Contribution to the study of the flora and vegetation of the Kithiraisland group: Offshore islets of Kithira (S Aegean, Greece)

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Contribution to the study of the flora and vegetation of the Kithira island group: Offshore islets of Kithira (S Aegean, Greece)

Abstract

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Data on the flora and vegetation of seven offshore islets of Kithira Island (Prasonisi, Megali Dragonera, Antidragonera, Kapelo, Avgo, Megalo Strongilo and Lidia) are presented. 145 vascular plant taxa (species and subspecies) are reported, of which all but three are new records for these islets. The observed vegetation units and habitat types are briefly described and the ecological value and biogeographical importance of the area are identified for conservation purposes and discussed.

Introduction

The South Aegean islands situated between southern Peloponnisos and Kriti are of great palaeogeographical significance and biogeographical interest. According to Creutzburg (1963) these islands belong to the Kithira-Antikithira island chain and are considered the remnant of a landbridge that once connected western Kriti with southern Peloponnisos. The largest of these islands is Kithira, which is situated only a few miles south of Peloponnisos. Kithira was separated from Peloponnisos in relatively recent geological times and as such should be considered the southernmost phytogeographical limit of mainland Greece (Iatrou 1994). Due to its biogeographically interesting position the area has been studied by many botanists (Greuter & Rechinger 1967, Yannitsaros 1969, 1971, 1998, 2004, Jagel 1992, Iatrou 1994, Tzanoudakis & al. 1998) and is considered one of the floristically best known areas in Greece. In the above studies emphasis has been given to the flora of the three largest islands (Kithira, Antikithira, Elafonisos) while data on the flora of the smaller islands and islets are very limited.

The present paper deals with the flora and vegetation of seven offshore islets of Kithira, namely Prasonisi, Megali Dragonera, Antidragonera, Kapelo, Avgo, Megalo Strongilo and Lidia.

These islets have been studied in the framework of two research projects ("Floristic and Phytogeographic Studies in the Aegean Area" and "Greek Natura 2000 Habitat Types Mapping and Documentation Project") both financially supported by the Greek Ministry of Environment, Regional Planning and Public Works. No literature exists on the flora and vegetation of these islets except an article by Artelari & Georgiou (2002), who report three *Limonium* species from the offshore islets of Kithira on the basis of collections made by the authors of the present study.

Study area

In spite of its close vicinity to Peloponissos, the Kithira island group belongs to the prefecture of Piraeus. The seven offshore islets studied here are situated close to the coasts of Kithira itself (Fig. 1). The surface area of the islets varies from less than one hectare to 32 hectares (Table 1). With one exception the highest point of the islets does not exceed 40 m, and the slopes are of more or less gentle gradients. The islet of Avgo (also named Chitra) has a rather different topography with steep hill slopes, very steep cliffs, and a highest altitude of 208 m above sea level.

All seven islets are uninhabited. However, human activities such as grazing and stock farming have taken place at some time, especially on the larger islets. Owing to its topography, the islet of Avgo has been left relatively undisturbed.

According to Emberger's coefficient (Emberger 1955, Mavrommatis 1980), the bioclimate of the Kithira area belongs to the sub-humid belt with warm winters almost free of frost and snow. According to the ombrothermic diagram of Bagnouls & Gaussen (1957), the dry period on Kithira Island lasts five and a half months, from early April to mid September.

Material and methods

The new floristic data on the Kithira offshore islets presented here are based on our collections and field observations during floristic and phytosociological investigations of the area in spring 1996 (24.-25.5.) and 2000 (22.-23.4.). Data on the islet Avgo, which must be assumed to have an almost virgin flora, should be considered insufficient as, with its very steep cliffs, the islet is almost inaccessible and hence we visited only one small part. Vouchers of our collections are deposited in the herbaria of Patras (UPA) and Athens (ATHU).

In the plant list, families, genera and species are in alphabetical order. Information regarding life form, chorological types and ecological preferences is given for each taxon.

To determine the plant material, Tutin & al. (1968-80, 1993) was mainly used, but Davis (1965-85) and Strid & Tan (1997, 2002) were also consulted. The nomenclature and distribution range of the taxa in most cases follows Tutin & al. (1968-80, 1993), Strid & Tan (1997, 2002) and, where available, Greuter & al. (1984-89). Chorological types and life form categories follow Pignatti (1982) and Raunkiaer (1934), respectively.

The ecological preferences of the taxa follow Böhling & al. (2002). Their ecological indicator value scales comprise: (1) 12 classes, expanded by an additional value "0" to reflect pronounced aridity in the Southern Aegean for moisture (F); (2) 9 classes for soil reaction related with the occurrence of the plants on the soil acidity gradient (R); (3) 9 classes for temperature reflecting the occurrence of the plants along a temperature gradient (T); (4) 9 classes for the occurrence of the plants along the general nutrient content gradient (N); (5) 9 classes for the occurrence of the plants depending on mean maximum salt concentration of sites (S). Value 1 reflects the lowest expression of a site factor, and value 9 the highest. 142 taxa were taken into consideration for this analysis, three taxa were identified only to the level of genus.

To allow floristic comparisons between the studied islets, a table presenting floristic similarities was prepared using Sørensen's similarity coefficient $C_s = 2j/(a+b)$ [where j = the number of plant taxa found on both of the two islets compared, a = the total number of plant taxa found on islet 1, and b = the total number of plant taxa found on islet 2] (Whittaker 1972).

