Contribution to the study of the Greek flora: Flora and vegetation of the E Aegean islands Agathonisi and Pharmakonisi

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Abstract

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The flora and vegetation of the north-easternmost islands of the prefecture of Dodekanisos, Agathonisi and Pharmakonisi, which remained floristically almost unexplored until recently, have been investigated. Included are also the flora and vegetation of the seven islets around Agathonisi. Altogether, 402 species and infraspecific taxa of higher plants belonging to 131 genera and 52 families have been found. The analysis of the flora and the classification of the taxa into three main chorological units and five life form types shows that the Mediterranean elements and the therophytes predominate. A comparison of the individual floras of the two islands and seven islets revealed very low values of Sørensen's similarity coefficient, indicating a remarkable floristic independence. This floristic independence is also expressed by the fact that the nine islands and islets have not one taxon in common, whereas 130 taxa occur only on one island or islet each. Three vegetation zones (littoral, epilittoral and interior) are distinguished and described. The vegetation physiognomy differs from islet to islet due to different dominant species. Human activities such as agriculture, grazing, fires, etc. likewise affect the local floristic composition and vegetation physiognomy.

Introduction

In the frame of a project dealing with the floristic investigation of the Greek islands and islets in the E Aegean area, the islands of Agathonisi and Pharmakonisi were given priority by the authors. These islands are the north-easternmost ones of the prefecture of Dodecanisos and in particular Pharmakonisi is among the most remote and isolated islands of the E Aegean area. Due to these reasons their flora was almost unknown. The only floristic data published are based on two collections, made by Gathorne-Hardy and by the Swedish botanists Hans Runemark & Roland von Bothmer on Agathonisi, of which some specimens were considered in the 'Flora of Turkey and the East Aegean islands' (Davis 1965-85). Hans Runemark and Roland von Bothmer also visited some of the rocky islets around Agathonisi and their unpublished records (specimens at LD) and field notes were kindly offered to us and have been included in the present study.

Geography

The investigated area includes the island of Agathonisi, its seven offshore islets and the island of Pharmakonisi. The data regarding the geographical position and islet names, size, altitude, degree of geographical isolation, etc., are provided in Fig. 1 and Tab. 1.

Regarding its geology and geomorphology, the investigated area belongs to the Menderes mass, consisting of schist, crystalline or semi-crystalline limestone and limestone-schist.

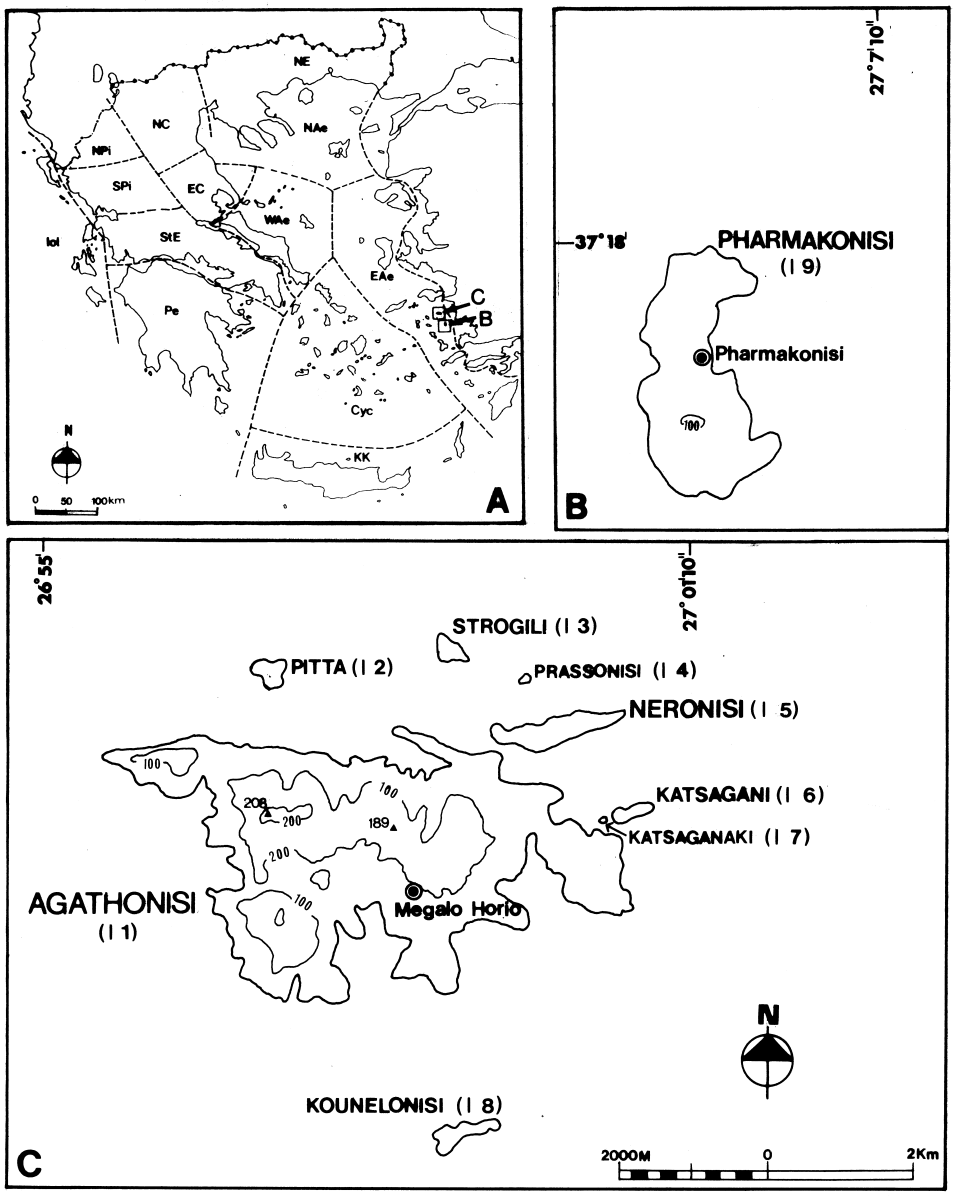

Fig. 1. Geographical position of the study area in Greece (A); detail maps of Pharmakonisi (B) and the Agathonisi group (C). – Biogeographical subdivision of Greece according to Strid & Tan (1997).

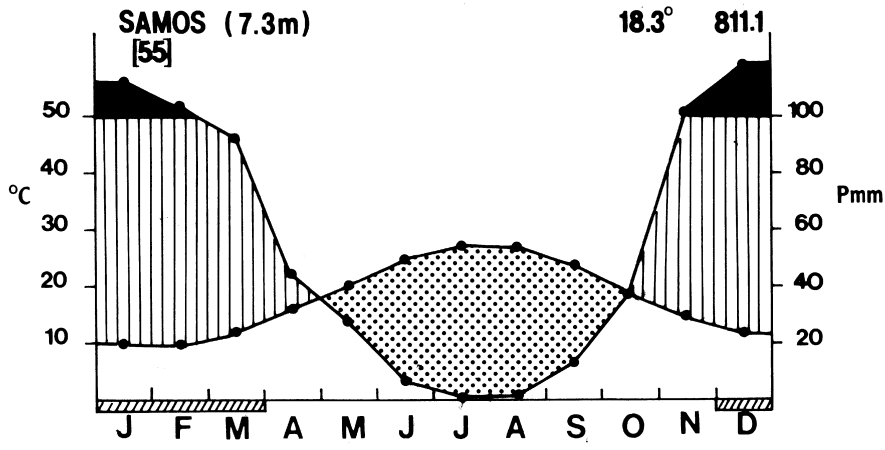

Fig. 2. Ombrothermic diagram of the meteorological station Samos (E Aegean).

Tab. 1. Geographical and floristic data on the studied islands and islets.

Island	Surface (km^2)	Max. altitude	Min. distance from the nearest inhabited island	Max. sea depth between the islet and its nearest bigger island	Number of plant taxa registered
Agathonisi (I1)	13.417	209 m	19.2 km from Samos	84 m	328
Pitta (I2)	0.127	10 m	0.7 km from I1	34 m	44
Stroggili (I3)	0.096	20 m	1.1 km from I1	42 m	63
Prassonisi (I4)	0.011	2 m	1.3 km from I1	46 m	13
Neronisi (I5)	0.500	63 m	0.2 km from I1	13 m	27
Katsagani (I6)	0.090	30 m	0.2 km from I1	28 m	74
Katsaganaki (I7)	0.002	10 m	0.1 km from I1	28 m	16
Kounelonisi (I8)	0.230	50 m	1.7 km from I1	81 m	59
Pharmakonisi (I9)	3.866	111 m	18.8 km from I1	92 m	201

All islets and islands are rather flat, the highest elevation in the study area is a hill of 209 m altitude on Agathonisi. The hill slopes and coastal escarpments are usually gentle. Extended vertical rock formations, gorges, valleys or other specialized habitats are not present, with the almost vertical cliffs occurring at the NNE coasts of Agathonisi as the only exception.

Only Agathonisi, the largest of the nine islands and islets, is permanently inhabited by about 100 inhabitants, who are occupied with fishing, stock farming and agriculture. Intense grazing takes place on the main island and on some of the offshore islets. Pharmakonisi appears to have been inhabited until some years ago but only a few people used to live there. Still extant are some ruins, waste land, abandoned cultivation and their are evident signs of ongoing grazing.

