–1070 in: Proceedings on Coastal Dynamics 2013, 7th International Conference on Coastal Dynamics, 24–28 June, Arcachon.
- Looney P. B. & Gibson D. J. 1995: The relationship between the soil seed bank and above-ground vegetation of a coastal barrier island. – *J. Veg. Sci.* **6**: 825–836.
- MacArthur R. H. & Wilson E. O. 1967: The theory of island biogeography. – Princeton: University Press.
- May S. M., Vött A., Brückner H., Grapmayer R., Handl M. & Wennrich V. 2012: The Lefkada barrier and beachrock system (NW Greece) – Controls on coastal evolution and the significance of extreme wave events. – *Geomorphology* **139–140**: 330–347.
- Panitsa M. & Tzanoudakis D. 2001: A floristic investigation of the islet groups Arki and Lipsi (East Aegean area, Greece). – *Folia Geobot.* **36**: 265–279.
- Panitsa M. & Tzanoudakis D. 2010: Floristic diversity on small islands and islets: Leros islet group (East Aegean area, Greece). – *Phytol. Balcan.* **16**: 271–284.
- Pignatti S. (ed.) 1982: Flora d’Italia **1–3**. – Bologna: Edagricole.
- Preston F. W. 1962: The canonical distribution of commonness and rarity: part I. – *Ecology* **43**: 185–215.
- Rosenzweig M. L. 1995: Species diversity in space and time. – Cambridge: University Press.
- Sørensen T. 1948: A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. – *Biol. Skr.* **5**: 1–34.
- Stallins J. A. & Parker A. J. 2003: The influence of complex systems interactions on barrier island dune vegetation pattern and process. – *Ann. Assoc. Amer. Geogr.* **93**: 13–29.
- StatSoft, Inc. 2001: STATISTICA, version 6. [data analysis software system] – Published at <http://www.statsoft.com>
- Strid A. & Tan K. (ed.) 1997: Flora hellenica **1**. – Königstein: Koeltz Scientific Books.
- Strid A. & Tan K. (ed.) 2002: Flora hellenica **2**. – Ruggell: A. R. G. Gantner.
- Triantis K. A., Mylonas M. & Whittaker R. J. 2008a: Evolutionary species-area curves as revealed by single-island endemics: Insights for the inter-provincial species-area relationship. – *Ecography* **31**: 401–407.
- Triantis K. A., Nogués-Bravo D., Hortal J., Borges P. A. V., Adersen H., Fernández-Palacios J. M., Araújo M. B. & Whittaker R. J. 2008b: Measurements of area and the (island) species-area relationship: new directions for an old pattern. – *Oikos* **117**: 1555–1559.
- Tutin T. G., Burges N. A., Chater A. O., Edmondson J. R., Heywood V. H., Moore D. M., Valentine D. H., Walters S. M. & Webb D. E. (ed.) 1993: Flora europaea, ed. 2, **1**. – Cambridge: University Press.
- Tutin T. G., Heywood V. H., Burges N. A., Moore D. M., Valentine D. H., Walters S. M. & Webb D. E. (ed.) 1968–1980: Flora europaea, **2–5**. – Cambridge: University Press.
- UNEP 2014: The Species+ Website. Nairobi, Kenya. Compiled by UNEP-WCMC, Cambridge, UK. – Published at: <http://www.speciesplus.net> [accessed 17 Nov 2014].
- UNESCO – FAO. 1963: Étude écologique de la zone méditerranéenne. Carte bioclimatique de la zone méditerranéenne. Notice explicative. – Paris: l’Organisation des Nations Unies pour l’éducation, la science et la culture; Rome: l’organisation des Nations Unies pour l’alimentation et l’agriculture. – [Recherches sur la Zone Aride XXI].
- Vött A., Brückner H., May M., Lang F. & Brockmüller S. 2007: Late Holocene tsunami imprint at the entrance of the Ambrakian gulf (NW Greece). – *Méditerranée* **108**: 43–57.
- Whittaker R. J. & Fernández-Palacios J. M. (ed.) 2007: Island biogeography. Ecology, evolution and conservation. – Oxford: University Press.
- Willerslev E., Hansen A. J., Nielsen K. K. & Adersen H. 2002: Number of endemic and native plant species in the Galápagos Archipelago in relation to geographical parameters. – *Ecography* **25**: 109–119.

## Appendix: Vascular plant catalogue

Symbols and abbreviations:

Life-form categories (following Dimopoulos & al. 2013):  
**C** = chamaephyte; **H** = hemicryptophyte; **G** = geophyte;  
**P** = phanerophyte; **T** = therophyte.

