

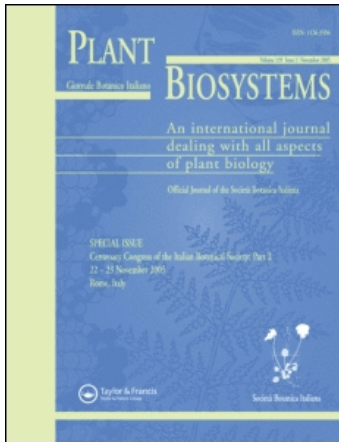
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## Identifying plant communities of thermophilous deciduous forest in Greece: Species composition, distribution, ecology and syntaxonomy

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### Abstract

Thermophilous deciduous forest is widespread in northern mainland Greece and extends in patches further south to Peloponnisos and the bigger islands. In this paper, we provide a phytosociological survey of the plant communities of deciduous oak and mixed forest throughout Greece, based on about 370 relevés from the literature and more than 300 personal unpublished ones. Association names of the thermophilous deciduous forest are re-evaluated, and syntaxonomic conclusions added. The relevés are classified, and 13 associations and several additional subtypes described and presented in synoptic constancy tables. The following associations were recognized, and characterized by species composition, ecology and distribution: 1. *Phillyreo-Carpinetum orientalis*, 2. *Dryopterido pallidae-Ostryetum carpinifoliae*, 3. *Tilio tomentosae-Castanetum*; 4. *Genisto carinalis-Quercetum petraeae*, 5. *Quercus frainetto-Castanetum*, 6. *Cytiso villosi-Castanetum*; 7. *Lathyro laxiflori-Castanetum*; 8. *Symphyto ottomani-Quercetum frainetto*, 9. *Verbasco glabrati-Quercetum frainetto*; 10. *Huetio cynapioidis-Quercetum frainetto*; 11. *Digitali viridiflorae-Quercetum frainetto*; 12. *Geranio asphodeloidis-Quercetum frainetto*; 13. *Oenanthe pimpinelloidis-Quercetum frainetto*. Associations 1–2 are assigned to the alliance *Fraxino ornii-Ostryion*, 4–6 and 8–13 to the *Quercion frainetto* (both *Quercetalia pubescentis*), 3 interim to the *Tilio-Acerion*, and 7 to the *Quercetalia ilicis*. The two *Quercetalia pubescentis* alliances co-occur in northern Greece; their habitats differ chiefly in terms of soil conditions, bedrock and topography, rather than in overall climatic character.

**Key words:** Greece, oak forest, phytosociology, *Quercus*, *Quercetalia pubescentis*, submediterranean forest, vegetation classification

### Introduction

Thermophilous deciduous forests are widely distributed in Greece, but have not yet been monographed except for contributions with a wider geographical scope (Horvat et al. 1974; Doniță et al. 2003). The potential range comprises about one-third of the Greek mainland from the north to the Peloponnisos (Bohn et al. 2000/2003; Bergmeier et al. 2004), but in real vegetation terms, the thermophilous deciduous forest covers only 7% (about 750,000 ha or 22% of the forested area) (Hellenic Ministry of Agriculture 1992). This statistical figure includes both open and dense forests and woodlands with trees generally taller than 7 m. Woody substitute vegetation, including semi-evergreen “pseudomaquis” and open

savanna-like pastures, do not fall under this definition, and were excluded from our study.

The most frequently dominating deciduous oak species of mainland Greece is *Quercus frainetto*. Other prevailing tree species are *Quercus petraea* subsp. *medwediewii* (*Q. dalechampii* sensu auct. balc.), *Q. cerris*, *Q. pubescens*, *Q. trojana*, *Castanea sativa*, *Carpinus orientalis*, *Tilia tomentosa*, *Ostrya carpinifolia* and *Fraxinus ornus*. Apart from *Quercus frainetto*, also *Q. petraea* and *Castanea sativa* tend to grow in pure stands, while the others are more or less common subordinate trees to which several less frequent species can be added. Most thermophilous deciduous forests are coppices which are cut at intervals for firewood, although only a fraction is still used in this way. The majority of coppices consist of stems

older than the usual coppice cycle of about 20 years. Many coppice woods are transferred to more productive stands for timber production. Old-growth forest with single-stemmed oaks is much less common. Both coppices and old-growth are commonly grazed by sheep or cattle, and sometimes frequented by domestic pigs. The proportion of pasture woods in the thermophilous deciduous forest is much higher than in beech, fir and pine forests.