The climate of the area (Fig. 2) is illustrated by an ombrothermic diagram according to Bagnouls & Gaussen (1957), using the climatic data of the nearest meteorological station (on Samos, altitude 7.3 m, data collected over a period of 15 years). According to the Emberger coefficient (Emberger 1955, Mavrommatis 1980) the area has a sub-humid climate with mild winter. The dry period lasts about six months.

Material and methods

The present study is based mainly on the authors' collections made during their repeated visits to the area, in spring and autumn, between 1990 and 1993. Vouchers of the authors' collections are deposited in the herbarium of the University of Patras (UPA). In addition, the collection and field notes of Runemark & Bothmer at LD from 1974 as well as the taxa collected by Gathorne-Hardy according to Davis (1965-85) have been taken into account.

For the identification of the plant material, Davis (1965-85) was used mainly, but also Tutin & al. (1968-80, 1993), Strid & Tan (1997) and Rechinger (1943) were consulted. The nomenclature and distribution information of the taxa follow, unless otherwise stated, Davis (1965-85) and Greuter & al. (1984-89).

In the plant list, the families, genera and species are given in alphabetic order. The chorological types are defined after Pignatti (1982) and the life form categories after Raunkiaer (1934).

The comparison of the floras of the nine islands and islets was made by means of Sørensen's similarity coefficient, i.e. $Cs = 2j/(a+b)$, in which j = the total number of plant taxa found on both of the two islets compared, a = the number of plant taxa found on islet 1 and b = the number of plant taxa found on islet 2.

Results

1. Plant list

Symbols and abbreviations used in the plant list

I1-I9 = the islands and islets coded according to Tab. 1
$ = islet specialist
* = reported by Panitsa (1997) as new to the E Aegean area
!! = observation only
(R) = taxon found by Runemark & von Bothmer but not by the authors
(G) = taxon collected by Gathorne-Hardy

Chorology

(a) widespread taxa:
Cosmop. = Cosmopolitan
Subcosmop. = Subcosmopolitan
Paleotemp. = Paleotemperate
Med.-Atl. = Mediterranean-Atlantic
Med.-Turan. = Mediterranean-Turanian
Ir.-Anat. = Irano-Anatolian

(b) Mediterranean taxa:
Eu.Med. = Eury-Mediterranean
S.Med. = South Mediterranean
E.Med. = East Mediterranean
W.Med. = West Mediterranean
St.Med. = Steno-Mediterranean

(c) endemic taxa:
Greek = Greek endemic
Aegean = Aegean endemic

Life form

Phanerophytes (Ph)
NPh = Nano-Ph.
Phscap = scapose Ph.
Phcaesp = caespitose Ph.
Nscand = Nano-scandent

Chamaephytes (Ch)
Chfrut = fruticose Ch.
Chsuffr = suffruticose Ch.
Chrept = reptant Ch.
Chsucc = succulent Ch.

Hemicryptophytes (H)
Hscap = scapose H.
Hcaesp = caespitose H.
Hros = rosulate H.

Geophytes (G)
Grhiz = rhizomatose G.
Gbulb = bulbose G.
Gpar = parasitic G.
Therophytes (Th)
Thscap = scapose Th.
Thcaesp = caespitose Th.
Thros = rosulate Th.
Thrept = reptant Th.
Thpar = parasitic Th.
A = annual
B = biennial
P = perennial
Fr = shrub
Ar = tree

PTERIDOPHYTA

Polypodiaceae
Asplenium ceterach L. – Hros-P, Paleotemp.; I1
Cheilanthes pteridioides (Reichard) C.Chr. – Hros-P, Med.-Turan; I1
Ch. vellea (Aiton) F. Muell. – Hros-P, Med.-Turan.; I1
Polypodium cambricum L. – Hros-P, Eu. Med; I1, I9

Selaginellaceae
Selaginella denticulata (L.) Link – Chrept-P, St.Med.; I1, I9 !!

GYMNOSPERMAE

Cupressaceae
Juniperus phoenicea L. – NPh-Fr(Ar), Eu.Med.; I9

Ephedraceae
Ephedra foeminea Forssk. – NPh-Fr, E.Med.; I1

DICOTYLEDONES

Anacardiaceae
Pistacia lentiscus L. – NPhcaesp-Fr, St.Med.; I1, I3, I4, I5, I6, I8, I9

Aristolochiaceae
Aristolochia parvifolia Sm. – Gbulb-P, E.Med.; I1, I9

Boraginaceae
Echium arenarium Guss. – Thscap-A, St.Med.; I1
Heliotropium europaeum L. – Thscap-A, Eu.Med.; I1
Neatostema apulum (L.) Johnst. – Thscap-A, St.Med.; I1, I9

Campanulaceae
Campanula delicatula Boiss. – Thscap-A, E.Med.; I1, I8(R.)
C. erinus L. – Thscap-A, St.Med.; I1, I8, I9
C. lyrata Lam. subsp. *lyrata* – Hscap-B/P, E.Med.; I1
Legousia pentagonia (L.) Druce – Thscap-A, E.Med.; I1, I5

Capparaceae
Capparis spinosa L. – NPh-Fr, Eu.Med.; I2, I3, I7(R.), I8

Caryophyllaceae
$*Arenaria aegaea* Rech.fil. – Thscap-A, Aegean; I3, I8
A. leptoclados (Reichb.) Guss. – Thscap-A, Paleotemp.; I1, I6

Cerastium glomeratum Thuill. – Thscap-A, Subcosmop.; I1
Herniaria hirsuta L. – Thscap-A, Paleotemp.; I1 (R.)
Minuartia hybrida (Vill.) Schichk. subsp. *hybrida* – Thscap-A, Paleotemp.; I1, I9
Petrorhagia velutina (Guss.) Ball. & Heywood – Thscap-A, Eu.Med.; I1
Polycarpon tetraphyllum (L.) L. – Thscap-A, St.Med.; I1, I2, I3, I5, I6(R.), I8, I9
Sagina apetala Ard. – Thscap-A, Eu.Med.; I1
S. maritima G. Don – Thscap-A, Med.-Atl.; I8 (R.)
Silene behen L. – Thscap-A, St.Med.; I1
S. gigantea L. subsp. *gigantea* – Hros-P, E.Med.; I1 (R.)
S. nocturna L. – Thscap-A, St.Med.; I1, I9
S. sedoides Poir. subsp. *sedoides* – Thscap-A, St.Med.; I1, I2, I3, I5, I6, I8, I9
S. vulgaris subsp. *macrocarpa* Turrill – Hscap-P, St.Med.; I1
Spergularia bocconei (Scheele) Asch. & Graebn. – Thscap-A, Subcosmop.; I1, I8(R.)
Stellaria cupaniana (Jordan & Fourr.) Bég. – Thrept-A, St.Med.; I1

Chenopodiaceae
Arthrocnemum macrostachyum (Moric.) Moris – Chsucc-P, St.Med.; I4, I7
Atriplex portulacoides L. – Chfrut-P, Paleotemp.; I4
Salsola kali L. – Thscap-A, Paleotemp.; I1

Cistaceae
Cistus creticus L. subsp. *creticus* – NPh-Fr, St.Med.; I1
C. parviflorus Lam. – NPh-Fr, E.Med.; I1
Fumana arabica (L.) Spach – Chsuffr-Fr, Med.-Turan.; I1
F. thymifolia (L.) Verlot – Chsuffr-Fr, St.Med.; I1
Helianthemum salicifolium (L.) Mill. – Thscap-A, Eu.Med.; I1, I9
Tuberaria guttata (L.) Fourr. – Thscap-A, Eu.Med.; I1, I9

Compositae
Aetheorhiza bulbosa subsp. *microcephala* Rech. fil. – Gbulb-P, E.Med.; I1, I3 (R.), I9
Anthemis chia L. – Thscap-A, E.Med.; I1, I3, I9
A. rigida Boiss. – Thscap-A, E.Med.; I5, I6, I9
Asteriscus aquaticus (L.) Less. – Thscap-A, St.Med.; I1 !!, I8
Atractylis cancellata L. – Thscap-A, St.Med.; I1, I6 (R.), I8 (R.), I9
Bellium minutum L. – Thscap-A, E.Med.; I8, I9
Calendula arvensis L. – Thscap-A, Eu.Med.; I1, I9
Carduus argentatus L. – Thscap-A, E.Med.; I1, I9
C. pycnocephalus subsp. *albidus* (M. Bieb.) Kazmi – Thscap-A, Med.-Turan.; I1, I2 (R.), I6 (R.), I8 (R.), I9
C. pycnocephalus subsp. *arabicus* (Murray) Nyman – Thscap-A, Med.-Turan.; I1, I9
Carlina corymbosa L. – Hscap-P, St.Med.; I1, I3 (R.), I6 (R.), I8 (R.)
C. lanata L. – Thscap-A, St.Med.; I1, I3(R.), I5, I8, I9
Carthamus dentatus Vahl – Thscap-A, E.Med.; I9
C. cf. *leucocaulos* Sm. – Thscap-A, Greek; I3 (R.)
Chrysanthemum coronarium L. – Thscap-A, St.Med.; I1
C. segetum L. – Thscap-A, Eu.Med.; I1
Cichorium pumilum Jacq. – Thscap-A, St.Med.; I8
C. spinosum L. – Chsuffr-Fr, St.Med.; I5, I9
Crepis commutata (Spreng.) Greuter – Thscap-A, E.Med.; I1, I2, I3, I6, I9
C. dioscoridis L. – Thscap-A, E.Med.; I9
C. multiflora Sm. – Thscap-A, E.Med.; I1, I9
C. sancta (L.) Babc. – Thscap-A, Med.-Turan.; I1, I9
Crupina crupinastrum (Moris) Vis. – Thscap-A, St.Med.; I9

