P. Koutsopoulos & G. Sarlis

Contribution to the study of the flora of Vouraikos gorge (Peloponnesos, Greece)

Abstract

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This study deals with the flora and certain ecological factors of Vouraikos gorge district. Our floristic records in the area reach the number of 275 species and 19 subspecies, a total of 290 taxa, which belong to 214 genera and 58 families. The richest in members families are the Asteraceae with 37 species and 4 subspecies (a total of 41 taxa), the Fabaceae with 34 species and 5 subspecies (a total of 39 taxa), the Lamiaceae with 21 species and the Poaceae with 18 species and 2 subspecies (a total of 20 taxa). Also, *Asperula arcadiensis*, *Aurinia moreana*, *Colchicum peloponnesiacum* and *Peucedanum achaicum* are local endemic taxa of Peloponnesos. Finally, *Silene conglomeratica* is a rare species, endemic to the Vouraikos gorge area.

Introduction

Vouraikos river is situated in the northern part of Peloponnesos (S Greece, Fig. 1). The river springs between mount Chelmos (2338 m) and mount Erymanthos (2221 m) and flows into the Corinthian gulf, near the town of Diakopto. The most interesting part of the river is the one between Kalavryta and Diakopto villages, which is known as the gorge of Vouraikos. The length of the gorge is c. 22 km and its altitude ranges between 0 and 1200 m (Fig. 2).

There are two reasons for which this particular gorge is amongst the most well-known gorges in Greece: on one hand it is deep and narrow at most of its part and on the other hand the presence of the rack railway which crosses the gorge over iron bridges and through tunnels and links Diakopto with Kalavryta. The passing of the gorge on foot over the rail track is safe and consists part of the European path E4 (Fig. 3, 4).

There are also two interesting rivers near Vouraikos, i.e. Kerynitis and Selinountas. The area close to the delta of these three rivers is a coastal plane where orange trees, olive trees and grapes are cultivated. One important city, the ancient Eliki was placed in this area, but was sunk into the sea in 373 A.D. due to an enormous earthquake.

In the gorge, c. 12 km southwards Diakopto and at an altitude of 620 m lies the small