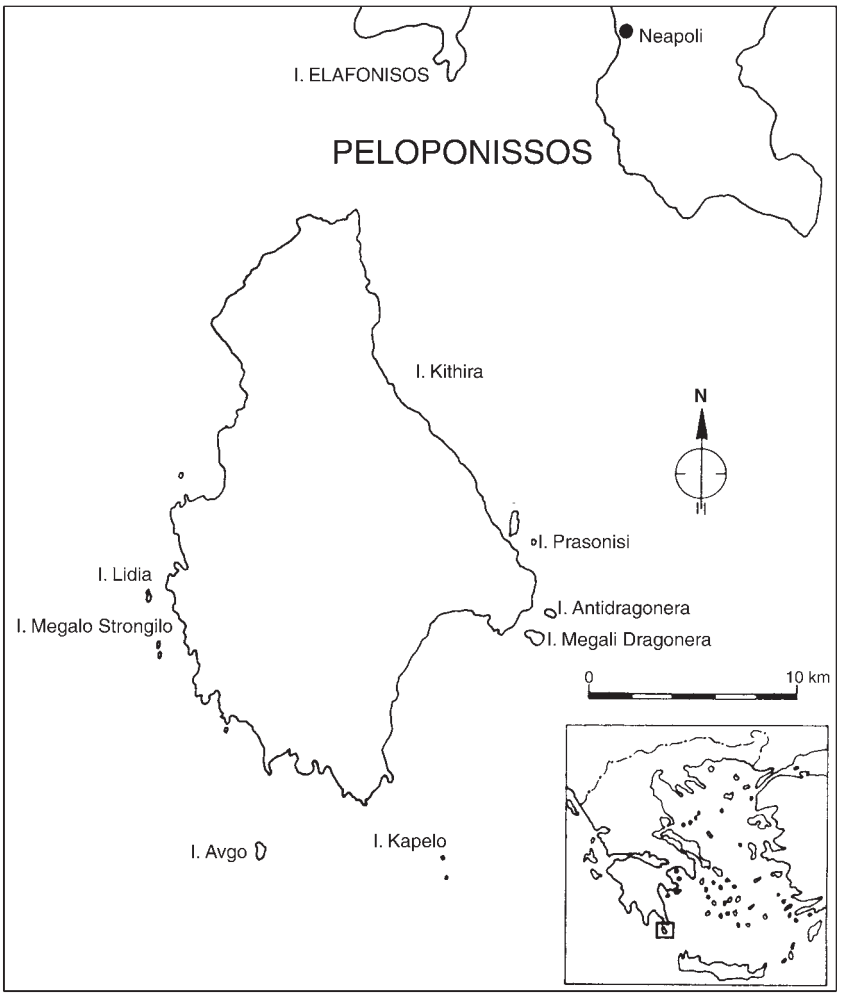

Fig. 1. Map of the offshore islets of Kithira.

Table 1. Geographical information on the offshore islets of Kithira.

Islet name and abbreviation	Geographical coordinates	Surface area (ha)	Highest altitude (m)	No. of taxa
Prasonisi (P)	36º16'00"N, 23º05'55"E	4	13	15
Antidragonera (An)	36º14'15"N, 23º06'50"E	15	40	88
Megali Dragonera (MD)	36º13'20"N, 23º06'45"E	32	36	109
Kapelo (K)	36º07'15"N, 23º05'40"E	<1	10	1
Lidia or Makronisi (L)	36º11'35"N, 22º54'05"E	3.5	27	15
Megalo Strongilo (MS)	36º10'30"N, 22º54'40"E	3	29	12
Avgo or Chitra (A)	36º06'00"N, 22º59'50"E	22	208	14

Symbols and abbreviations used in the floristic catalogue

1. Islet names (according to the topographical maps of H.A.G.S. 1976, 1977)
P = Prasonisi, An = Antidragonera, MD = Megali Dragonera, K = Kapelo, A = Avgo, MS = Megalo Strongilo, L = Lidia

2. Life forms
Phanerophytes (P): NP: Nano-p., Plian: lianose p.
Chamaephytes (C): Cfrut: fruticose c., Csuffr: suffruticose c., Csucc: succulent c.
Hemicryptophytes (H): Hscap: scapose h., Hcaesp: caespitose h., Hros: rosulate h.
Geophytes (G): Grhiz: rhizomatose g., Gbulb: bulbose g.
Therophytes (Th): Tscap: scapose t., Tros: rosulate t., Trept: reptant t., Tpar: parasite t.

3. Chorological types
Widespread: Cosmop.: Cosmopolitan, Subcosmop.: Subcosmopolitan, Subtropic.: Subtropical, Paleotrop.: Palaeotropical, Paleosubtrop.: Paleosubtropical, Paleotemp.: Paleotemperate, Medit.-Atl.: Mediterranean-Atlantic, Medit.-Turan.: Mediterranean-Turanian.
Mediterranean: E Medit.: East Mediterranean, Eurymedit.: Eurymediterranean, Stenomedit.: Stenomediterranean.
Endemic: Endem.: Greek, Aegean or local endemics, see Table 4.

4. Ecological indicator values
Temperature (T): T7: plants of fairly hot sites, T8: plants of fairly hot to hot sites, T9: plants of hot sites, º: plants with low indicator quality, but not indifferent.
Moisture (F): F1: indicator of very dry sites, F2: indicator of very dry to dry sites, F3: indicator of dry sites, F4: indicator of dry to fresh sites, F5: indicator of fresh-sites, F6: indicator of fresh to damp sites, F7: indicator of damp sites, º: plants with low indicator quality, but not indifferent.
Soil reaction (R): R7: indicator of weakly acid to weakly basic conditions, never found on very acid soils or always at pH 6.5-7.5, R8: indicator of weakly basic conditions, mostly indicating basic soils or always at pH 7.2-7.6, R9: lime indicator, always found on basic soils with pH > 7.6, #: the pH amplitude does not exceed the given pH values.
Salt stress tolerance (S): S0: halophob (glycophyte) species, S1: slightly halo-tolerant, S2: medium halo-tolerant or oligohaline, S3: very halo-tolerant or slightly mesohaline, S4: mesohaline, S5: highly mesohaline, S6: meso- to polyhaline, S7: polyhaline, S8: euhaline.
x: indifferent behaviour; wide ecological amplitude or different behaviour in different areas (no indicator properties).
?: unclarified ecological behaviour, assignment impossible so far.