Chorological categories (following Dimopoulos & al. 2013): **Co** = Cosmopolitan; **EA** = European-SW Asian; **EM** = East Mediterranean; **ES** = Euro-Siberian; **MA** = Mediterranean-Atlantic; **Me** = Mediterranean; **ME** = Mediterranean-European; **MS** = Mediterranean-SW Asian; **Pt** = Paleotemperate; **ST** = Subtropical-tropical.

**AG1–AG6, ML1–ML4** = Amvrakikos Gulf and Mesolongi Lagoon islet codes; see Table 1.

[ ] = Alien taxa according to Arianoutsou & al. (2010).

### Gymnosperms

#### Cupressaceae

*Juniperus phoenicea* L. – P, Me; AG1, AG6, ML1, ML2, ML3, ML4.

#### Ephedraceae

*Ephedra foeminea* Forssk. – P, Me; AG5.

### Angiosperms

#### Alliaceae

*Allium ampeloprasum* L. – G, Me; AG1, AG3, AG5, AG6.

*Allium subhirsutum* L. – G, Me; AG1, AG2, AG3.

#### Amaryllidaceae

*Narcissus tazetta* L. – G, MS; AG1, AG2, AG5.

*Pancratium maritimum* L. – G, Me; ML3.

#### Anacardiaceae

*Pistacia lentiscus* L. – P, Me; AG1, AG2, AG3, AG4, AG5, AG6, ML1, ML2, ML3, ML4.

#### Apiaceae

*Crithmum maritimum* L. – C, ME; AG1.

*Daucus guttatus* Sm. – T, Me; ML1, ML2, ML3.

*Echinophora spinosa* L. – H, Me; ML1, ML2.

*Eryngium maritimum* L. – G, ME; ML1, ML2, ML3.

*Ferula communis* subsp. *glauca* (L.) Rouy & Camus – H, Me; AG4, AG5.

*Oenanthe silaifolia* M. Bieb. – H, EA; AG1, AG2.

*Opopanax chironium* (L.) W. D. J. Koch – H, ME; AG1, AG2, AG3, AG4, AG5, ML3.

*Pseudorlaya pumila* (L.) Grande – T, Me; ML1, ML2.

*Torilis nodosa* (L.) Gaertn. – T, EA; ML1, ML2, ML3.

#### Apocynaceae

*Nerium oleander* L. – P, Me; ML1, ML3.

#### Araceae

*Arisarum vulgare* Targ. Tozz. – G, Me; AG1, AG2, AG3, AG5, AG6.

*Arum italicum* Mill. subsp. *italicum* – G, ME; AG5, AG6.

#### Asparagaceae

*Asparagus acutifolius* L. – P, Me; AG1, AG2, AG3, AG4, AG5, AG6, ML1, ML2, ML3, ML4.

#### Asphodelaceae

*Asphodelus ramosus* L. subsp. *ramosus* – G, Me; AG1, AG2, AG3, AG5, ML1, ML2, ML3, ML4.

#### Asteraceae

*Achillea maritima* (L.) Ehrend. & Y. P. Guo – C, MA; ML1, ML2.

*Aetheorhiza bulbosa* (L.) Cass. – G, EM; ML2, ML3, ML4.

*Andryala integrifolia* L. – T, Me; ML1.

*Anthemis arvensis* subsp. *incrassata* (Loisel.) Nyman – T, Me; AG1, ML2, ML3.

*Anthemis chia* L. – T, Me; AG1, ML2.

*Anthemis tomentosa* L. – T, EM; AG1, AG5, ML1, ML2.

*Bellis sylvestris* Cirillo – H, Me; AG1, AG2.

*Carduus pycnocephalus* L. – H, ME; AG5, ML1, ML3.

*Carlina gummifera* (L.) Less. – H, Me; ML2.

*Carlina lanata* L. – T, Me; AG1, ML1.

*Carthamus lanatus* L. – T, Me; AG1, AG5.

*Crepis multiflora* Sm. – T, EM; ML1.

[*Erigeron bonariensis* L.] – T, [Neotrop]; ML1, ML4.

*Filago gallica* L. – T, MA; ML2.

*Glebionis segetum* (L.) Fourr. – T, Me; AG5.

*Hedynois rhagadioloides* (L.) F. W. Schmidt – T, Me; AG1, AG2, AG4, AG5, ML1.

*Hyoseris scabra* L. – T, Me; AG1.