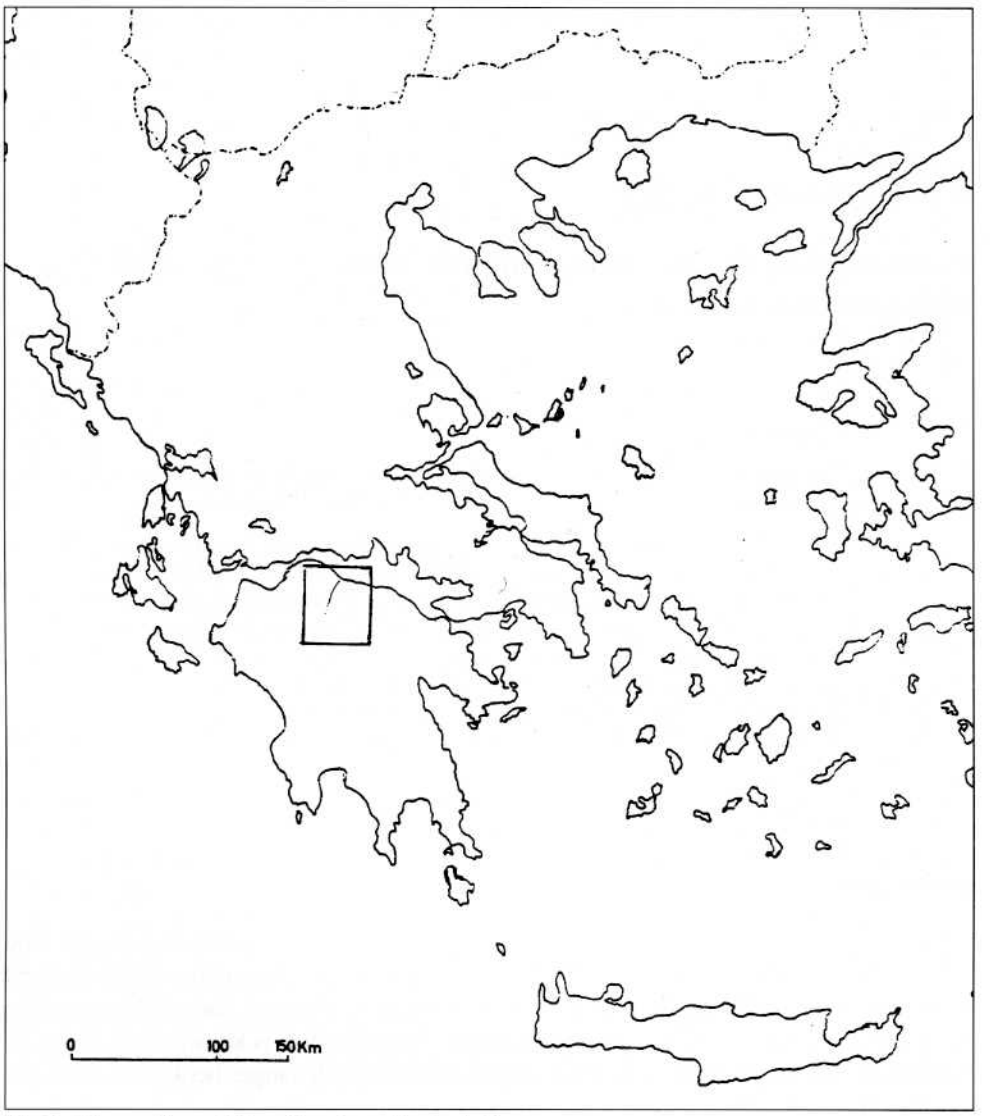

Fig. 1. The position of Vouraikos river district in Greece.

village of Zachlorou. The historic monastery of Mega Spilaion is built above Zachlorou, at an altitude of 924 m, situated in a cavity at the base of a big and precipitous rock.

Materials and methods

Our collections of plant specimens were made over the years 1999-2001, during continuous visits, especially during flowering season. Species were identified at the Institute of Systematic Botany of the Agricultural University of Athens.