Results and Discussion

1. Floristic catalogue

	Life form	Chorological type	Indicator values T	F	R	S	Distribution on the islets
Angiospermae							
Dicotyledones							
Anacardiaceae							
Pistacia lentiscus L.	NP	Stenomedit.	8	x	8	x	An, MD
Boraginaceae							
Anchusa variegata (L.) Lehm.	Tscap	Endem.	7º	3	7	0	An, MD

	Life form	Chorological type	Indicator values T	F	R	S	Distribution on the islets
Echium arenarium Guss.	Tscap	Stenomedit.	8	3	8	1	An
Neatostema apulum (L.) I. M. Johnst.	Tscap	Stenomedit.	8	2	8	1	MD
Campanulaceae							
Campanula drabifolia Sm.	Tscap	Endem.	8	2	8	1	An, MD
Capparaceae							
Capparis spinosa subsp. *rupestris* (Sm.) Nyman	NP	Stenomedit.	8	1	9#	3	P, An, L
Caryophyllaceae							
Polycarpon tetraphyllum (L.) L.	Tscap	Medit.-Turan.	8º	4	8	1	An
Silene sedoides Poir. subsp. *sedoides*	Tscap	Stenomedit.	8	1	9#	7	P, An, MD, A, MS, L
Spergularia bocconei (Scheele) Graebn.	Tscap	Subcosmop.	8	3	8	2	L
Chenopodiaceae							
Arthrocnemum macrostachyum (Moric.) K. Koch	Csucc	Stenomedit.	8	9º	9#	8	L
Suaeda vera J. F. Gmel.	Cfrut	Medit.-Atl.	8	x	8	5	K, A, MS, L
Compositae							
Aetheorhiza bulbosa subsp. *microcephala* Rech.f.	Gbulb	E Medit.	x	x	x	1	An, MD
Anthemis peregrina L. subsp. *peregrina*	Tscap	Stenomedit.	?	?	?	?	P, An, MD, MS, L
Anthemis rigida (Sm.) Boiss. & Heldr. subsp. *rigida*	Tscap	E Medit.	x	3º	x	2	An, MD
Anthemis scopulorum Rech.f.	Tscap	Endem.	8	4	9#	?	A
Asteriscus aquaticus (L.) Less.	Tscap	Stenomedit.	8	3	8	2	MD
Atractylis cancellata L. subsp. *cancellata*	Tscap	Stenomedit.	8º	2	8#	1	An, MD
Bellium minutum (L.) L.	Tscap	E Medit.	8	2	8	3	An
Carduus pycnocephalus subsp. *albidus* (M. Bieb.) Kazmi	Tscap	Medit.-Turan.	x	5º	7	0	MD
Carlina graeca Heldr. & Sart.	Hscap	E Medit.	x	3º	8	1	An, MD
Carlina lanata L.	Tscap	Stenomedit.	8	2	8	2	MD
Centaurea redempta subsp. *cytherea* (Rech.f.) Routsi & Georgiadis	Hscap	Endem.	8	2	8	x	A
Centaurea raphanina subsp. *mixta* (DC.) Runemark	Hros	Endem.	8	3º	8	1	An, MD
Cichorium spinosum L.	Csuffr	Stenomedit.	x	x	x	x	An, MD
Crepis ×*cytherea* Kamari	Tscap	Endem.	7	3	8	1	An, MD
Crepis multiflora Sm.	Tscap	E Medit.	8	x	9#	2	An, MD
Cynara cornigera Lindl.	Hscap	E Medit.	8	2	8	2	An
Galactites tomentosa Moench	Hbienn	Stenomedit.	8	6	7#	0	An
Hedypnois rhagadioloides subsp. *monspeliensis* (Murb.) Hayek	Tscap	Stenomedit.	8	4º	9#	0	An, MD
Hyoseris scabra L.	Tros	Stenomedit.	7º	5º	8	1	MD
Hypochaeris achyrophorus L.	Tscap	Stenomedit.	7º	3	x	1	An, MD
Phagnalon graecum Boiss. & Heldr.	Csuffr	E Medit.	8º	2	8#	1	An, MD
Ptilostemon chamepeuce (L.) Less.	Cfrut	E Medit.	7º	4º	8	1	An
Reichardia picroides (L.) Roth	Hscap	Stenomedit.	8º	x	8	x	P, An
Scorzonera cretica Willd.	Hscap	Endem.	8º	3	8	1	A
Scorzonera crocifolia Sm.	Hscap	Endem.	7º	3	8	1	MD