*Hypochaeris achyrophorus* L. – T, Me; AG1, AG2, AG3, AG4, AG5, ML1, ML2.

*Limbarda crithmoides* (L.) Dumort. – C, MA; AG1, AG2, AG3, AG4, AG5, AG6, ML1, ML2, ML3, ML4.

*Pallenis spinosa* (L.) Cass. – T, Me; AG1, AG2, AG4, ML4.

*Pulicaria odora* (L.) Rchb. – H, Me; AG1.

*Reichardia picroides* (L.) Roth – H, Me; AG1, AG2, AG3, AG4, ML1, ML2, ML3.

*Scolymus hispanicus* L. – H, ME; AG1, ML1, ML3.

*Silybum marianum* (L.) Gaertn. – H, Me; ML1.

*Sonchus asper* (L.) Hill – T, Pt; AG3, AG4, AG5, ML4.

*Sonchus oleraceus* L. – T, ME; AG1, AG3, ML3, ML4.

[*Symphotrichum squamatum* (Spreng.) G. L. Nesom] – T, [Neotrop]; ML3.

*Taraxacum* sp. – H; ML3.

*Urospermum picroides* (L.) F. W. Schmidt – T, Me; AG1, AG5, ML1, ML3, ML4.

[*Xanthium orientale* subsp. *italicum* (Moretti) Greuter] – T, [S-Eur. ]; ML1, ML2, ML3.

#### Boraginaceae

*Alkanna tinctoria* Tausch – H, Me; ML1, ML2.

*Borago officinalis* L. – T, Me; AG5.  
*Cerintho major* L. – T, MS; AG5.  
*Echium italicum* L. – H, MS; ML2.  
*Echium plantagineum* L. – T, ME; ML3.

### **Brassicaceae**

*Cakile maritima* Scop. – T, ME; AG1, AG5, ML2, ML3, ML4.  
*Capsella bursa-pastoris* (L.) Medik. – H, Co; AG3.  
*Enarthrocarpus arcuatus* Labill. – T, EM; AG5.  
*Hirschfeldia incana* (L.) Lagr.-Foss. – H, EA; ML1.  
*Malcolmia maritima* (L.) R. Br. – T, Me; AG1, AG5, ML3, ML4.  
*Matthiola tricuspidata* (L.) R. Br. – T, Me; AG1, AG5, ML1, ML2, ML3, ML4.  
*Rapistrum rugosum* (L.) All. – T, EA; AG1.

### **Caprifoliaceae**

*Lonicera implexa* Aiton – P, Me; AG1, AG2, AG3, AG4, AG5, AG6, ML1.

### **Caryophyllaceae**

*Cerastium glutinosum* Fr. – T, EA; ML1, ML2.  
*Cerastium semidecandrum* L. – T, EA; ML4.  
*Petrorhagia dubia* (Raf.) G. López & Romo – T, Me; ML1, ML2.  
*Sagina maritima* G. Don – T, MA; ML4.  
*Silene nocturna* L. – T, Me; ML1.  
*Silene vulgaris* subsp. *macrocarpa* Turrill – H, Me; AG5.  
*Spergularia marina* (L.) Besser – T, Pt; ML1.  
*Stellaria apetala* Ucria – T, EA; ML3.

### **Chenopodiaceae**

*Arthrocnemum macrostachyum* (Moric.) K. Koch – C, Me; AG1, ML2, ML3, ML4.  
*Atriplex prostrata* DC. – T, ES; AG1, AG5, ML1, ML3.  
*Beta vulgaris* subsp. *maritima* (L.) Arcang. – H, EA; AG4, ML1.  
*Chenopodium murale* (L.) S. Fuentes & al. – T, EA; AG1.  
*Halimione portulacoides* (L.) Aellen – C, ME; AG1, AG3, AG5, AG6, ML1, ML3, ML4.  
*Salicornia perennans* Willd. subsp. *perennans* – T, EA; ML1, ML3, ML4.  
*Salsola soda* L. – T, Pt; AG1, AG2, AG5, ML2, ML4.  
*Salsola tragus* L. – T, Pt; ML1, ML2, ML3, ML4.  
*Sarcocornia fruticosa* (L.) A. J. Scott – C, MA; AG1, AG2, AG5, ML2, ML3, ML4.  
*Sarcocornia perennis* (Mill.) A. J. Scott – C, MA; AG1, ML1, ML2, ML3, ML4.  
*Suaeda maritima* (L.) Dumort. – T, EA; ML1, ML3, ML4.