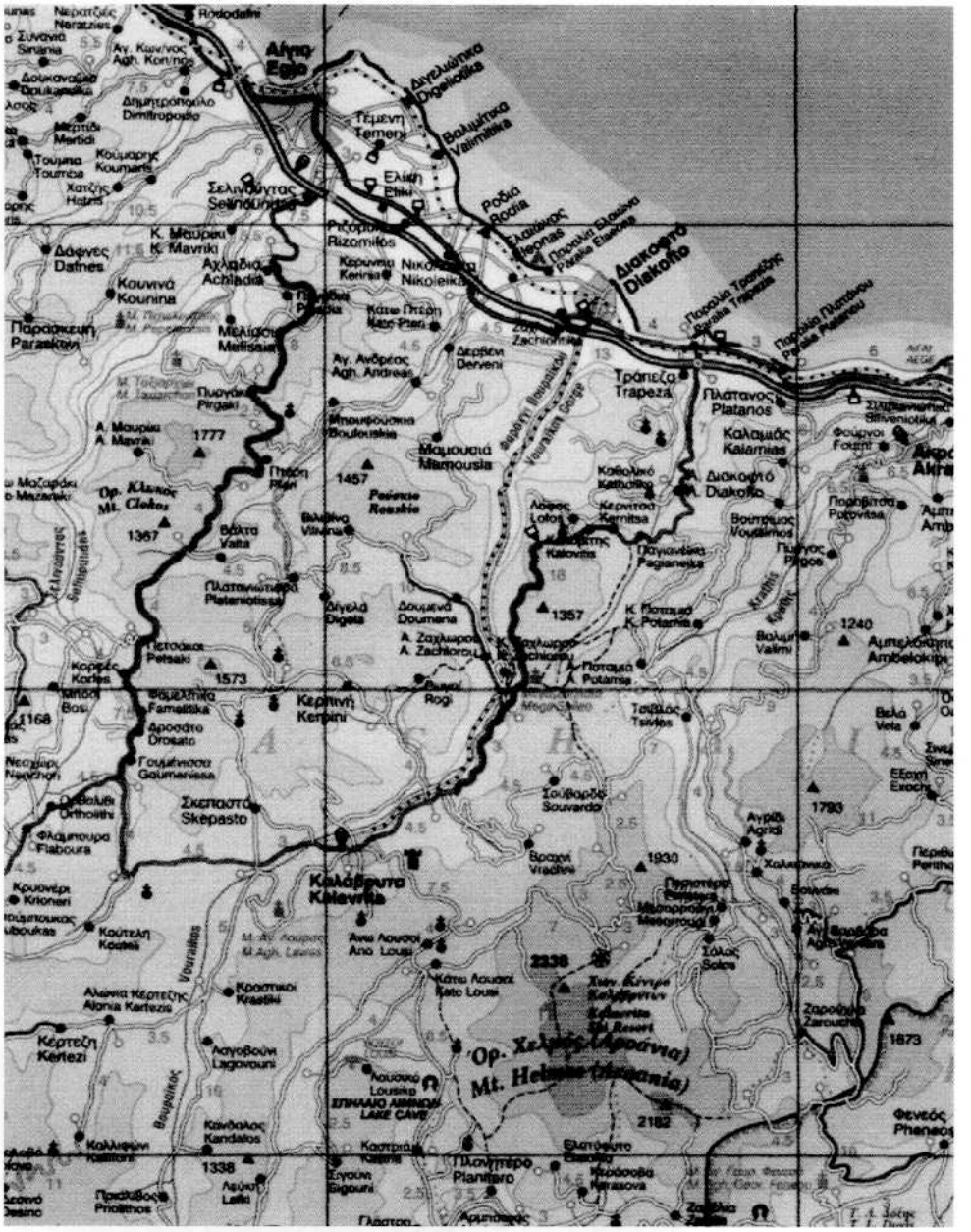

Fig. 2. Map of Vouraikos gorge in the eastern part of Achaia county.

For the determination of specimens and nomenclature the following works were used: Diapoulis (1939-1949), Greuter & al. (1984-1989), Kavvadas (1956-1964), Polunin (1980), Strid (1986-1991), Strid & Tan (1991) and Tutin & al. (1964-1980).

Fig. 3. The deep and narrow gorge of Vouraikos river.

Fig. 4. The rack railway which crosses the gorge over iron brigdes.

Ecological conditions

The geological formations that participate in the structure of the walls of the gorge are generally various sorts of limestone of the Paleocene period as well as Quaternary conglomerates. Limestone occupies the narrowest and most impressive part of the gorge, which extends between the fifth and eleventh kilometer southwards Diakopto. The presence of conglomerates in a continuous zone that covers much of remaining of the gorge and also the areas west of the gorge from Kalavryta to the ends of the Corinthian Gulf indicates that the are was covered by the sea at the end of the Tertiary period.

The climate of Vouraikos gorge, according to the Koeppen taxonomy, can be classified in the Csa type or in the "Mediterranean climate type", which is characterized by its semi-warm climate with an arid period during summer (Sc) and warm summer (a). From a bioclimatic point of view (Emberger, 1967; Mavrommatis, 1980) the Kalavryta district (upper end of the gorge) belongs in the humid Mediterranean Zone (mean annual temperature 13.3 °C, total annual precipitation 996.4 mm), while the Egio district (near the end of the gorge) belongs in the sub-humid Mediterranean Zone (mean annual temperature 18.3 °C, total annual precipitation 665.0 mm) (Fig. 5, 6).