	Life form	Chorological type	Indicator values T	F	R	S	Distribution on the islets
Senecio bicolor (Willd.) Tod. subsp. *bicolor*	Csuffr	Stenomedit.	?	?	8	?	An
Senecio vulgaris L.	Tscap	Cosmop.	x	4	x	1	An, MD, L
Sonchus oleraceus L.	Tscap	Subcosmop.	7º	5º	8	1	An, A
Steptorhamphus tuberosus (Jacq.) Grossh.	Hscap	E Medit.	7º	3	7	0	MD
Tragopogon sp.	Hbienn						MD
Urospermum picroides (L.) F. W. Schmidt	Tscap	Eurymedit.	8º	4º	8	1	An, MD
Convolvulaceae							
Convolvulus oleifolius Desr. var. *oleifolius*	Cfrut	Stenomedit.	8	3	8	1	MD
Crassulaceae							
Sedum litoreum Guss.	Tscap	Stenomedit.	x	3º	8	1	An, MD
Cruciferae							
Biscutella didyma L. s.l.	Tscap	Medit.-Turan.	7º	3	7	1	MD
Brassica cretica subsp. *aegaea* (Heldr. & Halácsy) Snogerup & al.	Csuffr	E Medit.	7º	4	8	0	P, An, A, L
Malcolmia flexuosa subsp. *naxensis* (Rech.f.) Stork	Tscap	E Medit.	8	3	7	4	P, An, MD, A
Matthiola sinuata (L.) R.Br.	Hscap	Stenomedit.	8	3	8	1	MS
Dipsacaceae							
Knautia integrifolia (L.) Bertol. s.l.	Tscap	Eurymedit.	7º	4	7	0	An
Euphorbiaceae							
Euphorbia dendroides L.	NP	Stenomedit.	8	4º	8	1	An, MD
Euphorbia peplus L.	Tscap	Cosmop.	x	4	x	1	An, MD
Mercurialis annua L.	Tscap	Paleotemp.	8	x	8	1	MS, L, An, MD
Frankeniaceae							
Frankenia hirsuta L.	Csuffr	Medit.-Turan.	8	3	9#	6	P, An, MD, A, MS, L
Fumariaceae							
Fumaria macrocarpa Parl. subsp. *macrocarpa*	Tscap	E Medit.	8	5	8	0	An
Gentianaceae							
Blackstonia perfoliata (L.) Huds. subsp. *perfoliata*	Tscap	Eurymedit.	7	7	7	0	MD
Centaurium pulchellum (Sw.) Druce	Tscap	Paleotemp.	8º	5	9#	1	MD
Centaurium tenuiflorum (Hoffmanns. & Link) Fritsch subsp. *tenuiflorum*	Tscap	Stenomedit.	8	7	8	x	An
Geraniaceae							
Erodium cicutarium (L.) L'Hér.	Tscap	Subcosmop.	x	4	x	1	An, MD
Geranium robertianum subsp. *purpureum* (Vill.) Nyman	Tscap	Eurymedit.	7º	5	7	0	MD
Labiatae							
Coridothymus capitatus (L.) Rchb.f.	Cfrut	Stenomedit.	x	3	8	1	An
Prasium majus L.	Cfrut	Stenomedit.	8	3	x	1	MD
Sideritis curvidens Stapf	Tscap	E Medit.	8º	5º	8	1	An, MD
Teucrium capitatum L.	Csuffr	Stenomedit.	8	2	8	1	An, MD

	Life form	Chorological type	Indicator values T	F	R	S	Distribution on the islets
Teucrium divaricatum Heldr. subsp. *divaricatum*	Cfrut	E Medit.	8º	2	8	1	An, MD
Leguminosae							
Anthyllis vulneraria subsp. *rubriflora* (DC.) Arcang.	Hscap	Eurymedit.	x	4	8	0	MD
Calicotome villosa (Poir.) Link	NP	Stenomedit.	x	3	7	0	An, MD
Genista acanthoclada DC. subsp. *acanthoclada*	Cfrut	E Medit.	7º	3	x	1	MD
Hippocrepis biflora Spreng.	Tscap	Eurymedit.	8º	3	8#	0	MD
Lotus cytisoides L.	Csuffr	Stenomedit.	8	2	8	3	P, An, MD, A, L
Medicago monspeliaca (L.) Trautv.	Tscap	Eurymedit.	x	3	8	x	An
Ononis reclinata L.	Tscap	Eurymedit.	8º	2	8	1	An, MD
Trifolium campestre Schreb.	Tscap	Paleotemp.	x	4º	x	1	An, MD
Trifolium scabrum L.	Tscap	Eurymedit.	x	2	8	1	An, MD
Trifolium stellatum L.	Tscap	Eurymedit.	x	4	x	1	MD
Trigonella balansae Boiss. & Reut.	Tscap	E Medit.	8	3	8	2	P, An, MD, A
(*) *Trigonella rechingeri* Širj.	Tscap	Endem.	8	3	9#	6	MS, L
Linaceae							
Linum pubescens subsp. *sibthorpianum* (Margot & Reut.) P. H. Davis	Tscap	Stenomedit.	8	5	8	0	MD
Linum strictum subsp. *spicatum* (Pers.) Nyman	Tscap	Stenomedit.	8º	4	8	1	MD
Malvaceae							
Althaea hirsuta L.	Tscap	Eurymedit.	7	5	7	0	MD
Lavatera arborea L.	Hscap	Stenomedit.	8	5	8	3	P, MS, L
Malva cretica Cav. subsp. *cretica*	Tscap	Stenomedit.	8º	3	8#	0	MD
Orobanchaceae							
Orobanche sp.	Tpar						An
Plantaginaceae							
Plantago bellardii All. subsp. *bellardii*	Tros	Eurymedit.	8º	3	8	1	MD
Plantago lagopus L.	Tros	Eurymedit.	8º	4	8	1	MD
Plantago weldenii Rchb. subsp. *weldenii*	Tros	Eurymedit.	7º	5º	8	2	An, MD
Plumbaginaceae							
Limonium echioides (L.) Mill.	Tros	S Medit.	9	1	8	3	An
Limonium runemarkii Rech.f.	Tros	Endem.	8	2	9#	6	An, MD
Limonium sieberi (Boiss.) Kuntze	Csuffr	E Medit.	8	2	9#	6	A, MS
Primulaceae							
Anagallis arvensis L.	Trept	Subcosmop.	x	x	8	1	An, MD
Asterolinon linum-stellatum (L.) Duby	Tscap	Stenomedit.	x	4º	x	1	MD
Cyclamen graecum Link	Gbulb	E Medit.	7º	3	8	1	An, MD
Ranunculaceae							
Clematis cirrhosa L.	Plian	Stenomedit. -Turan.	7	5	7	0	MD
Delphinium hellenicum Pawł.	Tscap	Endem.	8	4	8	0	MD
Nigella damascena L.	Tscap	Eurymedit.	7º	5	7	0	MD
Nigella stricta Strid	Tscap	Endem.	8	1	8	3	An
Rosaceae							
Sarcopoterium spinosum (L.) Spach	Cfrut	E Medit.	7º	4	7	1	MD