For more detailed accounts on the diversity of thermophilous deciduous forest in Greece and the southern Balkans, its structure, dynamics, forestry, conservation issues, climate and soil conditions the reader is referred to our previous papers (Bergmeier et al. 2004; Bergmeier 2005; Dimopoulos et al. 2005). This study builds upon these surveys, but is focused on the plant communities and their relations in terms of species composition, diversity and distribution. Our objective is to describe and define the plant communities and to link them firmly to ICPN-verified phytosociological syntaxon names (Weber et al. 2000).

## Materials and methods

Relevés of Greek thermophilous deciduous forest have been used more selectively for this survey than in our previous paper (Dimopoulos et al. 2005). Reliability in methodical standards (completeness of species records per relevé, taxonomic and geographical accuracy, presence of a proper set of environmental and structural data for each relevé) was a precondition. The size of most relevé plots was 100–400 m<sup>2</sup>. Larger plots (900 m<sup>2</sup>) were accepted in a few cases. The following sources, containing original relevés, were evaluated: Zoller et al. (1977), Gamisans and Hebrard (1979, 1980), Raus (1980), Bergmeier (1990), Theodoropoulos (1991), Theodoropoulos et al. (1995), Petermann (1999), Dimopoulos and Bergmeier (2004), Tsaliki et al. (2005), as well as 307 of our own unpublished relevés. A total of 681 relevés was used. Plant communities with only very few available records were not taken into consideration, neither were stands of scrub less than 5 m in height. Riparian and lowland forests with *Quercus robur* subsp. *pedunculiflora* and woodlands with *Q. ithaburensis* subsp. *macrolepis* were excluded for coenological reasons and lack of data.

The relevés were extracted from the vegetation database of the first author and edited under the TURBOVEG vs. 2 database system (Hennekens & Schaminée 2001). The taxonomy and nomenclature of taxa in the original relevés were updated where necessary. Some taxa were recombined in order to achieve common taxonomic standards. The relevés were grouped into five subsets:

- *Quercus frainetto* dominated woodlands,
- woodlands with *Tilia tomentosa*,
- woodlands dominated by *Quercus petraea* subsp. *medwediewii* (*Q. dalechampii*),
- *Castanea sativa* woodlands, and
- mixed woodlands with cover values of more than (15–)25% of either *Carpinus orientalis*, *Fraxinus ornus*, *Ostrya carpinifolia*, *Quercus pubescens* and/or *Quercus trojana*.

Each of the five subsets was exported to JUICE 6.3 (Tichý 2002) and classified separately. Classification was assisted by Two-way indicator species analysis (TWINSPAN, Gauch & Whittaker 1981), using default settings and three (0, 5, 25) “pseudospecies cut levels”. Some of the TWINSPAN relevé clusters were recombined in order to improve interpretability. A few relevés were manually assembled in biogeographically corresponding clusters. Ordinations (CA, DCA, PCA) based on the entire presence-absence transformed data set were calculated, and a DCA scatter diagram with species scores was plotted and used for the present paper.

An overall synoptic table and several on certain plant communities or groups of communities were generated using JUICE (Tichý 2002) to demonstrate the distinctness and similarities in species composition among and within plant associations, and to underpin taxonomic arguments. Associations were defined by different species combinations, a distinct set of differential species, and specific biogeographical situation and abiotic environment. In most associations, community subtypes were recognized. Several such community subtypes were found with species combinations related to degradation by over-exploitation and wood pasture. The latter subtypes were excluded from the total set of 681 relevés, leaving 592 relevés as a basis for the overall synoptic table, thus omitting groupings that represent the most degraded variants of plant communities. The identification of diagnostic (given in bold letters) and constant species indicated in the community accounts below is based on a fidelity threshold of 33% and a frequency threshold of 66% (Tichý 2002).

Except for *Charybdis maritima* (Speta 2004), *Primula veris* subsp. *columnae* (Wisskirchen & Haeupler 1998), *Achnatherum bromoides* (Scholz & Raus 2006), *Scabiosa ochroleuca* (Greuter et al. 1986) and *Dorycnium herbaceum* (Greuter et al. 1989), the nomenclature of vascular plants follows basic floras: Tutin et al. (1968–1980), Strid (1986), Strid and Tan (1991, 1997, 2002).

## Results

### *Species diversity*

The data set comprises about 850 plant taxa (after taxonomic and nomenclatural evaluation and

update) of which 193 occur with at least 33% in one or more of the 13 associations. A total of 203 species reaches constancy values of 5% or more; 346 species of  $\geq 2\%$ , and 518 of  $\geq 1\%$ . The most common species in the whole data set are *Dactylis glomerata* s.l. (80%), *Veronica chamaedrys* s.l. (79%), *Luzula forsteri* (73%), *Quercus frainetto* (69%), *Brachypodium sylvaticum* (60%), *Potentilla micrantha* (58%), *Silene italica* s.l. (57%), *Lathyrus laxiflorus* (56%), and *Viola alba* s.l. (50%).