Dittrichia viscosa (L.) Greuter – Hscap-P, Eu.Med.; I1, I8
Evax pygmaea (L.) Brot. – Thrept-A, St.Med.; I1, I9
Filago aegaea subsp. *aristata* Wagenitz – Thscap-A, E.Med.; I1, I9
F. cretensis Gand. subsp. *cretensis* – Thscap-A, Aegean; I9
F. eriocephala Guss. – Thscap, Eu.Med.; I1, I2, I3, I6, I8, I9
F. pyramidata L. – Thscap-A, Eu.Med.; I1, I9
Geropogon hybridus (L.) Sch. Bip. – Thscap-A, St..Med; I1, I9
Hedypnois cretica (L.) Dum.-Cours. – Thscap-A, St.Med.; I1, I9
$*Helichrysum orientale* (L.) DC. – Chsuffr-Fr, E.Med.; I1, I6, I7
H. stoechas subsp. *barrelieri* (Ten.) Nyman – Chsuffr-Fr, E.Med.; I1
Hyoseris scabra L. – Thros-A, St.Med.; I1, I9
Hypochaeris achyrophorus L. – Thscap-A, St.Med.; I1, I2, I3, I6, I9
Inula heterolepis Boiss. – Chsuffr-Fr, E.Med.; I1
Leontodon tuberosus L. – Hros-P, St.Med.; I1, I9
Logfia gallica (L.) Coss. & Germ. – Thscap-A, Eu.Med.; I1, I9
Notobasis syriaca (L.) Cass. – Thscap-A, St.Med.; I1, I3 (R.)
Phagnalon graecum Boiss. – Chsuffr-Fr, E.Med.; I1, I8
Picris pauciflora Willd. – Thscap-A, Eu.Med.; I1
Ptilostemon chamaepeuce (L.) Less. – Chfrut-Fr, E.Med.; I1
Reichardia intermedia (Sch. Bip.) Hayek – Thscap-A, St.Med.; I1, I9
R. picroides (L.) Roth – Hscap-P, St.Med.; I6, I9
Rhagadiolus stellatus (L.) Gaertn. – Thscap-A, Eu.Med.; I1, I9
Scolymus hispanicus L. – H-B, Eu.Med.; I1, I2, I3
Scorzonera cretica Willd. – Hscap-P, Aegean; I2 (R.)
S. elata Boiss. – Hscap-P, E.Med.; I2(R.), I9
S. sublanata Lipsch. – Hscap-P, E.Med.; I1
Senecio vulgaris L. – Thscap-A, Cosmop.; I1, I3 (R.), I6(R.), I9
Sonchus oleraceus L. – Thscap-A, Subcosmop.; I1, I7, I9
Taraxacum aleppicum Dahlst. – Hros-P, E.Med.; I1
T. hellenicum Dahlst. – Hros-P, St.Med.; I9
Tragopogon porrifolius L. – H-B, Eu.Med.; I1
Urospermum picroides (L.) Scop. ex F.W. Schmidt – Thscap-A, Eu.Med.; I1, I3, I6, I8, I9

Convolvulaceae
Convolvulus althaeoides L. – Hscand-P, St.Med.; I1, I2, I9,
C. elegantissimus Mill. – Hscand-P, St.Med.; I1, I9
$*C. oleifolius* Desr. – Chfrut-Fr, St.Med.; I9
C. siculus L. subsp. *siculus* – Thscap-A, St.Med.; I1, I9
Cuscuta palaestina Boiss. subsp. *palaestina* – Thpar-A, E.Med.; I1

Crassulaceae
Sedum litoreum Guss. – Thscap-A, St.Med.; I1, I3, I4, I6, I8, I9
Umbilicus horizontalis (Guss.) DC. – Gbulb-P, St.Med.; I1, I8 (R.)

Cruciferae
Alyssum simplex Rudolphi – Thscap-A, Med.-Turan.; I1
Arabis verna (L.) R. Br. – Thscap-A, St.Med.; I1
Biscutella didyma L. – Thscap-A, Med.-Turan; I1, I3 (R.), I9
Brassica cretica subsp. *aegaea* (Heldr. & Hal.) Snog. & al. – Chsuffr-P, E.Med.; I1 !!
B. nigra (L.) Koch – Thscap-A, Eu.Med.; I1
Cakile maritima Scop. subsp. *maritima* – Thscap-A, Med.-Atl.; I1
Calepina irregularis (Asso) Thell. – Thscap-A, Med.-Turan; I1

Capsella bursa-pastoris (L.) Medik. – Thscap-A, Cosmop.; I1
Cardamina hirsuta L. – Thscap-A, Cosmop.; I1
Clypeola jonthlaspi L. – Thscap-A, St.Med.; I1, I3 (R.), I8, I9
Erophila macrocarpa (Boiss. & Heldr.) Boiss. – Thscap-A, E.Med.; I1
E. praecox (Stev.) DC. – Thscap-A, Paleotemp.; I1
Hirschfeldia incana (L.) Lagr.-Foss. – Hscap-P, Eu.Med.(Atl.); I1
Malcolmia chia (L.) DC. – Thscap-A, E.Med.; I1, I9
M. flexuosa (Sm.) Sm. subsp. *flexuosa* – Thscap-A, E.Med.; I1, I2, I4, I5, I6, I7, I8
$*Matthiola sinuata* (L.) R. Br. – Hscap-P, Med.-Atl.; I3 (R.)
Raphanus raphanistrum L. subsp. *raphanistrum* – Thscap-A, Paleotemp.; I1
Sinapis arvensis L. – Thscap-A, Paleotemp.; I1
Sisymbrium officinale (L.) Scop. – Thscap-A, Subcosmop.; I1
S. orientale L. – Thscap-A, Eu.Med.; I1

Cynocrambaceae
Theligonum cynocrambe L. – Thscap-A, Med.-Turan.; I1, I3 (R.), I6 (R.)

Ericaceae
Erica manipuliflora Salisb. – NPh-Fr, E.Med.; I1

Euphorbiaceae
Euphorbia acanthothamnos Heldr. & Sart. ex Boiss. – Chfrut-Fr, E.Med.; I1, I6, I8, I9
E. exigua L. – Thscap-A, Eu.Med.; I1, I9
E. peplus L. – Thscap-A, Cosmop.; I1, I2, I3, I6, I8, I9
E. taurinensis All. – Thscap-A, Eu.Med.; I1
Mercurialis annua L. – Thscap-A, Paleotemp.; I1, I2, I3, I5, I6, I7 (R.), I8, I9

Fagaceae
Quercus coccifera L. – NPh-Fr, St.Med.; I1

Frankeniaceae
Frankenia hirsuta L. – Chsuffr-Fr, Med.-Turan.; I2, I3, I4, I5, I6, I7, I8, I9
F. pulverulenta L. – Thscap-A, Med.-Turan.; I4 (R.), I8(R.)

Gentianaceae
Blackstonia perfoliata (L.) Huds. subsp. *perfoliata* – Thscap-A, Eu.Med.; I1, I8, I9
Centaurium pulchellum (Sw.) Druce – Thscap-A, Paleotemp.; I1, I2, I3 (R.), I5, I9
C. tenuiflorum (Hoffmanns. & Link) Fritsch subsp. *tenuiflorum* – Thscap-A, St.Med.; I1, I8

Geraniaceae
Erodium cicutarium (L.) L'Hér. – Thscap-A, Subcosmop.; I1, I2, I3, I6, I9
E. gruinum (L.) L'Hér. – Thscap-A, Med.-Turan.; I1, I9
E. malacoides (L.) L'Hér. – Thscap-A, St.Med.; I1, I6 (R.), I9
E. moschatum (L.) L'Hér. – Thscap-A, Eu.Med.; I1
Geranium columbinum L. – Thscap-A, Paleotemp.; I1, I9
G. molle L. subsp. *molle* – Thscap-A, Subcosmop.; I1
G. robertianum subsp. *purpureum* (Vill.) Nyman – Thscap-A, Eu.Med.; I1, I9
G. rotundifolium L. – Thscap-A, Paleotemp.; I1, I3, I6 (R.), I8 (R.), I9

Labiatae (Lamiaceae)
Ajuga chamaepitys subsp. *chia* (Schreb.) Arcang. – Hscap-A, Eu.Med.(C.Europe); I8
Ballota acetabulosa (L.) Benth. – Chfrut-Fr, E.Med.; I1, I3 (R.), I8, I9
Coridothymus capitatus (L.) Reichenb. fil. – Chfrut-Fr, St.Med.; I1, I6, I9
Lamium amplexicaule L. – Thscap-A, Paleotemp.; I1
L. moschatum Mill. – Thscap-A, E.Med.; I1, I9