	Life form	Chorological type	Indicator values T	F	R	S	Distribution on the islets
Rubiaceae							
Crucianella latifolia L.	Tscap	Stenomedit.	8º	3º	8	1	MD
Galium capitatum Bory & Chaub.	Tscap	Endem.	8	3	8	1	MD
Galium murale (L.) All.	Tscap	Eurymedit.	x	x	7	0	An, MD
Sherardia arvensis L.	Tscap	Subcosmop.	x	4	7	0	MD
Valantia hispida L.	Tscap	Stenomedit.	x	4º	8	2	An, MD
Valantia muralis L.	Tscap	Stenomedit.	x	4º	x	x	An, MD
Rutaceae							
Ruta chalepensis subsp. *fumariifolia* (Boiss. & Heldr.) Nyman	Csuffr	Endem.	8	2	8	1	An, MD
Santalaceae							
Thesium humile Vahl	Tscap	E Medit.	7	3	8	0	MD
Solanaceae							
Mandragora autumnalis Bertol.	Hros	Eurymedit.	7º	4	8	1	An
Theligonaceae							
Theligonum cynocrambe L.	Tscap	Stenomedit.	7º	4	x	0	An, MD
Umbelliferae							
Bupleurum greuteri Snogerup	Tscap	Endem.	8	3	8	0	MD
Crithmum maritimum L.	Csuffr	Medit.-Atl.	8	2	8	5	A
Daucus guttatus Sm.	Tscap	E Medit.	8º	4	8	1	MD
Elaeoselinum asclepium (L.) Bertol. subsp. *asclepium*	Hscap	Stenomedit.	7º	4	7	0	MD
Ferula communis subsp. *glauca* (L.) Rouy & Camus	Hscap	Eurymedit.	8	4	8	0	An, MD
Lagoecia cuminoides L.	Tscap	Medit.-Turan.	x	4	x	1	An, MD
Thapsia garganica L.	Hscap	Stenomedit.	7º	5	7	0	An, MD
Tordylium apulum L.	Tscap	Stenomedit.	7º	4	8	1	An, MD
Torilis nodosa (L.) Gaertn.	Tscap	Medit.-Turan.	x	5	7	1	MD
Urticaceae							
Parietaria cretica L.	Trept	E Medit.	8º	5	9#	1	An, MD
Parietaria lusitanica L. subsp. *lusitanica*	Trept	Stenomedit.	8	5	8	1	MD
Monocotyledones							
Araceae							
Arisarum vulgare Targ.-Tozz. subsp. *vulgare*	Gbulb	Stenomedit.	8º	x	x	1	An, MD
Gramineae							
Andropogon distachyos L.	Hcaesp	Stenomedit.	8	4	8	0	An
Avena barbata Link	Tscap	Eurymedit.	7º	x	x	1	An, MD
Brachypodium pinnatum (L.) P. Beauv.	Hcaesp	Paleotemp.	7º	x	7	1	MD
Bromus fasciculatus C. Presl	Tscap	E Medit.	8º	2º	8	2	An
Bromus intermedius Guss.	Tscap	Eurymedit.	x	x	8	1	An, MD
Bromus rubens L.	Tscap	Medit.-Turan.	8	1	8	3	An, MD
Catapodium marinum (L.) C.E. Hubb.	Tscap	Eurymedit.	8	3	8	3	An, MD
Catapodium rigidum (L.) C.E. Hubb.	Tscap	Eurymedit.	x	3	7	0	An, MD
Dactylis glomerata subsp. *hispanica* (Roth) Nyman	Hcaesp	Eurymedit.	7º	4º	x	1	P, An, MD
Elymus rechingeri (Runemark) Runemark	Grhiz	E Medit.	8	x	8	5	P, MD, MS, L

	Life form	Chorological type	Indicator values T	F	R	S	Distribution on the islets
Hyparrhenia hirta (L.) Stapf	Hcaesp	Paleotemp.	8	4	8	1	An
Lagurus ovatus L.	Tscap	Eurymedit.	7º	x	8	1	An
Lolium rigidum Gaudin subsp. *rigidum*	Tscap	Paleosubtrop.	x	5	8	1	MD
Melica minuta L.	Hcaesp	Medit.-Atl.	7º	3	8	1	MD
Parapholis incurva (L.) C.E. Hubb.	Tscap	Medit.-Atl.	8	6º	9#	7	P, An, MD
Rostraria cristata (L.) Tzvelev	Tscap	Subcosmop.	x	4º	8	x	P, An, MD, A, MS
Trachynia distachya (L.) Link	Tscap	Medit.-Turan.	8º	x	8	1	An, MD
Liliaceae s. l.							
Allium commutatum Guss.	Gbulb	Stenomedit.	8	2	9#	3	P, An, MS, L
Allium gomphrenoides Boiss. & Heldr.	Gbulb	Endem.	8	3	7	1	An, MD
Allium subhirsutum L.	Gbulb	Stenomedit.	7º	4	8	1	MD
Asparagus aphyllus subsp. *orientalis* (Baker) P.H. Davis	Cfrut	Stenomedit.	x	x	7	1	MD
Asphodelus ramosus Brot. subsp. *ramosus*	Grhiz	Stenomedit.	x	3º	7	1	An, MD
Colchicum cupanii Guss.	Gbulb	Stenomedit.	8	4	8	0	An, MD
Muscari commutatum Guss.	Gbulb	E Medit.	7	4º	8	0	An, MD
Muscari comosum (L.) Mill.	Gbulb	Eurymedit.	x	5º	x	0	MD
Ornithogalum sp.	Gbulb						MD
Urginea maritima (L.) Baker	Gbulb	Stenomedit.	8º	2º	8	1	An, MD