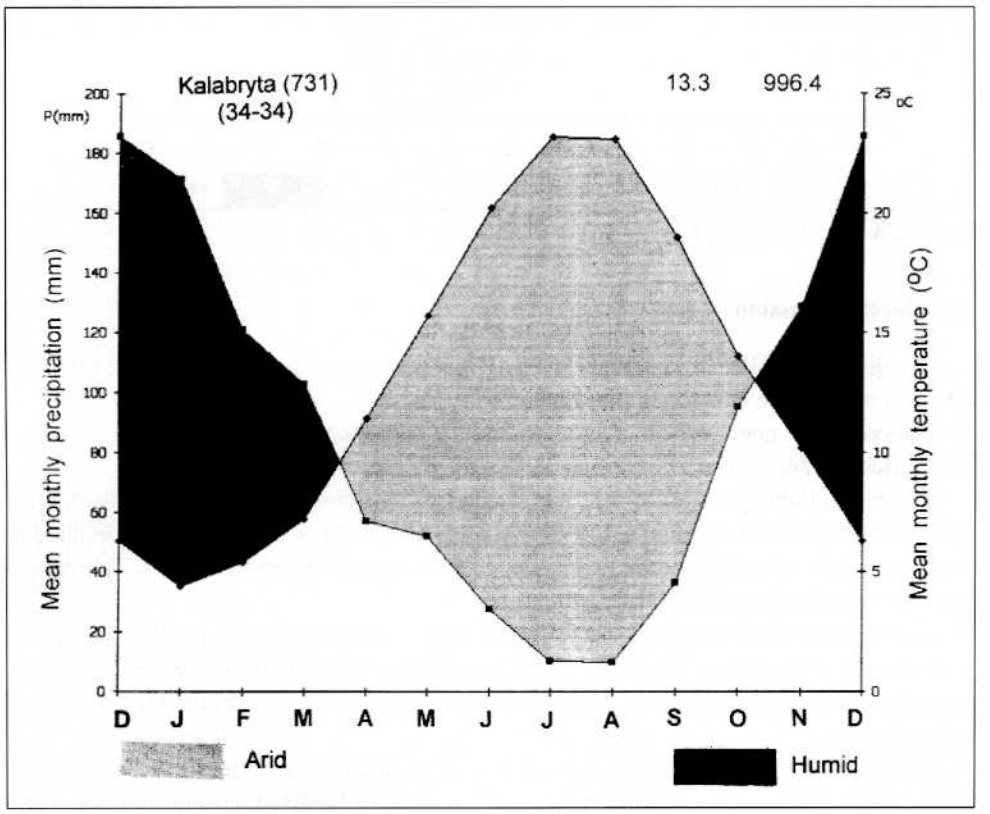

Fig. 5. Climatic diagram of Kalavryta weather station.

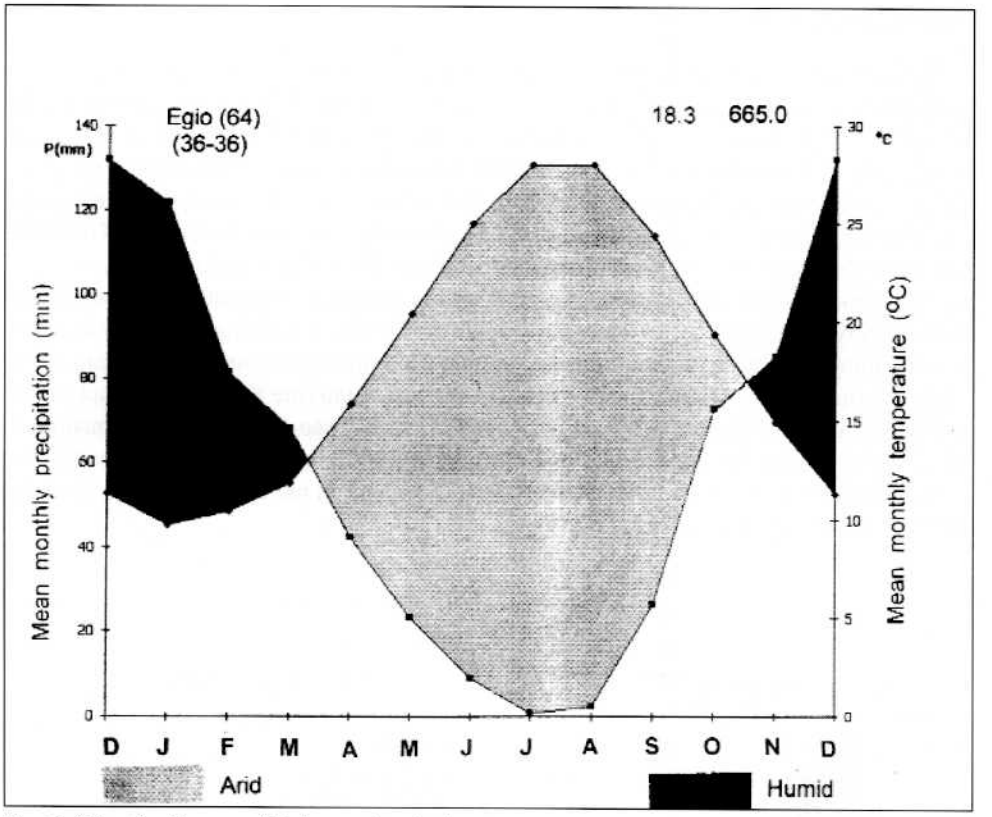

Fig. 6. Climatic diagram of Egio weather station.

Results & discussion

The diversity of the flora of Vouraikos george is summarized in Table 1 and the presentation of the flora is made in the Appendix.

The particular geomorphologic conditions, the soil, the climate and grazing pressures have affected the flora and vegetation of the gorge.