Marrubium vulgare L. – Hscap-P, Paleotemp.; I1
Origanum onites L. – Chsuffr-Fr, E.Med.; I1
Prasium majus L. – Chfrut-Fr, St.Med.; I1, I9
Salvia fruticosa Mill. – Phcaesp-P, E.Med.; I1
S. viridis L. – Thscap-A, St.Med.; I1, I8, I9
Satureja nervosa Desf. – Chsuffr-Fr, St.Med.; I1, I9
S. rotundifolia (Pers.) Briq. – Thscap-A, Eu.Med.; I1
Sideritis curvidens Stapf – Thscap-A, E.Med.; I1, I2, I3, I6, I9
Teucrium brevifolium Schreb. – Chsuffr-Fr, E.Med.; I1, I3 !!, I6 !!, I8
T. divaricatum Heldr. subsp. *divaricatum*: Chfrut-Fr, E.Med.; I8
T. polium L. – Chsuffr-P, St.Med.; I1 !!, I5, I9

Leguminosae
Anagyris foetida L. – Phcaesp-Fr, St.Med.; I1
Anthyllis hermanniae L. – Chfrut-Fr, St.Med.; I1 !!
A. vulneraria subsp. *rubriflora* (DC.) Arcang. – Hscap-P, St.Med.; I1
Astragalus hamosus L. – Thscap-A, Med.-Turan.; I1, I9
Ceratonia siliqua L. – NPh-P., St.Med.; I1, I9
Coronilla scorpioides (L.) Koch – Thscap-A, Eu.Med.; I1, I9
Genista acanthoclada DC. – NPh-Fr, E.Med. – I1, I6 (R.)
Hedysarum spinosissimum L. – Thscap-A, St.Med.; I1
Hippocrepis ciliata Willd. – Thscap-A, Eu.Med.; I1, I9
H. unisiliquosa L. subsp. *unisiliquosa* – Thscap-A, Eu.Med.; I1, I9
Hymenocarpus circinnatus (L.) Savi – Thscap-A, St.Med.; I1, I9
Lathyrus aphaca L. – Thscap-A, Eu.Med.; I1
Lens ervoides (Brign.) Grande – Thscap-A, Eu.Med.; I9 (R.)
L. nigricans (M. Bieb.) Godron – Thscap-A, Eu.Med.; I1
L. orientalis (Boiss.) Schmalh. – Thscap-A, E.Med.; I1, I9
Lotus cytisoides L. – Chsuffr-Fr, St.Med.; I7, I9
L. edulis L. – Thscap-A, St.Med.; I1, I2, I5, I9
L. peregrinus L. – Thscap-A, E.Med.; I1, I3, I9
Medicago coronata (L.) Bart. – Thscap-A, St.Med.; I1, I6 (R.), I9
M. disciformis DC. – Thscap-A, St.Med.; I1, I2
M. minima (L.) L. – Thscap-A, Paleotemp.; I1, I9
M. monspeliaca (L.) Trautv. – Thscap-A, Eu.Med.; I9
M. orbicularis (L.) Bart. – Thscap-A, Eu.Med.; I1
M. polymorpha L. – Thscap-A, Subcosmop.; I1
M. rugosa Desr. – Thscap-A, St.Med.; I9
M. truncatula Gaertn. – Thscap-A, Eu.Med.; I1, I9
M. tuberculata (Retz.) Willd. – Thscap-A, St.Med.; I9
Onobrychis aequidentata (Sm.) d'Urv. – Thscap-A, St.Med.; I1, I9
O. caput-galli (L.) Lam. – Thscap-A, St.Med.; I1, I9
Ononis reclinata L. – Thscap-A, Eu.Med.; I9
Scorpiurus muricatus L. – Thscap-A, Eu.Med.; I1, I8, I9
Trifolium arvense L. – Thscap-A, Paleotemp.; I8 (R.)
T. campestre Schreb. – Thscap-A, Paleotemp.; I1, I5, I6 (R.), I9
T. cherleri L. – Thscap-A, Eu.Med.; I1, I9
T. grandiflorum Schreb. – Thscap-A, E.Med.; I1
T. lappaceum L. – Thscap-A, Eu.Med.; I1, I9
T. physodes Stev. ex M. Bieb. – Hscap-P, Eu.Med.; I1
T. purpureum Lois. – Thscap-A, Eu.Med.; I1, I9
T. resupinatum L. – Thrept-A, Paleotemp.; I1

T. scabrum L. – Thscap-A, Eu.Med.; I1, I6, I9
T. stellatum L. – Thscap-A, Eu.Med.; I1, I6 (R.), I9
T. suffocatum L. – Thscap-A, Eu.Med.; I1 (R.)
T. tomentosum L. – Threpт-A, Paleotemp.; I1
Trigonella balansae Boiss. & Reut. – Thscap-A, E.Med.; I1, I9
T. cariensis Boiss. – Thscap-A, E.Med.; I1, I9
T. spicata Sm. – Thscap-A, E.Med.; I1
Tripodium tetraphyllum (L.) Fourr. – Thscap-A, St.Med.; I1
Vicia cretica Boiss. & Heldr. – Thscap-A, E.Med.; I1
V. cuspidata Boiss. – Thscap-A, E.Med.; I1 (R.)
V. hybrida L. – Thscap-A, Eu.Med.; I1
V. lathyroides L. – Thscap-A, Eu.Med.; I1
V. palaestina Boiss. – Thscap-A, E.Med.; I9
V. parviflora Cav. – Thscap-A, St.Med.; I1
V. peregrina L. – Thscap-A, Med.-Turan.; I1
V. pubescens (DC.) Link – Thscap-A, Eu.Med.; I1
V. sativa subsp. *nigra* (L.) Ehrh. – Thscap-A, Cosmop.; I1
V. sativa L. subsp. *sativa* – Thscap-A, Cosmop.; I1
V. tetrasperma (L.) Schreb. – Thscap-A, Paleotemp.; I1, I9
V. villosa Roth subsp. *microphylla* (d'Urv.) P.W. Ball – Thscap-A, E.Med.; I9

Linaceae
Linum bienne Mill. – H-B/Hscap-P, Med.-Atl.; I1, I2 (R.)
L. corymbulosum Reichenb. – Thscap-A, Med.-Turan.; I1
L. strictum subsp. *spicatum* (Pers.) Nyman – Thscap-A, St.Med.; I1, I2, I5, I6, I9
L. trigynum L. – Thscap-A, Eu.Med.; I1, I3 (R.)

Malvaceae
Alcea biennis Wintere – Hscap-P, E.Med.; I2, I3 (R.)
Althaea hirsuta L. – Thscap-A, Eu.Med.; I1
Lavatera arborea L. – Hscap-P, St.Med.; I4, I7 (R.)
**Malva aegyptia* L. – Thscap-A, St.Med.; I1, I5, I9
M. cretica Cav. subsp. *cretica* – Thscap-A, St.Med.; I1, I3, I6, I9

Moraceae
Ficus carica L. – NPh-P, Med.-Turan.; I1

Oleaceae
Olea europaea subsp. *oleaster* (Hoffmans. & Link) Negodi – NPh-Fr, St.Med.; I1, I3!!, I8!!

Orobanchaceae
Orobanche minor Sm. – Thpar-A, Paleotemp.; I1
O. oxyloba (Reut.) G. Beck – Thpar-A, Eu.Med.; I1
O. pubescens d'Urv. – Thpar-A, Eu.Med.; I1
O. ramosa subsp. *nana* (Reut.) Cout. – Thpar-A, Paleotemp.; I1, I9

Papaveraceae
Fumaria densiflora DC. – Thscap-A, Subcosmop.; I1
F. macrocarpa Parl. – Thscap-A, E.Med.; I1, I9
F. parviflora Lam. – Thscap-A, Med.-Turan.; I1
Papaver dubium L. – Thscap-A, Med.-Turan; I1, I3 (R.), I6 (R.)
P. gracile Boiss. – Thscap-A, E.Med.; I1
P. hybridum L. – Thscap-A, Med.-Turan.; I1

P. purpureomarginatum Kadereit – Thscap-A, E.Med.; I1
P. rhoeas L. – Thscap-A, Paleotemp.; I1

Plantaginaceae
Plantago afra L. – Thscap-A, St.Med.; I1, I3, I5, I6, I8, I9
P. cretica L. – Thros-A, E.Med.; I1, I3 (R.), I9
P. lagopus L. – Thros-A, St.Med.; I1, I2, I3, I6 (R.), I9
P. weldenii Reichenb. – Thros-A, Eu.Med.; I1, I2, I3, I9

Plumbaginaceae
Limonium graecum (Poir.) Rech. fil. – Chsuffr-P, E.Med.; I8
L. narbonense Mill. – Chsuffr-P, St.Med.; I2, I4, I6, I7, I8
L. sinuatum (L.) Mill. – Hscap-P, St.Med.; I5
L. virgatum (Willd.) Fourr. – Chsuffr-P, Med.-Atl.; I5, I9

Polygalaceae
Polygala monspeliaca L. – Thscap-A, St.Med.; I1, I9

Polygonaceae
Rumex bucephalophorus subsp. *gallicus* (Steinh.) Rech. fil. – Thscap-A, E.Med.; I1, I5, I6, I8
R. pulcher L. subsp. *pulcher* – Hscap-P, Eu.Med.; I1
R. tuberosus subsp. *creticus* (Boiss.) Rech. fil. – Gbulb-P, E.Med.; I3