(*) The specimens have intermediate characters between *Trigonella rechingeri* and *T. balansae* and therefore more material is needed for further study.

2. Flora

The known vascular plant flora of the offshore islets of Kithira comprises 145 native taxa (118 species and 27 subspecies) belonging to 36 families and 117 genera. All are angiosperms; 117 of them are dicotyledons (33 families and 95 genera) and 28 are monocotyledons (3 families and 22 genera). Families richest in taxa, representing 19.5 % of the families recorded, are: *Compositae* (31 taxa), *Gramineae* (17 taxa), *Leguminosae* (12 taxa), *Liliaceae* s. l. (10 taxa), *Umbelliferae* (9 taxa), *Rubiaceae* (6 taxa) and *Labiatae* (5 taxa). Together these seven families comprise 90 taxa or 62.1 % of the vascular plant flora of the islets. These families are among those best adapted to the ecological conditions of the Mediterranean region according to many floristic studies of insular and mainland Greece.

The life form spectra and the chorological spectra are presented in Tables 2 and 3, respectively, with the exception of the islets Kapelo (on which only one chamaephyte taxon with a widespread distribution has been recorded) and Avgo (which is almost inaccessible and consequently its floristic data are insufficient). Concerning the life form spectra on the individual is-

Table 2. Life form spectra of the offshore islets of Kithira.

Islet	Therophytes % (no. of taxa)	Hemicryptophytes % (no. of taxa)	Chamaephytes % (no. of taxa)	Geophytes % (no. of taxa)	Phanerophytes % (no. of taxa)
MS	41.6 (5)	16.7 (2)	25 (3)	16.7 (2)	–
L	40 (6)	6.7 (1)	33.3 (5)	13.3 (2)	6.7 (1)
P	40 (6)	20 (3)	20 (3)	13.3 (2)	6.7 (1)
An	60.7 (53)	11.2 (10)	13.5 (12)	10.1 (9)	4.5 (4)
MD	63.3 (69)	8.3 (9)	12.8 (14)	11 (12)	4.6 (5)

Table 3. Chorological spectra of the offshore islets of Kithira.

Islet	Stenomedit. % (no. of taxa)	E Medit. % (no. of taxa)	Eurymedit. % (no. of taxa)	Endemic % (no. of taxa)	Widespread % (no. of taxa)
MS	33.3 (4)	16.7 (2)	–	16.7 (2)	33.3 (4)
L	40 (6)	13.3 (2)	–	13.3 (2)	33.4 (5)
P	46.6 (7)	20 (3)	6.7 (1)	6.7 (1)	20 (3)
An	33.7 (29)	22.5 (20)	15.7 (14)	7.9 (8)	20.2 (18)
MD	33.1 (36)	16.5 (18)	18.3 (20)	10.1 (11)	22 (24)

Table 4. Distribution of the Greek endemic taxa found in the study area, chorology according to Greuter & al. (1984-89).

Taxa	Islets							Chorology
	A	MS	L	K	P	An	MD	
Anchusa variegata (L.) Lehm.						*	*	Gr, Cr, AE
Campanula drabifolia Sm.						*	*	Gr
Anthemis scopulorum Rech. f.	*							Gr, Cr, AE
Centaurea redempta subsp. *cytherea* (Rech. f.) Routsi & Georgiadis	*							Kithira
Centaurea raphanina subsp. *mixta* (DC.) Runemark						*	*	Gr, AE
Crepis ×*cytherea* Kamari						*	*	Kithira - Antikithira
Scorzonera cretica Willd.	*							Gr, Cr, AE
Scorzonera crocifolia Sm.							*	Gr
Trigonella rechingeri Sirj.		*	*					Gr, Cr, AE
Allium gomphrenoides Boiss. & Heldr.						*	*	Gr
Limonium runemarkii Rech.f.						*	*	Gr, Cr
Delphinium hellenicum Pawł.							*	Gr
Nigella stricta Strid						*		Gr, Cr
Galium capitatum Bory & Chaub.							*	Gr
Ruta chalepensis subsp. *fumariifolia* (Boiss. & Heldr.) Nyman						*	*	Gr, Cr
Bupleurum greuteri Snogerup							*	Gr

lets, the results seem to be in accordance with the bio-climatological position of the area (sub-humid with an intense thermo-Mediterranean character) as expressed by the predominance of therophytes. It is evident from Table 2 that the representation of Raunkiaer's five life forms may vary from islet to islet.