### **Cistaceae**

*Cistus salviifolius* L. – P, Me; ML1, ML2, ML4.  
*Fumana thymifolia* (L.) Webb – C, Me; AG1.

### **Convolvulaceae**

*Calystegia soldanella* (L.) Roem. & Schult. – G, Co; ML2.  
*Convolvulus arvensis* L. – G, Co; ML2.  
*Convolvulus elegantissimus* Mill. – H, Me; AG1.

### **Cyperaceae**

*Carex divisa* Huds. – G, EA; AG5, ML3.  
*Carex extensa* Gooden. – H, MA; AG1, ML1, ML2, ML3.  
*Carex flacca* subsp. *serrulata* (Spreng.) Greuter – G, MS; AG1, AG2, AG5.  
*Cyperus capitatus* Vand. – G, Me; ML2.  
*Schoenus nigricans* L. – H, Co; ML2, ML3, ML4.  
*Scirpoides holoschoenus* (L.) Soják – G, Pt; ML1, ML2, ML3, ML4.

### **Dipsacaceae**

*Knautia integrifolia* (L.) Bertol. – T, Me; AG5.

### **Ericaceae**

*Arbutus unedo* L. – P, Me; AG2, AG6.

### **Euphorbiaceae**

*Euphorbia dendroides* L. – P, Me; ML1, ML2.  
*Euphorbia exigua* L. – T, ME; AG2, AG5.  
*Euphorbia helioscopia* L. – T, Co; ML1.  
*Euphorbia paralias* L. – C, Me; AG1, ML1, ML2, ML3, ML4.  
*Euphorbia peplis* L. – T, ME; ML1.  
*Euphorbia peplus* L. – T, Co; AG1, AG3, ML2.  
*Mercurialis annua* L. – T, Pt; AG1, AG5, ML1.

### **Fabaceae**

*Anagyris foetida* L. – P, Me; ML1, ML4.  
*Anthyllis hermanniae* L. – C, Me; ML1, ML2, ML4.  
*Calicotome villosa* (Poir.) Link – P, Me; AG1, AG2.  
*Dorycnium hirsutum* (L.) Ser. – C, Me; AG1.  
*Genista acanthoclada* DC. – P, EM; ML2, ML4.  
*Lotus corniculatus* L. – H, EA; ML1.  
*Lotus ornithopodioides* L. – T, Me; AG1, AG2, AG3, AG5.  
*Medicago marina* L. – C, ME; ML2.  
*Medicago minima* (L.) Bartal. – T, Pt; AG1, AG2.  
*Medicago orbicularis* (L.) Bartal. – T, MS; ML1.  
*Medicago polymorpha* L. – T, Pt; AG1, AG2, AG5, ML1, ML3.  
*Medicago truncatula* Gaertn. – T, MS; AG1, ML1.  
*Melilotus indicus* (L.) All. – T, EA; AG1, ML1, ML3.  
*Melilotus sulcatus* Desf. – T, Me; AG1, AG5.  
*Ononis reclinata* L. – T, ME; ML1, ML2.  
*Scorpiurus muricatus* L. – T, Me; AG1, ML2.  
*Securigera securidaca* (L.) Degen & Dörfel. – T, Me; AG5.  
*Spartium junceum* L. – P, Me; AG2, AG3, AG5, AG6.  
*Tetragonolobus purpureus* Moench – T, Me; AG5.  
*Trifolium angustifolium* L. – T, EA; AG1, AG2, AG5, ML1, ML2, ML4.

*Trifolium campestre* Schreb. – T, EA; AG1, AG5, ML1, ML2.

*Trifolium lappaceum* L. – T, MS; AG1, ML1, ML2.

*Trifolium nigrescens* Viv. – T, Me; AG1.

*Trifolium scabrum* L. – T, EA; ML1, ML2, ML4.

*Trifolium stellatum* L. – T, Me; ML1.

*Trifolium tomentosum* L. – T, Me; ML1.

*Trigonella corniculata* subsp. *balansae* (Boiss. & Reut.) Lassen – T, EM; AG1, AG5.

*Vicia angustifolia* L. – T, Pt; AG2, ML3.

*Vicia villosa* subsp. *microphylla* (d'Urv.) P. W. Ball – T, EM; AG5.

### **Fumariaceae**

*Fumaria macrocarpa* Parl. – T, Me; AG1, AG2, AG3, AG5.

### **Gentianaceae**

*Blackstonia perfoliata* (L.) Huds. subsp. *perfoliata* – T, ME; AG1, AG5, ML1, ML2, ML3, ML4.