In general, the vegetation of the gorge is sparse. This is due to the fact that the largest part of the whole area is stony and rocky on one hand, but also to the intensive grazing at that parts of the gorge that border Diakopto, Zachlorou and Kalavryta villages. This resulted in the degradation of the bushy vegetation.

The largest proportion of the species in the flora of Vouraikos gorge are therophyta and low-shrubby xerophytes (phrygana). This is mostly due to the stony soil which keeps low amounts of humidity and also to the dry and warm climate, which prevails for a long period each year.

The vegetation of the northern part of the gorge, which extends up to the eighth kilometer south of Diakopto, belongs to the inferior zone of the Mediterranean conifers and the sclerophyllous broad-leaved shrubs and is characterized by the presence of *Pinus*

Table 1. Systematic units and taxa of the flora of Vouraikos gorge.

Systematic Units	Families	Genera	Species	Subspecies	Taxa	Percentage
Pteridophyta	4	4	4	-	4	1.4
Gymnospermae	2	3	3	-	3	1.0
Dicotyledones	46	170	224	18	242	83.5
Monocotyledones	6	37	40	1	41	14.1
Total	**58**	**214**	**271**	**19**	**290**	**100.00**

halepensis in association with *Arbutus andrachne*, *Cercis siliquastrum*, *Phillyrea latifolia*, *Pistacia lentiscus* and *P. terebinthus*. Various phrygana have penetrated this vegetation type, mainly *Ballota acetabulosa*, *Cistus creticus*, *Hypericum empetrifolium*, *Micromeria juliana*, *Phlomis fruticosa*, *Salvia fruticosa*, *Teucrium flavum* and *Coridothymus capitatus*.

Southwards this above-mentioned vegetation type a forest of *Quercus ilex* has been formed. Next to that and from Zachlorou to Kalavryta at the eastern part of the gorge a forest of *Abies cephalonica* can be observed. At the western part we meet a few individuals of *Abies* together with sparse bushes, mainly of *Quercus coccifera* and *Juniperus oxycedrus*.

The banks of the river are dominated by *Platanus orientalis*, especially in humid, cool and shadowy places. At the southern part of the gorge there are extensive and thick clusters of *Platanus orientalis* under which various herbaceous species grow, such as *Arum italicum*, *Ranunculus neapolitanus*, *R. repens*, *Symphytum bulbosum* and *Urtica dioica*. Moreover, the presence of *Nerium oleander* is prominent along the river near Diakopto.

Some of the endemic to Peloponnesos plant species are also met in the gorge of Vouraikos. These are *Asperula arcadiensis*, *Aurinia moreana*, *Colchicum peloponnesiacum*, *Peucedanum achaicum* and *Silene congesta* subsp. *moreana*. *Achillea umbellata* subsp. *monocephala*, once considered a local endemic taxon of Vouraikos gorge, has now been assigned to the variation of the polymorphic *A. umbellata* without any special taxonomic status (Tzanoudakis & Iatrou 1981; Dimopoulos & Georgiadis 1992; Iatrou 1992).

Finally, a number of species that are met mainly or exclusively on the rocks of the gorge are worth mentioning:

Achillea umbellata, *Adiantum capillus-veneris*, *Asperula arcadiensis*, *Atractylis gummifera*, *Aubrieta deltoidea*, *Aurinia moreana*, *A. saxatilis* subsp. *orientalis*, *Bupleurum fruticosum*, *Campanula versicolor*, *Centaurea raphanina* subsp. *mixta*, *Centranthus ruber*, *Cephalaria ambrosioides*, *Ceterach officinarum*, *Fibigia eriocarpa*, *Inula verbascifolia* s.l., *Lamium garganicum*, *Leontodon crispus*, *Odontites linkii* subsp. *linkii*, *Onosma frutescens*, *Phagnalon graecum*, *Pterocephalus perennis* subsp. *perennis*, *Ptilostemon chamaepeuce*, *Salvia ringens*, *Scrophularia heterophylla*, *Sedum album*, *S. laconicum*, *S. ochroleucum*, *Silene congesta* subsp. *moreana*, *S. italica*, *S. vulgaris*, *Stachys parolinii*, *Thymus atticus*, *Umbilicus horizontalis*.

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Address of the authors:
Assoc. Prof. G. Sarlis & P. Koutsopoulos, Institute of Systematic Botany, Agricultural University of Athens, Iera Odos 75, 118 55 Athens, Greece.