Primulaceae
Anagallis arvensis L. – Thrept-A, Subcosmop.; I1, I5, I6, I8, I9
Asterolinon linum-stellatum (L.) Duby – Thscap-A, St.Med.; I1, I6, I8, I9

Ranunculaceae
Adonis microcarpa DC. – Thscap-A, Eu.Med.; I1
Anemone coronaria L. – Gbulb-P, St.Med.; I1, I9
A. pavonina Lam. – Gbulb-P, Eu.Med.; I1
Clematis cirrhosa L. – Nscand-Fr, St.Med.; I1, I9
Garidella nigellastrum L. – Thscap-A, Eu.Med.; I1, I9
Nigella arvensis subsp. *glauca* (Boiss.) Terracc. – Thscap-A, E.Med.; I1
Ranunculus cf. *bullatus* L. – Hros-P, St.Med.; I9
R. chius DC. – Thscap-A, E.Med.; I1
R. paludosus Poir. – Hscap-P, Eu.Med.; I1, I9

Rosaceae
Sarcopoterium spinosum (L.) Spach – NPh-Fr, E.Med.; I1, I6

Rubiaceae
Crucianella latifolia L. – Thscap-A, St.Med.; I1, I9
Galium aparine L. – Thscap-A, Paleotemp.; I1
G. brevifolium subsp. *insulare* Ehrend. & Schönb.-Temesy – Thscap-A, E.Med.; I1
G. murale (L.) All. – Thscap-A, Eu.Med.; I1, I3, I6, I9
G. setaceum Lam. – Thscap-A, Med.-Turan.; I1, I9
Sherardia arvensis L. – Thscap-A, Subcosmop.; I1, I9
Valantia hispida L. – Thscap-A, St.Med.; I1, I3, I6, I9
V. muralis L. – Thscap-A, St.Med.; I1, I2, I3, I6, I7, I9

Scrophulariaceae
Cymbalaria longipes (Boiss. & Heldr.) A. Chev. – Chrept-P, E.Med.; I1
Kickxia commutata subsp. *graeca* (Bory & Chaub.) R. Fern. – Hrept-P, St.Med.; I1, I3 (R.), I9
Linaria simplex (Willd.) DC. – Thscap-A, Eu.Med.; I1
Misopates orontium (L.) Rafin. – Thscap-A, Paleotemp.; I1

Parentucellia latifolia (L.) Caruel subsp. *latifolia* – Thscap-A, Eu.Med.; I1, I9
Scrophularia heterophylla Willd. – Hscap-P, E.Med.; I1
S. peregrina L. – Thscap-A, St.Med.; I1
Veronica arvensis L. – Thscap-A, Subcosmop.; I1
V. cymbalaria Bodard – Thscap-A, Eu.Med.; I1, I9

Solanaceae
Mandragora autumnalis Bertol. – Hros-P, St.Med.; I1, I2 (R.), I5, I6 (R.), I8, I9
Solanum nigrum L. – Thscap-A, Cosmop; I1

Theligonaceae
Theligonum cynocrambe L. – Thscap-A, Med.-Turan.; I1, I3 (R.), I6

Thymelaeaceae
Daphne gnidioides Jaub. & Spach – NPh-Fr,E.Med.; I8
Thymelaea tartonraira subsp. *argentea* (Sm.) Holmboe – NPh-Fr, E.Med.; I8

Umbelliferae
Bupleurum gracile d'Urv. – Thscap-A, E.Med.; I1, I5, I9
Daucus guttatus Sm. – Thscap-A, E.Med.; I1
D. involucratus Sm. – Thscap-A, E.Med.; I1, I6 (R.), I8 (R.), I9,
Ferula communis subsp. *glauca* (L.) Rouy & Camus – Hscap-P, Eu.Med.; I7
Lagoecia cuminoides L. – Thscap-A, Med.-Turan.; I1, I3, I6, I8, I9
Microsciadium minutum (d'Urv.) Briq. – Thscap-A, E.Med.; I1
Orlaya daucoides (L.) Greuter – Thscap-A, Eu.Med.; I1, I9
Scaligeria napiformis (Spreng.) Grande – Hbienn-B, E.Med.; I1
Scandix pecten-veneris L. – Thscap-A, Subcosmop.; I1, I6, I9
Thapsia garganica L. – Hscap-P, St.Med.; I1
Tordylium aegaeum Runemark – Thscap-A, E.Med.; I1
T. apulum L. – Thscap-A, St.Med.; I1, I3 (R.), I5, I6, I8 (R.), I9
Torilis arvensis subsp. *purpurea* (Ten.) Hayek – Thscap-A, Eu.Med.; I9
T. leptophylla (L.) Reichenb. – Thscap-A, Med.-Turan.; I1, I9
T. nodosa (L.) Gaertn. – Thscap-A, Med.-Turan.; I1, I9

Urticaceae
Parietaria cretica L. – Thrept (Hscap)-A(P), E.Med.; I1, I2, I3, I6, I7, I9
P. lusitanica L. – Thrept-A, St.Med.; I1, I9
Urtica pilulifera L. – Thscap-A, St.Med.; I1

Valerianaceae
Centranthus calcitrapae (L.) Dufr. – Thscap-A, St.Med.; I1, I9
Valerianella coronata (L.) DC. – Thscap-A, Paleotemp.; I1, I6 (R.), I9
V. discoidea (L.) Lois. – Thscap-A, St.Med.; I1, I9
V. obtusiloba Boiss. – Thscap-A, E.Med.; I1, I9
V. vesicaria (L.) Moench – Thscap-A, Med.-Turan.; I1

MONOCOTYLEDONES

Amaryllidaceae
Narcissus serotinus L. – Gbulb-P, St.Med.; I1

Araceae
Arisarum vulgare Targ.-Tozz. – Grhiz-P, St.Med.; I1, I3 (R.), I8 (R.), I9
Arum dioscoridis Sm. – Grhiz-P, E.Med.; I1, I8 (R.), I9 (R.)

Cyperaceae
Carex distachya Desf. – Hcaesp-P, St.Med.; I2 (R.)

Dioscoraceae
Tamus communis subsp. *cretica* (L.) Kit Tan – Grhiz-P, Eu.Med.; I1, I9

Gramineae
Aegilops biuncialis Vis. – Thscap-A, Eu.Med.; I1, I6 (R.), I9
A. geniculata Roth – Thscap-A, Eu.Med.; I9
A. markgrafii (Greuter) Hammer – Thscap-A, E.Med.; I9 (R.)
Aira elegantissima Schur subsp. *elegantissima* – Thscap-A, Eu.Med.; I1, I9
Avellinia michelii (Savi) Parl. – Thscap-A, St.Med.; I9 (R.)
Avena barbata Link subsp. *barbata* – Thscap-A, Eu.Med.; I1, I2, I3, I6 (R.), I9
Brachypodium retusum (Pers.) P. Beauv. – Hcaesp-P, St.Med.; I1, I2, I3, I6, I9
Briza maxima L. – Thscap-A, Paleosubtrop.; I1, I6 (R.), I9
Bromus alopecuros subsp. *caroli-henrici* (Greuter) P.M. Smith – Thscap-A, E.Med.; I6 (R.), I9
B. fasciculatus C. Presl. – Thscap-A, E.Med.; I1, I3 (R.), I6 (R.), I8, I9
B. intermedius Guss. – Thscap-A, Eu.Med.; I1, I3, I6, I9
B. madritensis L. subsp. *madritensis* – Thscap-A, Eu.Med.; I1, I2, I3, I6, I8, I9
B. sterilis L. – Thscap-A, Paleotemp.; I1, I9
Catapodium marinum (L.) C.E. Hubb. – Thscap-A, Med.-Atl.; I1, I2, I3, I6, I8, I9
C. rigidum (L.) C.E. Hubb. subsp. *rigidum* – Thscap-A, Eu.Med.; I1
Cynodon dactylon (L.) Pers. – Grhiz-P, Cosmop.; I9
Cynosurus echinatus L. – Thscap-A, Eu.Med.; I9
Dactylis glomerata subsp. *hispanica* (Roth) Nyman – Hcaesp-P, St.Med.; I1, I2, I6, I9
Echinaria capitata (L.) Desf. – Thscap-A, Med.-Turan.; I1, I6 (R.), I9
Elymus farctus subsp. *rechingeri* (Runemark) Melderis – Grhiz-P, E.Med.; I4, I7
Gastridium ventricosum (Gouan) Schinz & Thell. – Thscap-A, Eu.Med.; I9 (R.)
Hordeum bulbosum L. – Hcaesp-P, Paleosubtrop.; I2 (R.), I9
H. murinum subsp. *leporinum* (Link) Arcang. – Thscap-A, Eu.Med.; I1, I2, I6 (R.), I9
Hyparrhenia hirta (L.) Stapf. – Hcaesp-P, Paleotrop; I3, I5, I6 (R.)
Lagurus ovatus L. – Thscap-A, Eu.Med.; I1, I5, I6
Lolium rigidum Gaudin subsp. *rigidum* – Thscap-A, Paleosubtrop.; I1, I9
Melica minuta L. – Hcaesp-P, St.Med.; I1
Parapholis incurva (L.) C.E. Hubb. – Thscap-A, Med.Atl.; I1, I2, I4, I9
Phleum graecum subsp. *aegaeum* (Vierh.) Greuter – Thscap-A, E.Med.; I1 (R.), I2 (R.), I6 (R.), I9
Poa bulbosa L. – Hcaesp-P, Paleotemp.; I1, I9
Polypogon subspathaceus Reg. [see Scholz 1991: 139] – Thscap-A, St.Med.; I8 (R.)
Psilurus incurvus (Gouan) Schinz & Thell. – Thscap-A, Eu.Med.; I1, I9
Rostraria cristata (L.) Tzvelev – Thcaesp-A, Subcosmop.; I1, I9
Stipa capensis Thunb. – Hcaesp-P, St.Med.; I1, I3 (R.), I6 (R.), I9
Trachynia distachya (L.) Link – Thscap-A, Med.-Turan.; I1, I6 (R.), I9
Vulpia ciliata Dumort. – Thcaesp-A, Eu.Med.; I1, I3(R.), I9 (R.)
V. fasciculata (Forssk.) Fritsch – Thcaesp-A, Med.-Atl.; I6 (R.)