*Centaureum erythraea* Raf. – H, EA; AG1, AG5, ML2.

*Centaureum tenuiflorum* (Hoffmanns. & Link) Fritsch – T, ME; AG1.

### **Geraniaceae**

*Geranium purpureum* Vill. – T, Me; ML1, ML3.

*Geranium rotundifolium* L. – T, Pt; AG5.

### **Hyacinthaceae**

*Drimia numidica* (Jord. & Fourr.) J. C. Manning & Goldblatt – G, Me; AG2, ML1.

*Muscari comosum* (L.) Mill. – G, ME; AG1, AG2, AG5.

### **Hypericaceae**

*Hypericum tetrapterum* Fr. – H, EA; AG1.

### **Iridaceae**

*Gladiolus italicus* Mill. – G, MS; AG1, AG2, ML1, ML2.

### **Juncaceae**

*Juncus acutus* L. – H, ES; AG1, AG5, ML1, ML2, ML3, ML4.

*Juncus hybridus* Brot. – T, MA; ML1, ML2, ML4.

*Juncus inflexus* L. – H, Pt; AG1, ML1, ML2, ML3, ML4.

*Juncus maritimus* Lam. – G, ME; ML1, ML2, ML3, ML4.

### **Lamiaceae**

*Micromeria graeca* (L.) Rchb. – C, Me; AG1.

*Prasium majus* L. – C, Me; AG1, AG2, AG3, AG5, ML1, ML2.

*Thymbra capitata* (L.) Cav. – C, Me; AG1, ML1, ML2.

### **Linaceae**

*Linum bienne* Mill. – H, Me; ML2.

*Linum corymbulosum* Rchb. – T, EA; AG1, ML2.

*Linum strictum* L. – T, Me; ML1, ML2.

### **Malvaceae**

*Malva parviflora* L. – T, MS; ML1, ML3.

*Malva punctata* (All.) Alef. – T, Me; AG5.

### **Moraceae**

*Ficus carica* L. – P, MS; AG5, ML3.

### **Myrtaceae**

*Myrtus communis* L. – P, Me; AG1, AG2, AG3, AG4, AG5, ML1, ML4.

### **Oleaceae**

*Olea europaea* L. subsp. *europaea* – P, Me; AG1, AG2, AG4, AG5, AG6, ML1, ML4.

### **Orchidaceae**

*Ophrys scolopax* subsp. *cornuta* (Steven) E. G. Camus – G, ME; AG1.

*Serapias vomeracea* (Burm. f.) Briq. – G, ME; AG1.

### **Orobanchaceae**

*Orobanche minor* Sm. – T, EA; ML1, ML2.

### **Papaveraceae**

*Glaucium flavum* Crantz – H, ME; ML1, ML4.

### **Plantaginaceae**

*Plantago afra* L. – T, Me; AG1.

*Plantago coronopus* L. – T, MA; ML1, ML2.

*Plantago crassifolia* Forssk. – H, Me; ML1, ML2.

*Plantago lagopus* L. – T, Me; AG1, ML1.

*Plantago lanceolata* L. – H, Co; AG1, AG2, ML2.

### **Plumbaginaceae**

*Limonium narbonense* Mill. – H, MS; AG1, AG5, ML1, ML2, ML3, ML4.

*Limonium virgatum* (Willd.) Fourr. – H, Me; AG1, AG5, ML1, ML2, ML3, ML4.

### **Poaceae**

*Aegilops biuncialis* Vis. – T, MS; ML1.

*Aeluropus littoralis* (Gouan) Parl. – G, MS; ML1.

*Avena barbata* Link – T, Me; AG1, AG2, AG3, AG4, AG5, ML1.

*Brachypodium distachyon* (L.) P. Beauv. – T, MS; AG1, ML1, ML2.

*Brachypodium retusum* (Pers.) P. Beauv. – H, Me; AG1, AG2, AG3, AG4, AG5, ML1, ML2.

*Briza maxima* L. – T, ST; ML1, ML2.

*Bromus alopecuroides* Poir. – T, Me; AG1.

*Bromus diandrus* Roth – T, Me; ML1.

*Bromus madritensis* L. – T, MS; ML1.

*Bromus rigidus* Roth – T, ST; AG1, AG2, ML1.

*Bromus rubens* L. – T, MS; AG3, AG5.