A similar situation is observed in the chorological spectra of the islets studied (Table 3). The Mediterranean element as a unique chorological unit predominates. The endemic element is represented in the area by sixteen taxa, fourteen of which are Greek (s.str.) and/or Aegean endemics, and two endemics of the Kithira-Antikithira area (Table 4). It should be noted that three of these taxa (i.e. *Anthemis scopulorum, Scorzonera cretica* and *Trigonella rechingeri*) have not been found so far on the main island of Kithira. The percentages of the endemic element are rather high and emphasize the floristic and phytogeographical significance of the area. It should be mentioned that, according to data derived from Greuter & al. (1984, 1986, 1989), Turland & al. (1993), Tan & Iatrou (2001), Artelari & Georgiou (2002) and Yannitsaros (unpublished data), Kithira island has a significant number of Greek endemic taxa (at least 61 species and subspecies). Out of these taxa, six (3 species and 3 subspecies) are local endemics of the island of Kithira.

Table 5. Floristic relationships (b-diversity) between the investigated islets. The number of common taxa is shown above the diagonal and the values of Sørensen's similarity coefficient below it. The bold numbers along the diagonal show the number of plant taxa recorded from each islet.

Islet	MS	L	K	P	An	MD
MS	**12**	9	1	7	6	6
L	0.67	**15**	1	9	9	7
K	0.15	0.12	**1**	0	0	0
P	0.52	0.60	0	**15**	13	10
An	0.12	0.17	0	0.25	**88**	63
MD	0.10	0.11	0	0.16	0.63	**109**

The floristic independence of the islets and their floristic diversity are illustrated by the fact that none of the 145 taxa found has been recorded from all the seven islets. Among the most common species are *Silene sedoides* and *Frankenia hirsuta* that were both found on six islets. Other frequently encountered taxa are: *Lotus cytisoides, Rostraria cristata, Anthemis peregrina* subsp. *peregrina* on five islets, and *Brassica cretica* subsp. *aegaea, Allium commutatum, Elymus rechingeri, Malcolmia flexuosa* subsp. *naxensis, Suaeda vera* and *Trigonella balansae* on four islets. In contrast, 72 taxa (49.6 % of the taxa recorded) have been registered on not more than one islet and 57 taxa (39.3 %) on not more than two islets.

Peculiarities in the composition of the islet floras can be explained by a combination of random and other parameters (Panitsa & al. 1994, Panitsa & Tzanoudakis 2001). Of these peculiarities, the presence of plant taxa that behave as obligatory chasmophytes on larger islands and mainland areas (e.g. *Brassica cretica* subsp. *aegaea,* one of the most common taxa in the area studied, and *Scorzonera cretica*) should be mentioned. In addition, the "islet specialist" group of taxa, and a few other taxa that can adapt and behave as "islet specialists" (Rechinger & Rechinger-Moser 1951: 201, Höner 1991: 58-69) are well represented by *Allium commutatum* (on five of the seven islets), *Anthemis scopulorum, Convolvulus oleifolius, Matthiola sinuata, Lavatera arborea* and *Trigonella rechingeri* (Panitsa 1997, Panitsa & Tzanoudakis 1998, 2001, Bergmeier & Dimopoulos 2003). The presence of these taxa in combination with other Greek endemics (*Crepis ×cytherea, Allium gomphrenoides, Centaurea redempta* subsp. *cytherea, Bupleurum greuteri, Campanula drabifolia,* etc.) gives special ecological and biogeographical importance to the area. As showed by recent studies (Tzanoudakis & al. 1998, and unpublished data; Yannitsaros 2004, and unpublished data) the area is characterized biogeographically also by the fact that some Greek endemics (s.l.) that have their main distribution range in northern or southern areas have populations in the islands and islets of this specific geographical arc at the limits of their distribution range, or connect distribution areas that were previously considered not connected.

The floristic relationships between the islets studied (b-diversity), expressed by Sørensen's similarity coefficient, is shown in Table 5. It is evident from the low values that even neighbouring islets show remarkable differences in their floristic composition, or have a small number of species in common. Some of these values are remarkably low, indicating a considerable random factor in the floristic composition of the islets. The highest value of Sørensen's similarity coefficient (0.67) was calculated between islets that have almost the same surface, altitude, gentle geomorphology and land use (grazing).

An additional analysis was made with respect to the indicator values proposed by Böhling & al. (2002) for the southern Aegean Islands. The vascular flora of the islets was accordingly assigned to ecological groups on the basis of temperature (T), moisture (F), soil reaction (R) and salt tolerance stress (S), as presented in Table 6. These results show that 23.2 % and 52.8 % of the taxa are indicators of fairly hot sites and of fairly hot to hot sites respectively, 40.8 % are indicators of very dry and dry habitats, 25.4 % are indicators of dry to fresh sites and 13.4 % indicators of fresh sites. Concerning the occurrence of taxa in relation to acidity, 16.2 % of the taxa

Table 6. Percentages (and number of taxa) of species indicator values (after Böhling & al. 2002) for temperature (T), moisture (F), soil reaction (R) and salt stress (S) in the flora of Kithira's offshore islets.

Scale	T	F	R	S
0				22.54 (32)
1		3.52 (5)		48.59 (69)
2		12.68 (18)		7.04 (10)
2°		1.41 (2)		
3		22.54 (32)		6.34 (9)
3°		4.23 (6)		
4		17.61 (25)		0.70 (1)
4°		7.75 (11)		
5		9.15 (13)		2.11 (3)
5°		4.23 (6)		
6		0.70 (1)		2.82 (4)
6°		0.70 (1)		
7	4.23 (6)	1.41 (2)	16.20 (23)	1.41 (2)
7°	19.01 (27)			
7#			0.70 (1)	
8	37.32 (53)		56.34 (80)	0.70 (1)
8°	15.49 (22)			
8#			2.82 (4)	
9	0.70 (1)			
9°		0.70 (1)		
9#			9.86 (14)	
?	1.41 (2)	1.41 (2)	0.70 (1)	2.11 (3)
x	21.83 (31)	11.97 (17)	13.38 (19)	5.63 (8)

are indicators of weakly acidic to weakly basic conditions, and the basidiophilous taxa account for 56.3 % of the total taxa. The majority of taxa (48.6 %) are slightly halo-tolerant, with the second highest percentage representing halophobic taxa. The above-mentioned percentages are in accordance with the intense thermo-Mediterranean climatic character of the area, the geological substrata and the relatively gentle topography with moderately inclined coasts of the islets, which allow direct and indirect sea influence to a rather extended coastal zone.