Iridaceae
Crocus cancellatus subsp. *mazziaricus* (Herbert) Mathew – Gbulb-P, E.Med.; I1
Gynandriris sisyrinchium (L.) Parl. – Gbulb-P, St.Med.; I2, I9
Romulea tempskyana Freyn – Gbulb-P, E.Med.; I1

Liliaceae
Allium ampeloprasum L. – Gbulb-P, Eu.Med.; I4
$*A. commutatum* Guss. – Gbulb-P, St.Med.; I4, I7, I9

A. cupanii subsp. *hirtovaginatum* (Kunth) Stearn – Gbulb-P, Eu.Med.; I1
A. flavum subsp. *tauricum* (Reichenb.) Stearn – Gbulb-P, St.Med.; I1
A. neapolitanum Cirillo – Gbulb-P, St.Med.; I1
A. pallens L. subsp. *pallens* – Gbulb-P, Eu.Med.; I3
A. subhirsutum L. – Gbulb-P, St.Med.; I1, I9
Asparagus acutifolius L. – Grhiz-P, St.Med.; I1, I9
A. aphyllus subsp. *orientalis* (Baker) P.H. Davis – Grfrut-P, E.Med.; I1, I2, I3(R.), I6, I7
Asphodelus aestivus Brot. – Grhiz-P, St.Med.; I1, I9 !!
Gagea graeca (L.) Terracc. – Gbulb-P, E.Med.; I1, I9
Muscari commutatum Guss. – Gbulb-P, E.Med.; I9
M. comosum (L.) Mill. – Gbulb-P, Eu.Med.; I1, I2cf.(R.), I9
M. macrocarpum Sweet – Gbulb-P, E.Med.; I1
M. neglectum Guss. – Gbulb-P, Eu.Med.; I1, I9
M. weissii Freyn – Gbulb-P, E.Med.; I1, I9
Ornithogalum narbonense L. – Gbulb-P, Eu.Med.; I9
O. sphaerocarpum A. Kern. – Gbulb-P, Eu.Med.; I1 (G.), I9
Scilla autumnalis L. – Gbulb-P, Eu.Med.; I1, I9
Urginea maritima (L.) Baker – Gbulb-P, St.Med.; I1 !!, I3 (R.), I6 (R.), I9 !!

Orchidaceae
Anacamptis pyramidalis (L.) L.C.M. Richard – Gbulb-P, Eu.Med.; I2 (R.), I8
Ophrys apifera Hudson – Gbulb-P, Eu.Med.; I1
O. ferrum-equinum Desf. – Gbulb-P, E.Med.; I1
O. holoserica subsp. *heterochila* Renz & Taub – Gbulb-P, E.Med.; I1
O. holoserica (Burm. f.) Greuter subsp. *holoserica* – Gbulb-P, Eu.Med.; I1
O. lutea subsp. *galilaea* (H. Fleischm. & Bornm.) Soó – Gbulb-P, St.Med.; I1
O. lutea subsp. *minor* (Guss.) O. & E. Danesch – Gbulb-P, St.Med.; I1
O. regis-ferdinandii (Renz) Buttler – Gbulb-P, E.Med.; I1
O. sphegodes Mill. – Gbulb-P, Eu.Med.; I1
O. umbilicata Desf. subsp. *umbilicata* – Gbulb-P, E.Med.; I1
Orchis anatolica Boiss. – Gbulb-P, E.Med.; I1
O. morio subsp. *picta* (Loisel.) K. Richter – Gbulb-P, Eu.Med.; I1
O. sancta L. – Gbulb-P, E.Med.; I1, I2 (R.), I9
Serapias vomeracea subsp. *laxiflora* (Soó) Gölz & Reinhard – Gbulb-P, E.Med.; I1

2. Flora

As a result of our field work and other floristic data available, a total of 402 taxa of higher plants are recorded from the studied islands and islets (cultivated species are not included). Most of them are new records for the investigated area, since in Davis (1965-85) only 19 species have been reported from Agathonisi.

The 402 taxa belong to 52 families and 131 genera. Three families, viz *Leguminosae*, *Compositae* and *Gramineae*, represented by 65, 55 and 38 taxa respectively, make up almost 40 % of the total flora (Tab. 2).

Regarding their total distribution, the taxa can be categorized in the following three main chorological units:

a) The widespread unit: cosmopolitan, subcosmopolitan, paleotemperate, temperate, Mediterranean-Atlantic, Mediterranean-Turanian and Irano-Anatolian taxa.

b) The Mediterranean unit: eury-Mediterranean (Eu.Med.), steno-Mediterranean (St.Med.) and E Mediterranean taxa (E.Med.).

c) The endemic unit: E Aegean, Aegean or Greek endemic taxa.

Tab. 2. Representation of the 10 largest families in the flora of the study area (absolute numbers) and in the individual flora of each island and islet (in %). – The island names are coded I1 to I9 according to Tab. 1.

Families	Total number of taxa	Taxa (in %) per islands / islets								
		I1	I2	I3	I4	I5	I6	I7	I8	I9
Leguminosae	65	15.5	6.8	1.6	–	7.4	–	–	3.4	15.9
Compositae	55	12.8	13.6	19.3	–	11.1	15.3	12.5	18.6	17.9
Gramineae	38	7.9	20.4	14.5	23.1	7.4	25.0	6.2	6.8	14.9
Liliaceae	20	4.6	4.5	4.8	15.4	–	2.8	12.5	–	6.5
Cruciferae	20	5.8	1.3	4.8	7.7	3.7	1.4	6.2	3.4	1.5
Labiatae	18	4.2	1.3	4.8	–	–	–	–	8.5	4.0
Caryophyllaceae	16	4.2	4.5	4.8	–	7.4	4.1	6.2	8.5	2.0
Umbelliferae	15	3.9	–	3.2	–	7.4	5.5	6.2	5.1	4.5
Orchidaceae	14	3.9	4.5	–	–	–	–	–	1.7	0.5
Scrophulariaceae	10	3.0	–	1.6	–	–	–	–	–	1.5

Tab. 3. Chorological spectra (in %) of the islands and islets studied (abbreviations in Tab. 1).

		I1	I2	I3	I4	I5	I6	I7	I8	I9	Total
Widespread		27.1	34.1	30.7	38.5	37.1	34.7	18.8	22.0	25.4	25.6
	Eu.Med.	33.3	25.0	32.3	23.1	22.2	30.5	18.8	37.3	34.8	
Mediterranean	St. Med.	15.5	18.2	14.5	23.1	22.2	12.5	31.2	11.9	19.9	73.4
	E. Med.	24.1	20.4	19.3	15.3	18.5	22.3	31.2	27.1	19.4	
Endemic		0	2.3	3.2	0	0	0	0	1.7	0.5	0.1

Tab. 4. E Mediterranean elements showing a distribution range restricted to the E Aegean area and to one or more of the adjacent regions.

a. Balkan-Aegean-Anatolian
Ballota acetabulosa
Crepis multiflora
Daphne gnidioides
Erophila macrocarpa
Euphorbia acanthothamnos
Muscari weissii
Ophrys ferrum-equinum
Rumex tuberosus subsp. *creticus*

b. Aegean-SW Anatolian-Cypriot
Anthemis rigida
Campanula delicatula
Daucus involucratus
Limonium graecum
Microsciadium minutum
Trigonella cariensis
Vicia cretica

c. Aegean-Anatolian
Muscari macrocarpum
Nigella arvensis subsp. *glauca*
Tordylium aegaeum

d. E Aegean-Anatolian
Campanula lyrata subsp. *lyrata*
Scorzonera elata
S. sublanata

e. Aegean islands endemics
Arenaria aegaea
Filago cretensis subsp. *cretensis*
Scorzonera cretica

From the chorological data (Tab. 3), it is evident that the Mediterranean element predominates the flora of the entire study area as well as the flora of each individual island and islet. The widespread element is also well represented by 103 taxa, i.e. 25.6 % of the total flora. More interesting from a biogeographical point of view is the E Mediterranean element, which represents 22.9 % of the total flora. Among the 92 taxa of this element are 22 with a distribution range restricted to the Aegean area and one or more of the adjacent regions (Tab. 4, categories a-d).

The biological spectrum of the flora of the study area as well as of the individual islands and islets are illustrated in Tab. 5. The results seem to be in accordance with the bioclimatological position of the area (subhumid stage with an intense thermo-Mediterranean character). The therophytes dominate on average with c. 64 %, but a significant variation in the percentages of the remaining life forms has been observed from islet to islet (Tab. 5).