Appendix 1. List of species found in the Vouraikos gorge district.

PTERIDOPHYTA
Adiantaceae
Adiantum capillus-veneris L.

Aspleniaceae
Ceterach officinarum DC.

Hypolepidaceae
Pteridium aquilinum (L.) Kuhn

Polypodiaceae
Polypodium cambricum L.

SPERMATOPHYTA
GYMNOSPERMAE

Cupressaceae
Juniperus oxycedrus L.

Pinaceae
Abies cephalonica Loudon
Pinus halepensis Miller

ANGIOSPERMAE
DICOTYLEDONES

Acanthaceae
Acanthus spinosus L.

Anacardiaceae
Pistacia lentiscus L.
P. terebinthus L. subsp. *terebinthus*
Rhus coriaria L.

Apiaceae
Apium nodiflorum (L.) Lag.
Bupleurum fruticosum L.
Daucus guttatus Sm. subsp. *guttatus*
Ferula communis L.
Ferulago nodosa (L.) Boiss.
Malabaila aurea (Sm.) Boiss.
Myrrhoides nodosa (L.) Cannon
Opopanax hispidus (Friv.) Griseb.
Orlaya grandiflora (L.) Hoffm.
O. daucoides (L.) Greuter
Peucedanum achaicum Halácsy
P. aegopodioides (Boiss.) Vandas
Pimpinella peregrina L.
Scaligeria napiformis (Sprengel) Grande
Tordylium apulum L.
T. officinale L.
Torilis arvensis subsp. *purpurea* (Ten.) Hayek

Apocynaceae
Nerium oleander L.

Araliaceae
Hedera helix L. s.l.

Aristolochiaceae
Aristolochia sempervirens L.

Asteraceae
Achillea umbellata Sm.
Andryala integrifolia L.
Anthemis chia L.
Atractylis gummifera L.
Bellis perennis L.
B. sylvestris Cyr.
Carduus pycnocephalus L. s.l.
Carlina graeca Heldr. & Sart.
Carthamus dentatus Vahl subsp. *ruber* (Link) Hanelt

Centaurea cyanus L.
C. raphanina Sm. subsp. *mixta* (DC.) Runemark
Cirsium creticum (Lam.) D'Urv. subsp. creticum
Crepis dioscoridis L.
C. neglecta L.
C. fraasii Schultz Bip.
Crupina crupinastrum (Moris) Vis.
Dittrichia viscosa (L.) W. Greuter
Doronicum orientale Hoffm.
Hypochoeris achyrophorus L.
Inula verbascifolia (Willd.) Hausskn. s.l.
Leontodon tuberosus L.
L. crispus Vill.
Mycelis muralis (L.) Dumort.
Pallenis spinosa (L.) Cass. s.l.
Phagnalon graecum Boiss. & Heldr.
Picnomon acarna (L.) Cass.
Picris echioides L.
Ptilostemon chamaepeuce (L.) Less.
P. stellatus (L.) W. Greuter
Pulicaria dysenterica (L.) Bernh.
Reichardia picroides (L.) Roth
Rhagadiolus stellatus (L.) Gaertner
Scolymus hispanicus L.
Scorzonera crocifolia Sm.
S. laciniata L.
Silybum marianum (L.) Gaertner
Sonchus asper (L.) Hill s.l.
Tanacetum parthenium (L.) Schultz
Tussilago farfara L.
Tyrimnus leucographus (L.) Cass.
Urospermum picroides (L.) Scop.

Boraginaceae
Alkanna methanea Hausskn.
Anchusa cretica Miller
A. officinalis L.
Cerinthe retorta Sm.
Cynoglossum officinale L.
Echium italicum L.
E. plantagineum L.
Myosotis congesta R.J. Shuttlew
Neatostema apulum I.M. Johnston
Onosma frutescens Lam.
O. montana Sm.
Symphytum bulbosum C. Schimper

Brassicaceae
Alliaria petiolata (Bieb.) Cavara & Grande
Alyssum siculum Jordan

Arabis verna (L.) R. Br.
Aubrieta deltoidea (L.) DC.
Aurinia moreana Tzanoudakis & Iatrou
A. saxatilis (L.) Desv. subsp. *orientalis* (Ard.) Dudley
Biscutella didyma L.
Bunias erucago L.
Cardamine graeca L.
Fibigia eriocarpa (DC.) Boiss.
Lunaria annua L.
Malcolmia graeca subsp. *bicolor* (Boiss. & Heldr.) A.L. Stork
Thlaspi praecox Wulfen