Figure 1 shows the distribution of the most important species in the relevés space spanned by the first two axes of a detrended correspondence analysis. The first axis ranges from species of acidic soils such as *Oenanthe pimpinelloides*, *Erica arborea*, *Castanea sativa*, *Cistus creticus* and *Arbutus unedo* on the left side of the diagram to the right side with *Acer hyrcanum*, *Ostrya carpinifolia*, *Fraxinus ornus* and *Hippocrepis emerus*. The latter species occur chiefly, though not exclusively, on limestone. The first axis is best interpreted as a gradient from base-poor or impoverished soils to base-rich calcareous soils. The second axis ranges from the lower part with *Rosa gallica*, *Quercus cerris*, *Q. pubescens*, *Lithospermum purpurocaeruleum* to the upper part with species such as *Verbascum nigrum*, *Viola reichenbachiana*, *Mycelis muralis* and *Fagus sylvatica*. This axis is well interpretable as a gradient from dry and warm

conditions to mesic and relatively cool sites. It is a complex gradient of water supply and temperature.

#### Plant communities

Apart from the brief descriptions given below, the plant communities are presented as synoptic tables. An inventory of the species composition of the major units (phytosociological associations) is given in Table I. Distribution maps and a table with locality names (Table II) are also provided. The associations are described below in the sequence of Table I.

#### *Phillyreo latifoliae-Carpinetum orientalis*

(Table I, column 1; Table III)

Ecology and forest use: chiefly calcareous but occasionally schistose, rocky, sun-exposed slopes with stony soils that are drier than in habitats of the *Dryopterido-Ostryetum*; no current forest use but previously irregular wood cutting; current wood pasture occurs but is insignificant.

Distribution records (Figure 2): Epirus: near Konitsa, Timfi, Valaoritis; C and W Macedonia: Voras, Paiko, Chasia; E Thessaly: Kato Olimbos; E Macedonia: Rodopi; W Thrace; occurring as far south as C Peloponnisos (Bergmeier, unpubl.) and presumably much more widespread than available records suggest.

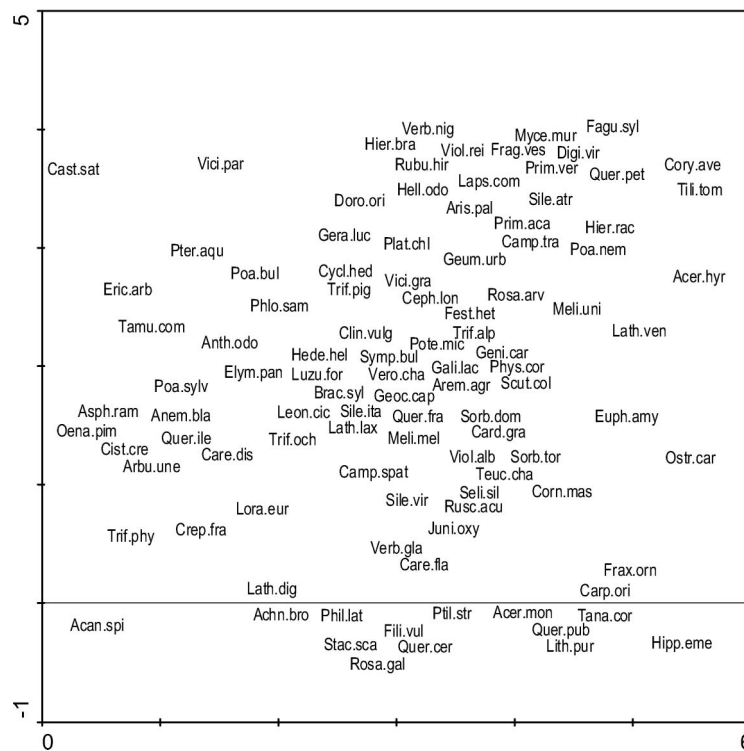


Figure 1. DCA species scores of the most important taxa in the entire data set of thermophilous deciduous forests in Greece. The names are abbreviated to four letters of the genus and three of the species epithet. See Table I for full names. Woody species are represented by occurrences in the highest strata. Eigenvalue of axis 1: 0.444, of axis 2: 0.330; sum of all eigenvalues with all species (854) and samples active: 17.108.