*Bromus squarrosus* L. – T, Pt; ML2.  
*Bromus sterilis* L. – T, MS; ML1, ML2, ML3.  
*Catapodium marinum* (L.) C. E. Hubb. – T, MA; AG1, AG3.  
*Catapodium rigidum* (L.) C. E. Hubb. – T, Me; AG1, AG3, AG5, ML1, ML2, ML4.  
*Cynosurus echinatus* L. – T, Me; AG5, ML1, ML2, ML3.  
*Dactylis glomerata* L. – H, Pt; AG1, AG2, AG3, AG4, AG5.  
*Digitaria sanguinalis* (L.) Scop. – T, Co; AG5.  
*Elytrigia juncea* (L.) Nevski – G, Me; AG1, AG2, AG3, AG4, AG5, ML2, ML3, ML4.  
*Festuca arundinacea* Schreb. – H, Pt; ML2.  
*Gastridium ventricosum* (Gouan) Schinz & Thell. – T, Me; AG1.  
*Gaudinia fragilis* (L.) P. Beauv. – T, Me; AG1, AG5, ML2.  
*Hordeum murinum* subsp. *leporinum* (Link) Arcang. – T, Me; AG1, AG2, ML1, ML2.  
*Imperata cylindrica* (L.) Raeusch. – G, Co; ML3, ML4.  
*Lagurus ovatus* L. – T, Me; AG1, AG3, AG5, ML1, ML2, ML3.  
*Lolium perenne* L. – H, ES; ML1, ML2.  
*Parapholis incurva* (L.) C. E. Hubb. – T, MA; AG1, AG2, AG4, AG5, ML1, ML2.  
[*Phalaris canariensis* L.] – T, [Macaronesian]; AG2, AG4, AG5.  
*Phragmites australis* (Cav.) Steud. – G, Co; AG1, ML1, ML2, ML3, ML4.  
*Piptatherum miliaceum* (L.) Coss. – H, Me; AG1.  
*Polypogon monspeliensis* (L.) Desf. – T, ST; AG1, ML1, ML2, ML4.  
*Puccinellia distans* (L.) Parl. – H, Pt; ML2, ML4.  
*Rostraria cristata* (L.) Tzvelev – T, Co; AG1, ML1.  
*Sporobolus pungens* (Schreb.) Kunth – G, ST; AG1, ML2, ML4.  
*Vulpia fasciculata* (Forssk.) Fritsch – T, MA; ML1, ML2.

#### **Polygonaceae**

*Rumex bucephalophorus* L. – T, Me; ML1, ML2, ML3.  
*Rumex conglomeratus* Murray – H, EA; ML2, ML3.

#### **Primulaceae**

*Anagallis arvensis* L. – T, Co; AG1, AG2, AG3, ML1, ML2, ML4.  
*Cyclamen hederifolium* Aiton – G, Me; AG1, AG3, AG5.

#### **Ranunculaceae**

*Ranunculus chius* DC. – T, MS; ML1.  
*Ranunculus neapolitanus* Ten. – H, Me; AG1.

#### **Rhamnaceae**

*Rhamnus alaternus* L. – P, Me; ML2, ML4.

#### **Rosaceae**

*Rosa* sp. – P; AG2, AG4, AG5.  
*Rubus sanctus* Schreb. – P, MS; ML1.

#### **Rubiaceae**

*Crucianella latifolia* L. – T, ME; AG1.  
*Galium aparine* L. – T, EA; AG5, AG6, ML3.  
*Rubia peregrina* L. – P, MA; AG1, AG2, AG3, AG4, AG5, ML1, ML2, ML3.  
*Sherardia arvensis* L. – T, EA; AG5.  
*Theligonum cynocrambe* L. – T, Me; AG2.  
*Valantia hispida* L. – T, Me; ML2, ML3.  
*Valantia muralis* L. – T, Me; AG1, AG3, AG5, ML2, ML3.

#### **Scrophulariaceae**

*Verbascum blattaria* L. – H, EA; ML1.  
*Verbascum sinuatum* L. – H, MS; ML1, ML3.

#### **Smilacaceae**

*Smilax aspera* L. – P, Me; AG1, AG2, AG3, AG4, AG5, AG6, ML1, ML2, ML4.

#### **Solanaceae**

*Solanum nigrum* L. – T, Co; ML4.

#### **Tamaricaceae**

*Tamarix hampeana* Boiss. & Heldr. – P, EM; AG1, AG5, ML1, ML2, ML3, ML4.

#### **Urticaceae**

*Urtica urens* L. – T, Co; ML4.

#### **Vitaceae**

*Vitis* sp. – P; ML1.