Campanulaceae
Campanula ramosissima Sm.
C. rupestris Sm.
C. spatulata Sm. s.l.
C. versicolor Andrews

Caryophyllaceae
Petrorhagia obcordata (Margot & Reuter) Greuter
P. saxifraga (L.) Link
P. dubia (Rafin.) G. López & Romo
Silene behen L.
S. congesta Sm.
S. corinthiaca Boiss. & Heldr.
S. graeca Boiss.& Spruner
S. italica (L.) Pers.
S. nutans L.
S. vulgaris (Moench) Garcke
Stelaria cupaniana (Jordan & Fourr.) Béguinot
Velezia rigida L.

Cistaceae
Cistus creticus L. s.l.
C. salvifolius L.
Helianthemum hymettium Boiss. & Heldr.
H. nummularium (L.) Miller

Convolvulaceae
Calystegia silvatica (Kit.) Griseb
Convolvulus elegantissimus Miller
Cuscuta palaestina Boiss.

Crassulaceae
Sedum album L.
S. cepaea L.
S. laconicum Boiss. & Heldr.
S. ochroleucum Chaix
S. rubens L.
Umbilicus horizontalis (Guss.) DC.

Dipsacaceae
Cephalaria ambrosioides (Sm.) Roemer & Schultes
Knautia integrifolia (L.) Bertol.
Pterocephalus perennis Coulter subsp. *perennis*
P. plumosus (L.) Coulter
Tremastelma palaestinum (L.) Janken

Ericaceae
Arbutus andrachne L.

Euphorbiaceae
Euphorbia characias L. subsp. *wulfenii* (Hoppe) A.R. Sm.

Fabaceae
Anthyllis hermanniae L.
A. vulneraria subsp. *rubriflora* (DC.) Arcangeli
Astragalus hamosus L.
A. monspessulanus L.
Calicotome villosa (Poiret) Link
Cercis siliquastrum L.
Colutea arborescens L.
Coronilla scorpioides (L.) Koch
Dorycnium hirsutum (L.) Ser.
D. pentaphyllum Scop. s.l.
Hippocrepis emerus (L.) Lassen subsp. *emeroides* (Boiss. & Spruner) Lassen
H. unisiliquosa L.
Lathyrus setifolius L.
Lotus cytisoides L.
L. ornithopodioides L.
Medicago disciformis DC.
M. minima (L.) Bartal
M. orbicularis (L.) Bartal
M. praecox DC.
M. rugosa Desr.
Melilotus neapolitanus Ten.
Onobrychis aequidentata (Sm.) D'Urv.
O. ebenoides Boiss. & Spruner
O. caput-galli (L.) Lam.
O. ebenoides Boiss. & Spruner
Ononis pubescens L.
O. viscosa L. subsp. *breviflora* (DC.) Nyman
Psoralea bituminosa L.
Scorpiurus muricatus L.
Securigera securidaca (L.) Degen
Spartium junceum L.
Trifolium angustifolium L.
T. campestre Schreber
T. nigrescens Viv.
T. physodes Steven
T. speciosum Willd.

T. stellatum L.
Vicia sativa L. subsp. *nigra* (L.) Ehrh.
V. villosa Roth subsp. *eriocarpa* (Hausskn.) P.W. Ball

Fagaceae
Quercus coccifera L.
Q. ilex L.

Gentianaceae
Blackstonia perfoliata (L.) Hudson
Centaurium erythraea Rafn. s.l.
C. tenuiflorum (Hoffmanns & Link) Fritsch

Geraniaceae
Geranium lucidum L.
G. purpureum Vill.

Hypericaceae
Hypericum empetrifolium Willd. subsp. *empetrifolium*
H. vesiculosum Griseb.

Juglandaceae
Juglans regia L.

Lamiaceae
Ballota acetabulosa (L.) Bentham
Calamintha nepeta (L.) Savi s.l.
Coridothymus capitatus (L.) Reichenb. fil.
Lamium garganicum L. s.l.
Lycopus europaeus L.
Mentha longifolia (L.) Hudson
Micromeria juliana (L.) Bentham
Phlomis fruticosa L.
Salvia fruticosa Miller
S. ringens Sm.
S. verbenaca L.
S. viridis L.
Teucrium capitatum L.
T. chamaedrys L. subsp. *chamaedrys*
T. divaricatum Sieber s.l.
T. flavum L. s.l.
Thymus atticus ?elak.
Sideritis curvidens Stapf
Stachys cretica L. s.l.
S. graeca Boiss. & Heldr.
S. parolinii Vis.