Table I. Synoptic constancy table of the associations of thermophilous deciduous forest found in Greece: PhC, *Phillyreo-Carpinetum orientalis*; DrO, *Dryopterido pallidae-Ostryetum carpinifoliae*; TiC, *Tilio tomentosae-Castanetum*; GQp, *Genisto carinalis-Quercetum petraeae*; QC, *Quercus-Castanetum*; CyC, *Cytiso villosi-Castanetum*; LaC, *Lathyro laxiflori-Castanetum*; SyQ, *Symphyto ottomani-Quercetum frainetto*; VeQ, *Verbasco glabrati-Quercetum frainetto*; HuQ, *Huetio-Quercetum frainetto*; DiQ, *Digitali viridiflorae-Quercetum frainetto*; GeQ, *Geranio asphodeloidis-Quercetum frainetto*; OeQ, *Oenanthe pimpinelloidis-Quercetum frainetto*. Constancy values are in percent. The background was shaded for constancy values of taxa diagnostic for one or several associations (i.e. occurring with  $\geq 20\%$  higher constancy value, but at least 40% constancy, in the respective column(s) than in others). Species with less than 33% constancy in any column are omitted. Strata codes for woody species: t, tree; s, shrub; h, herb layer.

Association	PhC	DrO	TiC	GQp	QC	CyC	LaC	SyQ	VeQ	HuQ	DiQ	GeQ	OeQ
Number of relevés	29	41	43	90	31	12	15	47	111	26	74	14	59
Number of constant species ( $\geq 33\%$ )	38	37	41	37	43	65	37	22	47	49	48	48	31
<i>Quercus pubescens</i> t+s	72	80	9	1	13	.	.	23	30	.	4	.	.
<i>Quercus pubescens</i> h	52	78	.	1	48	17	.	11	23	.	5	7	.
<i>Carpinus orientalis</i> t	86	90	33	11	.	.	.	13	12	.	3	.	.
<i>Carpinus orientalis</i> s+h	76	85	42	33	6	.	.	79	27	.	7	.	.
<i>Fraxinus ornus</i> t	86	90	49	17	6	.	.	28	13	.	3	.	.
<i>Fraxinus ornus</i> s+h	83	93	95	62	29	8	.	94	54	4	8	.	.
<i>Acer monspessulanum</i> t+s	31	27	.	.	.	.	.	.	5	.	.	.	.
<i>Acer monspessulanum</i> h	38	32	7	2	.	.	.	4	14	.	.	.	.
<i>Quercus ilex</i> t,s,h	28	15	5	2	16	8	20	.	.	.	9	.	15
<i>Quercus coccifera</i> s+h	62	12	.	.	16	50	.	2	5	.	26	43	17
<i>Ostrya carpinifolia</i> t	10	66	30	9	.	.	.	.	2	.	1	7	.
<i>Ostrya carpinifolia</i> s+h	3	32	26	.	10	.	.	11	.	.	.	7	2
<i>Tilia tomentosa</i> t	.	.	98	.	3	.	.	.	.	.	.	.	.
<i>Tilia tomentosa</i> s+h	.	7	91	17	6	.	.	11	.	.	.	.	.
<i>Quercus petraea</i> subsp. <i>medwediewii</i> t	.	15	70	100	6	.	.	17	3	8	.	.	.