3. Vegetation

Many studies of Aegean islets have shown that the physiognomy of the vegetation is affected by the geographical characteristics of each islet (geology, altitude, slope gradients), the microclimatic conditions (wind currents, exposition) and the human interference and management actions in the area (frequency and intensity of grazing, fires, cultivation, etc.). The islets in our study do not seem to have been used for cultivation because of their small size and geomorphology. Some of them have, however, certainly been used for grazing, but no data are available.

The gentle geomorphology of these islets corresponds to little habitats diversity and consequently to a low number of vegetation units. In general, two main vegetation units can be distinguished: (1) a halophytic vegetation of rocky coasts, and (2) a plant community with *Euphorbia dendroides* L.

(1) The halophytic vegetation is restricted to the littoral zone of 0-20 m width on all the islets studied and is strongly affected by seawater and the other specific climatic characteristics of the

area. This vegetation unit includes taxa adapted to these extreme conditions. It is well distinguished on the two largest islets (Megali Dragonera and Antidragonera) from the vegetation unit with *Euphorbia dendroides* in the interior of these islets. On the smaller islets, the latter unit is absent and the halophytic unit predominates on almost all their surface. The halophytic vegetation is homogenous but plant coverage increases from the coasts to the interior, and also the floristic composition shows some quantitative and/or qualitative changes. According to Directive 92/43/EEC, this unit corresponds to the habitat type with code 1240, viz. Class: Crithmo-Limonietea Br.-Bl. in Br.-Bl., Roussine & Negre 1952, Order: Crithmo-Limonietalia Molinier 1934, Alliance: Crithmo-Frankenion hirsutae Mayer 1995, Association: Limonio-Cichorietum spinosi. Characteristic taxa are: *Silene sedoides* subsp. *sedoides, Lotus cytisoides, Malcolmia flexuosa* subsp. *naxensis, Frankenia hirsuta, Anthemis rigida* subsp. *rigida, Cichorium spinosum, Limonium runemarkii* and *Sedum litoreum*. On the smaller islets, such as Prasonisi, Megalo Strongilo and Lidia, some of the above-mentioned taxa may be absent and the floristic composition and vegetation physiognomy may be determined by taxa such as *Brassica cretica* subsp. *aegaea, Elymus rechingeri, Anthemis peregrina* subsp. *peregrina, Allium commutatum, Suaeda vera* and *Lavatera arborea*.

Chasmophytic-halophytic vegetation covers the almost vertical coastal limestone cliffs of the islet Avgo (code for the habitat type: 1240 according to Annex I of the Directive 92/43 EEC). Although only a small part of this islet has been investigated, there is no doubt that this islet houses many more taxa and endemics than those given in Tables 1 and 4. When circumnavigating the islet, dense and diverse chasmophytic communities were observed, especially on the upper part of the cliffs of southeastern aspect. However, collecting and long distance identification of the taxa was not possible due to the geomorphology of the coasts and the stormy sea. Considering the geographic position of the islet between Kithira and Antikithira and that within the Aegean area endemic elements prefer similar habitat types, the island must be considered as very important from a floristic and biogeographical point of view.

(2) The community with *Euphorbia dendroides* (association Euphorbietum dendroidis) occurs on rocky coasts at a distance from the sea of more than 70 m, so that it is present only on Megali Dragonera and Antidragonera. It is characterized by shrub heights between 0.8-1.5 m and a plant coverage of about 80 % (where *Pistacia lentiscus* is also present), and occurs at altitudes of 20-40 m and on rocky slopes with inclinations of 5-25 %. The most important taxa characterizing it are *Euphorbia dendroides, Asphodelus ramosus, Calicotome villosa* and *Pistacia lentiscus*. The Euphorbietum dendroidis corresponds to the habitat type with code 5331 according to Directive 92/43/EEC; the type with high *Pistacia lentiscus* coverage is assigned to the habitats type with code 5340. Syntaxonomically it belongs to the class Cisto-Micromerietea julianae Oberd. 1954 and the order Cisto-Micromerietalia Oberd. 1954. Presently there is no clear syntaxonomic assignment at the alliance level.

4. Nature conservation

Of the islets treated here, only Megali Dragonera and Antidragonera are included in the Natura 2000 network of Sites of Community Interest (SCI) for nature conservation in the European Union (Dafis & al. 1996, Dimopoulos & al. 2000). Apart from the two offshore islets, this Natura 2000 site entitled “Kithira: Karavas to Mylopotamos, Palaiopolis, Avlemonas”, also includes a great part of Kithira island. Dragonera and Antidragonera are included in one unified and interrelated management unit with the opposite coasts of Kithira. Presently, no intense human disturbances take place in any of the studied islets, which are uninhabited, and only grazing and stock farming have taken place at some time especially on the larger ones. Effective nature conservation and management of the small islets and their floras would mean leaving them completely ungrazed and untouched. Dissemination of the importance of the small islets and the necessity for effective nature conservation of these fragile ecosystems, between the fishermen and the residents of Kithira is presently an important task, since no project has been performed to elaborate a conservation and management concept.

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