Five of the plant species recorded from the study area are under a protection status according to the lists of WCMC and/or UNEP. These are: *Campanula delicatula*, which is considered as rare (R) in Greece, has been found on Agathonisi and Kounelonisi, *Garidella nigellastrum,* which is considered as vulnerable (V) in Greece, has been found on Agathonisi and Pharmakonisi, *Muscari macrocarpum* and *Romulea tempskyana*, which are both considered as rare (R) and *Ophrys holoserica* subsp. *heterochila*, which is considered as endangered (E) in Greece, have been found on Agathonisi.

The floristic relationships between the islands and islets studied (b-diversity), expressed in the Sørensen similarity coefficient is shown in Tab. 6. It is evident from the low values that even neighbouring islets show remarkable differences in their floristic composition, or, vice versa, have a small number of species in common. The highest value of the Sørensen coefficient (0.63) was calculated for the two large islands Agathonisi and Pharmakonisi. They have 167

Tab. 5. Biological spectra of the islands and islets studied (abbreviations in Tab. 1).

	Islands and islets									
Life form (%)	I1	I2	I3	I4	I5	I6	I7	I8	I9	Total
Chamaephytes	6.1	2.3	4.8	23.1	14.8	6.9	25.0	13.5	6.0	7.2
Geophytes	11.9	11.4	9.7	23	3.7	2.8	18.7	6.8	10.9	12.2
Hemicryptophytes	11.0	25.0	12.9	15.4	11.1	9.7	18.7	5.1	8.0	11.7
Phanerophyts	3.6	4.5	4.8	7.7	3.7	2.8	6.3	8.5	2.5	4.7
Therophytes	67.4	59.1	67.8	30.8	66.7	77.8	31.3	66.1	72.6	64.2

Tab. 6. Floristic relationships (b-diversity) between the investigated islands and islets. The number of the common taxa is shown above the diagonal and the values of the Sørensen similarity coefficient below it. The bold numbers along the diagonal show the number of plant taxa registered from each island or islet.

	I1	I2	I3	I4	I5	I6	I7	I8	I9
I1	**328**	34	53	4	20	66	9	43	167
I2	0.18	**44**	23	3	9	25	6	13	33
I3	0.27	0.43	**63**	2	10	38	5	25	44
I4	0.02	0.10	0.05	**13**	2	3	6	4	4
I5	0.11	0.25	0.22	0.10	**27**	15	3	12	20
I6	0.33	0.43	0.57	0.07	0.30	**74**	6	26	57
I7	0.05	0.20	0.13	0.41	0.14	0.14	**16**	4	7
I8	0.22	0.25	0.41	0.11	0.28	0.39	0.10	**59**	33
I9	0.63	0.27	0.33	0.04	0.17	0.42	0.06	0.25	**201**

taxa in common, 83 of which are found only on these two islands. Of these 83 taxa, 80.7 % (67 taxa) are therophytes. On the two islands the percentage of therophytes is 67.4 and 73.1, respectively (Tab. 5) and the three largest families *(Leguminosae, Compositae* and *Gramineae)* constitute 36.2 % and 48.7 % of their flora (Tab. 2).

3. Vegetation

The floristic diversity, in the area as a whole and on the individual islands and islets, affects the physiognomy and the other characteristics of the vegetation of the area. As already has been mentioned by Panitsa & al. (1994), three main vegetation zones can be distinguished on the small Aegean islands: the littoral, the epilittoral (also sublittoral or supralittoral) and the interior zone. Size and geomorphology of each island play the major role regarding the presence or absence as well as the extent of these vegetation zones. In the study area the littoral zone is dominated by halophytic communities, the interior zone mainly by phrygana and macchie (on the larger islands), while the epilittoral zone often exhibits a mixture of halophytic and phrygana species. The composition of these elements depends on the geomorphology, the exposure and the inclination of the coasts as well as on the human impact (grazing, fires, etc.).

The syntaxonomic assignment of the plant communities represented in the study area is given in Tab. 7 and the main characteristics of the three vegetation zones distinguished are briefly described.

a. Littoral vegetation zone

The littoral vegetation zone is restricted to a more or less narrow rocky belt and is characterized by a loose floristic composition with a low cover-abundance degree. In almost all the islets, the whole surface of this zone exposed to the sea surf is inhabited by true halophytes. The plant communities of this zone belong to the class and order Crithmo-Staticetea (-etalia) and the alliance Crithmo-Frankenion hirsutae Mayer 1995, which includes associations common on rocky coasts and littoral cliffs of the E Mediterranean. The local characteristic species of this alliance is *Frankenia hirsuta,* found on eight of the islets studied, accompanied by different *Limonium* spp. On most of the rocky coasts, the flora of the communities consists of species characteristic of the class and order Crithmo-Staticetea (-etalia) such as *Malcolmia flexuosa* (on I1, I2, I4, I5, I6, I7, I8), *Silene sedoides* (on I1, I2, I3, I5, I6, I8, I9), *Catapodium marinum* (on I1, I2, I3, I6, I8, I9), *Sedum litoreum* (on I1, I3, I4, I6, I8, I9), *Limonium narbonense* (on I2, I4, I6, I7, I8), *Parapholis incurva* (on I1, I2, I4, I9), *Lotus cytisoides* (I7, I9) and *Reichardia picroides* (on I6, I9). Two associations, viz Crithmo-Limonietum virgati Mayer 1995 and Limonio-Arthrocnemetum macrostachyi Mayer 1995, have been recognized from the area. The characteristic species of the former are *Limonium virgatum* and *Cichorium spinosum*, registered on Neronisi (I5) and Pharmakonisi (I9), while the characteristic species of the latter are *Limonium* spp. and *Arthrocnemum macrostachyum*, found on Prassonisi (I4) and Katsaganaki (I7).

b. Epilittoral vegetation zone

This zone succeeds the littoral and is only weakly influenced by wave action and sea spray. Being transitional between the littoral and the interior zone, it has inaccurately been named ‘sublittoral’ (Rechinger 1951, Runemark 1969, etc.). Bothmer (1974) more appropriately named it ‘epilittoral’, while Höner (1991) considered the term ‘supralittoral’ as more convenient. In this zone halophytic species of the class and order Crithmo-Staticetea (-etalia) coexist with phrygana species of the class and order Cisto-Micromerietea (-etalia) as well as with species of the class Quercetea ilicis and the order Pistacio-Rhamnetalia, which are found on almost all the islets studied.

A particular type of supralittoral vegetation composition and physiognomy was observed on Prassonisi and Katsaganaki, which are, due to their small size, entirely affected by the sea and winds and are not influenced by any human activity. The whole area of these islets is charac-

Tab. 7. Syntaxonomic assignment of the plant communities represented in the area studied.

Crithmo-Staticetea Br.-Bl. 1947
- *Crithmo-Staticetalia* Mol. 1934
  - *Crithmo-Frankenion* Mayer 1995
    - ***Crithmo-Limonietum virgati* Mayer 1995**
    - ***Limonio-Arthrocnemetum macrostachyi* Mayer 1995**

Asplenietea rupestris (H. Meier) Br.-Bl. 1934
- *Cirsietalia chamaepeucis* Horvat 1974
  - *Inulion heterolepis* Horvat 1974

Quercetea ilicis Br.-Bl. 1947
- *Pistacio-Rhamnetalia* Rivas-Martinez 1974
  - *Ceratonio-Rhamnion* Barbero & Quézel 1980
    - ***Ceratonio-Pistacietum lentisci* Zohary & Orshan 1959**

Cisto-Micromerietea Oberdorfer 1954
- *Cisto-Micromerietalia* Oberdorfer 1954
  - *Hyperico empetrifolii-Micromerion graecae* Barbero & Quézel 1989
    - *Helichryso orientale-Phagnalenion graeci* Barbero & Quézel 1989
    - *Phlomido fruticosae-Euphorbienion acanthothamni* Barbero & Quézel 1989

terized by a dense and uniform vegetation (coverage 90-100 %), characterized by species that prefer small islet's ecosystems (islet specialists, see Rechinger 1951: 201, Runemark 1969: 126, Höner & Greuter 1988: 129, Raus 1989: 34). Prassonisi is predominated by *Allium commutatum, Lavatera arborea* and *Elymus farctus* subsp. *rechingeri* but species like *Arthrocnemum macrostachyum, Frankenia hirsuta* and *Atriplex portulacoides* also play an important role. Katsaganaki has an impressive and quite different vegetation physiognomy predominated by *Helichrysum orientale* and *Convolvulus oleifolius*, with scattered occurrence of *Lavatera arborea* and *Allium commutatum* as well as *Sedum litoreum, Malcolmia flexuosa*. *Helichrysum orientale* is an example of a species that behaves as an islet specialist in our area, although it can be found also as a chasmophyte on larger Aegean islands (see also Höner 1991).
On Pharmakonisi, the supralittoral zone, where present, is dominated by *Cichorium spinosum* and in this case the plant cover is about 60-80 % and the mean vegetation height c. 20 cm. In the north of Agathonisi, there are steep coastal limestone cliffs and the supralittoral vegetation is characterized by species such as *Ptilostemon chamaepeuce, Capparis spinosa, Inula heterolepis, Scrophularia heterophylla*. Plant communities like these belong to the class Asplenietea rupestris (H. Meier) Br.-Bl. 1934, the order Cirsietalia chamapeucis Horvat 1974 and the alliance Inulion heterolepis Horvat 1974.