<i>Quercus petraea</i> subsp. <i>medwediewii</i> s+h	.	17	63	99	19	.	.	15	3	8	.	.	.
<i>Castanea sativa</i> t	.	.	42	3	100	100	100	2	.	.	7	43	.
<i>Castanea sativa</i> h	.	7	42	21	94	100	73	11	5	.	20	79	.
<i>Quercus cerris</i> t+s	17	.	5	.	.	.	.	.	42	.	.	.	.
<i>Quercus cerris</i> h	10	.	5	.	.	.	.	.	32	.	.	.	.
<i>Quercus frainetto</i> t	31	15	28	28	10	25	.	100	95	100	100	100	100
<i>Quercus frainetto</i> s+h	34	12	14	27	16	42	.	91	89	100	99	100	97
<i>Fagus sylvatica</i> s.l. t	.	.	19	20	3	.	.	2	1	23	7	.	.
<i>Fagus sylvatica</i> s.l. s+h	.	7	23	41	10	.	.	6	4	54	32	.	.
<i>Quercus trojana</i> h	17	.	.	.	.	.	.	.	13	.	.	.	.
<i>Quercus trojana</i> t+s	14	.	.	.	.	.	.	.	10	.	.	.	.
<i>Phillyrea latifolia</i> t,s,h	93	29	2	.	.	.	13	.	21	.	1	.	20
<i>Clematis flammula</i>	41	27	.	1	.	.	.	.	13	.	.	.	.
<i>Asplenium ceterach</i>	41	39	2	3	.	.	.	13	2	.	.	.	.
<i>Lithospermum purpurcaeruleum</i>	52	51	.	.	3	.	.	2	14	.	.	.	.
<i>Hippocrepis emerus</i> subsp. <i>emeroides</i>	38	59	.	.	.	.	.	4	2	.	.	.	.
<i>Arabis turrata</i>	.	56	12	2	.	.	.	.	.	.	.	.	.
<i>Euonymus verrucosus</i>	.	54	2	.	.	.	.	2	.	.	.	.	.
<i>Daphne laureola</i>	.	54	9	.	.	.	.	.	1	.	1	.	.
<i>Lathyrus venetus</i>	14	54	79	18	23	.	.	9	4	23	.	.	.
<i>Campamula trachelium</i>	.	5	67	30	35	8	.	19	10	.	36	7	12
<i>Mycelis muralis</i>	.	5	49	23	35	17	.	4	.	.	8	.	.
<i>Acer hyrcanum</i>	.	2	40	20	.	.	.	9	1	.	.	.	.
<i>Silene atropurpurea</i>	.	2	.	39	.	83	.	28	3	.	.	21	.
<i>Sedum amplexicaule</i> subsp. <i>tenuifolium</i>	.	.	.	3	3	83	13	.	7	31	.	29	.
<i>Aristolochia elongata</i>	.	.	.	.	.	75	.	.	.	.	.	14	3
<i>Peucedanum vittijugum</i>	.	.	.	.	.	75	.	.	.	.	.	14	.
<i>Achillea ligustica</i>	.	.	.	.	.	75	.	.	.	.	.	29	17
<i>Euphorbia oblongata</i>	.	.	2	4	13	67	.	.	.	.	.	.	.
<i>Elymus panormitanus</i>	.	5	.	.	.	67	.	.	6	.	1	21	32
<i>Lonicera etrusca</i>	10	10	5	8	16	58	.	.	5	.	4	7	.
<i>Rosa canina</i>	.	.	.	4	.	58	.	.	7	.	.	36	.
<i>Saxifraga bulbifera</i> + <i>graeca</i>	.	.	2	2	19	58	.	.	1	.	8	7	.
<i>Ranunculus psilostachys</i>	.	.	.	4	.	58	.	.	2	4	.	14	.
<i>Bromus sterilis</i>	.	.	.	4	.	58	7	.	2	.	3	.	2
<i>Epilobium lanceolatum</i>	.	.	5	4	3	50	.	.	.	4	3	.	.
<i>Rumex tuberosus</i> s.l.	.	2	.	1	.	50	7	.	5	19	.	.	.
<i>Cytisus villosus</i>	.	2	.	.	.	50	.	.	3	.	.	.	5