Linaceae
Linum pubescens Banks & Solander
L. strictum L.

Lythraceae
Lythrum salicaria L.

Malvaceae
Alcea pallida (Willd.) Waldst. & Kit.
Althaea hirsuta L.
Lavatera bryonniifolia Miller

Moraceae
Ficus carica L.

Oleaceae
Fraxinus ornus L.
Phillyrea latifolia L.

Orobanchaceae
Orobanche pubescens D'Urv.

Papaveraceae
Fumaria parviflora Lam.
Papaver apulum Ten.
P. rhoeas L.

Plantaginaceae
Plantago afra L.

Platanaceae
Platanus orientalis L.

Primulaceae
Anagallis arvensis L.
Cyclamen hederifolium Aiton

Ranunculaceae
Anemone blanda Schott. & Kotschy
A. pavonina Lam.
Clematis vitalba L.
Consolida ajacis (L.) Schur
Nigella damascena L.
Ranunculus ficarioides Bory & Chaub.
R. neapolitanus Ten.
R. paludosus Poiret
R. repens L.
R. sprunerianus Boiss.

Rosaceae
Rosa canina L.
Sanguisorba minor Scop. s.l.
Sarcopoterium spinosum L.

Rubiaceae
Asperula arcadiensis Sims
Rubia peregrina L.

Salicaceae
Salix alba L.
S. elaeagnos Scop.
S. fragilis L.

Saxifragaceae
Saxifraga rotundifolia L. subsp. *chrysosplenifolia* (Boiss.) D.A. Webb

Scrophulariaceae
Odontites linkii Heldr. & Sart. subsp. *linkii*
Parentucellia latifolia (L.) Caruel
Scrophularia heterophylla Willd.
Verbascum macrurum Ten.
V. sinuatum L.

Solanaceae
Solanum dulcamara L.

Urticaceae
Urtica dioica L.

Valerianaceae
Centranthus calcitrapae (L.) Dufresne
C. ruber (L.) DC. subsp. *sibthorpii* (Heldr. & Sart. ex Boiss.) Hayek
Valeriana italica Lam.
Valerianella discoidea (L.) Loisel.

Verbenaceae
Vitex agnus-castus L.

Violaceae
Viola odorata L.

Vitaceae
Vitis vinifera L.

MONOCOTYLEDONES

Amaryllidaceae
Sternbergia lutea (L.) Ker-Gawler

Araceae
Arisarum vulgare Targ.-Tozz.
Arum italicum Miller

Iridaceae
Crocus boryi Gay

Liliaceae
Allium amethystinum Tausch
A. subhirsutum L.
Asparagus acutifolius L.
Asphodeline liburnica (Scop.) Reichenb.
Colchicum peloponnesiacum Rech. fil. & P.H. Davis
Gagea arvensis (Pers.) Dumort.
Ornithogalum exscapum Ten.
Muscari commutatum Guss.
M. comosum (L.) Miller
M. pulchellum Heldr. & Sart.
Ruscus aculeatus L.
Smilax aspera L.
Urginea maritima (L.) Baker

Orchidaceae
Anacamptis pyramidalis (L.) L.C.M. Richard
Barlia robertiana (Loisel.) W. Greuter
Orchis italica Poiret
O. quandripunctata Cyr.

Poaceae
Aegilops geniculata Roth
Aira elegantissima Schur
Alopecurus utriculatus Solander
Anthoxanthum odoratum L.
Avena sterilis L.
Briza minor L.
Bromus madritensis L. s.l.
Cynodon dactylon (L.) Pers.
Cynosurus echinatus L.
Dactylis glomerata L. subsp. *hispanica* (Roth) Nyman
Desmazeria rigida (L.) Tutin
Hordeum murinum L. subsp. *leporinum* (Link) Archangeli
Lagurus ovatus L.
Lolium perenne L.
Melica ciliata L.
Phalaris arundinacea L.
Piptatherum miliaceum (L.) Cosson
Poa annua L.
Setaria viridis (L.) Beauv.
Stipa lagascae Roemer & Schultes