c. Interior vegetation zone
The interior vegetation zone occupies most of the surface on, especially, the larger islets. This zone is present on Agathonisi, Katsagani, Kounelonisi and Pharmakonisi and is characterized by dwarf, xerophytic phrygana formations belonging to the class and order Cisto-Micromerietea (-etalia) Oberdorfer 1954. They have a combination of species characteristic of the alliances Helichryso sanguinei-Origanion syriaci Barbero & Quézel 1989 (*Teucrium brevifolium, Daphne gnidioides*, etc.) and Hyperico empetrifolii-Micromerion graecae Barbero & Quézel 1989 with its suballiances Helichryso orientale-Phagnalenion graeci Barbero & Quézel 1989 *(Helichrysum orientale, Phagnalon graecum)* and Phlomido fruticosae-Euphorbienion acanthothamni *(Euphorbia acanthothamnos)* Barbero & Quézel 1989. Based on physiognomic criteria (dominant species) the following vegetation types can be distinguished:

c1. Type with *Erica manipuliflora:* This vegetation type occupies extended areas on Agathonisi and is characterized by the dominance of *Erica manipuliflora*. Several other species participate with a lower frequency and coverage degree, such as *Euphorbia acanthothamnos*, *Genista acanthoclada* and *Sarcopoterium spinosum*. The plant cover is about 80-90 % and the mean vegetation height is c. 1 m.
c2. Type with *Genista acanthoclada:* This vegetation type occurs mainly on Agathonisi but has been found also on Katsagani. It is characterized by the dominant and constant presence of *Genista acanthoclada*, which is occasionally associated with species like *Sarcopoterium spinosum, Cistus creticus* and *Pistacia lentiscus*. The plant cover is about 80-90 % and the mean vegetation height c. 80 cm.
c3. Type with *Sarcopoterium spinosum:* This vegetation type occurs mainly on previously cultivated areas on Agathonisi and in the central part of Pharmakonisi and is characterized by the almost exclusive presence of *Sarcopoterium spinosum*. The plant cover is about 70 % and the mean vegetation height c. 30 cm. *Pistacia lentiscus, Euphorbia acanthothamnos* and *Anthyllis hermanniae* participate with a low frequency. A special form was found on Kounelonisi (I9), where the physiognomy of the interior vegetation zone is characterized by the dominance of *Daphne gnidioides, Teucrium divaricatum* and *Pistacia lentiscus*. The plant cover is about 80 % and the mean vegetation height is c. 150 cm.

On the islets of Pitta, Stroggili and Neronisi, a significant degradation of the interior vegetation zone due to intense grazing and burning has been registered. On Pitta were also signs of a previous cultivation. Phrygana species were lacking, the only perennial shrubby species was *Pistacia lentiscus*, which was accompanied by *Brachypodium retusum* and other annual species.

The larger islands have an interior vegetation, which, apart from phrygana, is characterized by pre-forest formations of the thermo-Mediterranean macchie. These belong to the association Ceratonio-Pistacietum lentisci Zohary & Orshan 1959, the order Pistacio-Rhamnetalia Rivas-Martinez 1974 and the class Quercetea ilicis Br.-Bl. 1947. In the WSW of Agathonisi and in areas that have not been burned or cultivated, there are restricted formations with the characteristic species of this association, viz *Ceratonia siliqua* and *Pistacia lentiscus*. In the SW of Pharmakonisi, an extended stand of this association dominated by *Juniperus phoenicea* has been registered. The plant cover is 100 % and the mean vegetation height c. 170 cm.

Discussion

Of the total of 402 plant taxa known from the study area, 328 have been found on Agathonisi and 201 on Pharmakonisi, the two larger islands. The individual floras of the seven islets consist of a number of plant taxa ranging from 13 to 72, but no correlation of the islet size and the number of taxa is evident (Tab. 1). There is no doubt, however, that these small islets contribute considerably to the floristic diversity of the area, since 24 taxa have been registered exclusively from the islets and since their individual floras show remarkable differences not only in the number of taxa but also in species composition (Tab. 6). The important role of such small islets and their habitats in the floristic diversity of the Aegean area becomes evident by a floristic comparison of Agathonisi and its offshore islets Prassonisi (I5) and Katsaganaki (I7). From these two islets, 13 and 16 species, respectively, are known, but of these only 4 and 9 species, respectively, are among the 328 taxa found on Agathonisi.

It is also noteworthy that none of the 402 plant taxa was found on all the nine islands and islets. *Mercurialis annua* and *Frankenia hirsuta* are the most common species, occurring on eight islands. *Malcolmia flexuosa, Polycarpon tetraphyllum* and *Silene sedoides* are found on seven and *Filago eriocephala*, *Sedum litoreum*, *Plantago afra, Valantia muralis, Mandragora autumnalis, Tordylium apulum, Bromus madritensis* and *Catapodium marinum* on six islands and islets. Out of the total number of 402 taxa in the area, 130 (32.3 %) were found on one islet or island only: 87 of them are restricted to Agathonisi, 19 to Pharmakonisi, 10 to Kounelonisi, 5 to Stroggili, 4 to Prassonisi, 2 to Pitta and Neronisi each, and 1 to Katsaganakii.

The individual floras of the nine islands and islets also differ from each other in their spectra of life forms and chorological elements (Tab. 3-4). However, in the chorological spectra the Mediterranean elements predominate with a percentage higher than 70 % (Tab. 3) and in the life form spectra the percentage of therophytes exceeds 60 % (Tab. 5). It appears most interesting from a biogeographical point of view that the E Mediterranean element is represented in the study area by 92 taxa (22.9 %). Of these, the E Mediterranean elements with a narrow distribution range can, following Christodoulakis (1996), be categorized to one of five chorological subunits, viz (a) Balkan-Aegean-Anatolian, (b) Aegean-SW Anatolian-Cyprian, (c) Aegean-Anatolian, (d) E Aegean-Anatolian, and (e) Aegean island endemics. These chorological subunits are represented in our area by 9, 7, 3, 3 and 3 taxa respectively (Tab. 4). Also the low number of taxa with a distribution range restricted to the E Aegean area and the neighbouring coasts of Asia minor reflects the only recent geographical isolation of the study area. The low altitude (maximum 209 m on Agathonisi) as well as the maximal sea depth of 92 m between the study area and a larger island or Asia Minor also minimize the role of isolation as a floristic differentiation factor.

The Greek endemic element is represented in our area by three insular taxa *(Arenaria aegaea, Filago cretensis* subsp. *cretensis* and *Scorzonera cretica)* and by *Carthamus leucocaulos* known from both the Greek islands and the mainland. However, *Scorzonera cretica* and *Carthamus leucocaulos*, although found by Runemark & Bothmer in 1974 on Pitta (I2) and Stroggili (I3) respectively, were not found by us 17 years later. Extinction of these two species could be caused by random factors as those mentioned by Runemark (1969), or by human interference such as grazing, fires, etc., which are not uncommon on Aegean islets. Random factors and human interference have presumably given rise also to the differences in the floristic composition of the individual islets, either by random elimination of some species from an islet or by affecting the competition due to the invasion of other taxa. Greuter (1995) indicated an overall picture of remarkable stability of islet floras and plant populations when they are left untouched, contrasted with their fragility with regard to external impact and human interference. Snogerup & Snogerup (1987) mention considerable floristic changes in an islet complex during a period of 14 years, an observation that suggests the fragility of these ecosystems under human impact or extreme natural events (dry season, storm, etc.). In this context, the life form spectra are useful to detect the human impact on the flora of an island or islet (Tab. 5). Characteristic examples are Prassonisi (I4) and Katsaganaki (I7), which seem to have remained untouched from human impact. The percentage of therophytes on these islets is only c. 30 %, thus only half of the percentage of the total flora of the area (Tab. 5), and anthropophytes, in particular annual *Leguminosae*, are not represented, and the two islets have very few species in common. Agathonisi and Pharmakonisi, where human activities (agriculture, grazing and fires) take place, in contrast, show high percentages of therophytes (Tab. 5) and *Leguminosae* species (Tab. 2) as well as a higher floristic similarity (Tab. 6): among the 83 taxa found exclusively on these two islands, 67 taxa (80.7 %) are therophytes and 25 (30 %) are *Leguminosae*. A high percentage of these two species groups is considered an indicator of disturbance in Mediterranean ecosystems, caused by humen impact (Arianoutsou & Margaris 1981, Barbero & al. 1990, Panitsa & al. 1994).

Overgrazing and fire affect the flora of an area in different ways. According to Pettit & al. (1995) and Lillis & Testi (1992), overgrazing can dramatically change the floristic composition and the structure of the vegetation, transforming woodlands into grasslands, while the impact of fire on floristic composition and b-diversity is rather temporary and depends on the relative changes in the competitive relationships among species. It should be pointed out, however, that kind and extent of floristic and structural changes in fragile and vulnerable ecosystems as those of the small Aegean islands can come out quite different. A change caused by the same factor can be minimal in a mainland or larger island ecosystem but fatal for the ecosystem of an islet. This must be taken into consideration when planning nature conservation and management of the small island ecosystems.

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