(continued)

Table I. (Continued).

Association	PhC	DrO	TiC	GQp	QC	CyC	LaC	SyQ	VeQ	HuQ	DiQ	GeQ	OeQ
<i>Lathyrus grandiflorus</i>	.	.	2	.	3	42	.	.	.	.	.	.	.
<i>Vicia melanops</i>	.	.	.	.	.	42	.	.	.	.	.	.	.
<i>Muscari comosum</i>	.	2	.	12	6	83	60	.	4	8	12	21	.
<i>Tamus communis</i>	24	7	33	17	35	50	93	21	15	.	38	.	.
<i>Pulicaria odora</i>	7	.	.	.	3	.	87	.	1	.	.	.	2
<i>Cyclamen creticum</i>	.	.	.	.	.	.	87	.	.	.	.	.	.
<i>Arisarum vulgare</i>	.	.	.	.	.	.	73	.	.	.	.	.	.
<i>Aetheorhiza bulbosa</i> subsp. <i>microcephala</i>	.	.	.	.	.	.	60	.	.	.	.	.	.
<i>Lecokia cretica</i>	.	.	.	.	.	.	53	.	.	.	.	.	.
<i>Charybdis maritima</i>	.	.	.	.	.	.	53	.	.	.	.	.	.
<i>Tolpis virgata</i>	.	.	.	.	.	.	53	.	.	.	.	.	.
<i>Brachypodium retusum</i>	.	.	.	.	.	.	47	.	.	.	.	14	5
<i>Trifolium repens</i>	.	.	2	3	3	.	47	.	1	.	9	.	.
<i>Hypericum empetrifolium</i>	.	.	.	.	.	.	47	.	.	.	.	.	.
<i>Selaginella denticulata</i>	.	.	.	.	3	.	40	.	.	.	.	.	.
<i>Acanthus spinosus</i>	7	.	.	.	.	.	40	.	21	.	.	.	15
<i>Phleum montanum</i> + <i>phleoides</i>	3	.	.	17	.	.	.	62	22	8	19	.	.
<i>Sedum cepaea</i>	.	10	5	11	6	.	.	40	4	.	7	.	.
<i>Rosa gallica</i>	7	.	.	6	.	.	.	.	48	.	.	.	.
<i>Verbascum glabratum</i>	7	.	.	4	23	.	.	4	42	.	.	.	.
<i>Ptilostemon strictus</i>	3	17	2	3	.	.	.	.	41	.	.	.	.
<i>Stachys scardica</i>	.	.	.	.	.	.	.	.	41	.	.	.	.
<i>Verbascum aphantulum</i>	.	.	.	2	6	.	.	.	.	69	.	.	.
<i>Anthemis tinctoria</i> s.l.	28	.	.	31	10	33	.	26	26	69	28	21	.
<i>Hieracium bauhini</i> , <i>cymosum</i> + <i>piloselloides</i>	21	20	.	23	13	25	.	23	27	54	14	29	8
<i>Vicia cracca</i> agg.	3	5	14	21	26	17	.	2	14	81	64	.	.
<i>Helleborus odoratus</i> subsp. <i>cyclophyllus</i>	3	5	7	29	39	.	.	.	9	65	66	.	.
<i>Aristolochia pallida</i>	28	10	5	8	.	.	.	4	7	.	69	.	.
<i>Viola reichenbachiana</i>	.	12	16	22	26	.	.	.	.	4	68	.	.
<i>Muscari neglectum</i>	10	7	.	24	.	.	.	.	33	.	66	.	.
<i>Verbascum nigrum</i> subsp. <i>abietinum</i>	.	.	.	4	.	.	.	4	.	8	58	.	.
<i>Primula veris</i> subsp. <i>columnae</i>	.	10	9	9	.	.	.	9	2	.	49	.	.
<i>Digitalis viridiflora</i>	.	.	12	20	.	.	.	9	.	.	42	.	.
<i>Cephalanthera longifolia</i>	10	22	33	26	29	17	.	.	32	4	73	64	22
<i>Cruciata laevipes</i>	.	.	.	13	10	8	.	.	1	.	41	43	.
<i>Geranium asphodeloides</i>	.	.	.	1	10	42	.	.	13	.	4	86	2
<i>Chamaespartium sagittale</i>	.	.	.	.	.	25	.	.	.	.	.	64	.
<i>Lathyrus digitatus</i>	.	.	.	.	.	8	.	.	21	4	.	57	19
<i>Carex distachya</i>	41	10	7	3	.	25	20	.	14	4	12	64	71
<i>Anemone blanda</i>	.	.	.	.	.	.	.	.	.	.	.	43	54
<i>Loranthus europaeus</i>	.	.	7	4	16	25	.	.	32	12	3	.	75
<i>Asphodelus ramosus</i>	.	.	.	.	.	.	20	.	7	12	.	.	49
<i>Arbutus unedo</i>	.	.	.	.	6	.	13	.	5	.	5	.	41
<i>Oenanthe pimpinelloides</i>	10	.	.	1	39	.	87	6	23	8	12	.	69
<i>Achnatherum bromoides</i>	41	24	.	2	.	.	7	.	39	.	5	.	68
<i>Brachypodium pinnatum</i> + <i>rupestre</i>	52	32	.	6	3	.	.	.	55	.	.	.	27
<i>Cardamine graeca</i>	59	61	26	26	3	.	7	.	8	46	30	.	.
<i>Primula acaulis</i>	3	51	67	32	68	.	13	9	3	15	7	.	.
<i>Genista carinalis</i>	7	.	.	43	3	.	.	45	21	15	7	.	.
<i>Festuca circummediterranea</i> + <i>valesiaca</i>	17	5	2	49	.	17	.	57	12	.	31	100	.
<i>Silene vulgaris</i>	3	27	9	47	16	8	20	19	4	27	53	.	.
<i>Galium laconicum</i> + <i>pseudaristatum</i>	.	29	40	14	61	17	.	.	30	100	1	.	.
<i>Rubus hirtus</i>	.	2	44	17	71	.	.	.	.	58	.	.	.
<i>Hieracium bracteolatum</i>	.	.	35	13	61	.	.	.	.	77	55	.	.
<i>Festuca heterophylla</i>	3	32	7	37	48	.	.	13	36	73	45	.	.
<i>Fragaria vesca</i>	.	.	26	58	55	25	.	28	6	.	80	36	.
<i>Silene viridiflora</i>	.	15	26	12	6	75	.	11	47	.	8	29	5
<i>Abies cephalonica</i>	.	.	.	.	.	67	.	.	.	.	.	50	.
<i>Orchis mascula</i> et <i>spec.</i>	.	.	.	1	.	50	.	.	.	.	8	71	.
<i>Arrhenatherum elatius</i>	.	.	.	6	10	50	.	.	.	19	27	71	.
<i>Trifolium physodes</i> agg.	24	.	.	.	3	67	60	.	25	4	.	14	80
<i>Erica arborea</i>	3	.	.	4	19	8	60	.	2	50	19	93	56

(continued)

Table I. (Continued).

Association	PhC	DrO	TiC	GQp	QC	CyC	LaC	SyQ	VeQ	HuQ	DiQ	GeQ	OeQ
<i>Anthoxanthum odoratum</i>	17	7	2	29	32	8	67	6	38	92	49	14	5
<i>Thymus longicaulis</i> + <i>sibthorpii</i>	31	2	.	30	.	.	.	36	41	.	32	.	61
<i>Phlomis samia</i>	3	5	2	10	.	8	.	.	3	42	28	21	76
<i>Poa bulbosa</i> + <i>timoleontis</i>	7	.	2	13	42	100	13	.	26	58	27	36	24
<i>Melica uniflora</i>	38	76	79	42	52	8	.	13	5	12	23	7	5
<i>Platanthera chlorantha</i>	.	7	2	13	45	8	.	.	13	42	53	79	.
<i>Trifolium ochroleucon</i>	21	7	9	14	19	75	.	.	49	69	20	21	54
<i>Cyclamen hederifolium</i> + <i>peloponnesiacum</i>	.	15	28	17	19	58	.	11	15	77	38	100	46
<i>Juniperus oxycedrus</i> (+ <i>communis</i> )	76	80	2	17	32	25	.	19	68	.	46	86	.
<i>Poa nemoralis</i>	7	56	81	83	23	25	.	55	8	4	49	7	.
<i>Doronicum orientale</i>	.	5	19	11	84	92	.	.	15	88	54	71	3
<i>Trifolium pignanti</i>	3	22	16	12	58	75	.	.	25	77	41	71	.
<i>Symphytum bulbosum</i>	.	5	7	19	48	25	.	.	54	50	72	14	66
<i>Campanula spatulata</i> subsp. <i>spruneriana</i>	59	27	33	20	97	100	.	.	77	96	.	86	24
<i>Asplenium adiantum-nigrum</i> + <i>onopteris</i>	59	66	93	62	58	33	33	77	10	19	38	29	20
<i>Dactylis glomerata</i> s.l.	52	83	49	90	58	75	60	77	77	96	96	100	90
<i>Luzula forsteri</i>	55	61	40	66	90	100	87	23	90	96	76	100	88
<i>Veronica chamaedrys</i> s.l.	69	76	60	88	94	92	.	70	85	96	76	86	85
<i>Brachypodium sylvaticum</i>	59	76	44	63	77	50	27	68	55	31	58	100	92
<i>Lathyrus laxiflorus</i>	45	63	37	57	77	50	27	.	79	73	57	64	88
<i>Potentilla micrantha</i>	55	71	65	68	65	83	.	28	50	96	27	100	90
<i>Silene italica</i> s.l.	62	85	28	48	52	42	.	26	53	88	61	64	71
<i>Clinopodium vulgare</i>	28	32	40	61	68	100	20	6	47	85	55	79	42
<i>Poa trivialis</i> subsp. <i>sylvicola</i>	24	10	28	19	58	100	100	2	59	81	51	43	71
<i>Pteridium aquilinum</i>	7	7	51	32	90	100	93	13	17	81	57	93	88
<i>Viola alba</i> s.l.	72	85	58	56	68	25	.	28	64	31	57	50	22
<i>Aremonia agrimonoides</i>	52	68	23	40	32	42	.	9	38	15	62	93	64
<i>Leontodon cichoriaceus</i>	31	22	9	17	61	75	.	.	63	62	61	36	83
<i>Rubus canescens</i> + <i>sanctus</i>	17	2	12	49	23	58	33	2	55	8	86	50	80
<i>Galium mollugo</i> agg.	31	34	9	66	35	75	.	83	53	12	97	100	.
<i>Sorbus torminalis</i> t,s,h	41	78	79	52	29	.	.	30	44	58	20	.	20
<i>Crepis fraasii</i>	41	5	26	8	45	58	67	.	59	58	.	36	15
<i>Crataegus monogyna</i> s.l.	14	.	7	36	39	42	20	32	59	42	73	36	58
<i>Melittis melissophyllum</i> subsp. <i>albida</i>	17	17	42	31	61	.	.	4	43	81	.	.	41
<i>Hedera helix</i> h	34	54	77	14	71	42	40	11	14	4	16	36	17
<i>Galium aparine</i>	14	.	19	41	3	67	53	2	26	35	51	7	2
<i>Rosa arvensis</i>	45	54	14	40	29	.	.	2	19	27	64	7	.
<i>Geocaryum capillifolium</i>	7	2	9	16	26	.	.	.	58	58	42	.	.
<i>Hypericum montbretii</i> , <i>rumeliacum</i> + <i>spruneri</i>	14	7	23	24	45	.	.	28	40	62	5	.	2
<i>Sorbus domestica</i>	14	10	35	33	45	8	.	40	47	.	38	.	.
<i>Lathyrus niger</i>	.	17	28	27	6	17	.	53	34	42	20	36	2
<i>Origanum vulgare</i>	10	.	9	8	32	.	47	.	1	42	11	.	.
<i>Selinum silaifolium</i>	7	56	35	6	42	17	.	.	29	69	.	.	.
<i>Physospermum cornubiense</i>	.	20	35	28	48	.	.	15	37	50	31	.	.
<i>Chamaecytisus</i> div. spec.	.	.	33	44	26	.	.	28	7	31	41	7	.
<i>Trifolium alpestre</i>	17	7	.	42	.	.	.	45	33	.	34	29	.
<i>Cornus mas</i>	38	61	58	42	19	.	.	26	39	.	4	.	.
<i>Euphorbia amygdaloides</i>	3	63	44	68	.	.	.	28	27	.	5	.	.
<i>Asplenium trichomanes</i>	10	51	28	12	10	.	.	40	1	.	4	.	2
<i>Carex flacca</i> s.l.	52	41	2	18	39	.	7	2	69	23	26	7	7
<i>Teucrium chamaedrys</i>	41	32	2	33	3	.	.	55	16	8	30	29	12
<i>Tanacetum corymbosum</i>	38	32	19	8	.	.	.	4	20	.	.	.	.
<i>Campanula persicifolia</i>	.	20	23	46	.	.	.	23	.	.	35	.	.
<i>Lapsana communis</i>	.	.	30	38	3	50	.	4	6	27	24	.	2
<i>Geum urbanum</i>	10	15	7	17	10	50	.	2	10	4	34	7	.
<i>Digitalis ferruginea</i>	.	2	.	.	.	50	.	.	.	.	.	36	25
<i>Ranunculus neapolitanus</i>	10	.	.	4	26	.	53	.	24	38	22	.	14
<i>Trifolium campestre</i>	14	.	2	10	13	33	47	6	23	15	1	7	17
<i>Cynosurus echinatus</i> + <i>effusus</i>	21	.	.	3	10	25	40	2	28	12	3	.	34
<i>Vicia grandiflora</i>	14	2	9	23	32	.	.	17	13	50	19	.	.
<i>Crocus spec.</i>	.	.	.	.	.	.	.	.	35	46	8	.	10
<i>Silene coronaria</i>	.	2	7	31	.	.	.	34	15	8	46	.	.

(continued)

Table I. (Continued).

Association	PhC	DrO	TiC	GQp	QC	CyC	LaC	SyQ	VeQ	HuQ	DiQ	GeQ	OeQ
<i>Dorycnium herbaceum</i>	7	.	.	6	35	.	.	23	17	15	9	50	.
<i>Prunus avium</i> h	.	5	5	18	.	33	7	2	1	.	7	43	3
<i>Orchis provincialis</i>	.	.	2	.	23	8	.	.	.	.	.	43	12
<i>Ruscus aculeatus</i>	38	37	30	6	13	8	.	23	24	.	8	7	10
<i>Asparagus acutifolius</i>	34	7	5	.	23	.	.	.	14	.	1	.	22
<i>Dorycnium hirsutum</i>	24	2	.	2	.	8	.	.	35	.	.	.	15
<i>Scutellaria altissima</i> + <i>columnae</i>	10	24	35	30	16	.	.	.	17	4	.	.	14
<i>Polystichum setiferum</i>	.	10	35	2	23	17	.	2	1	.	.	.	.
<i>Corylus avellana</i>	.	2	33	19	3	.	.	21	1	.	.	.	.
<i>Festuca drymeja</i>	.	7	35	8	26	.	.	.	.	.	.	.	.
<i>Prunella vulgaris</i>	3	.	19	2	39	8	7	.	2	8	.	.	2
<i>Digitalis laevigata</i>	.	5	12	3	35	.	.	.	1	15	.	.	.
<i>Campanula stenosphon</i>	.	.	.	.	.	33	.	.	.	.	.	7	8
<i>Sanguisorba minor</i>	7	.	.	3	.	33	.	.	14	.	3	14	12
<i>Aira elegantissima</i>	.	.	.	1	.	33	27	4	9	.	.	7	7
<i>Hypericum vesiculosum</i>	.	.	.	.	.	33	.	.	.	.	.	.	.
<i>Trifolium aurantiacum</i>	.	.	.	.	.	33	.	.	7	.	.	.	5
<i>Vicia lathyroides</i>	.	.	.	.	3	33	.	.	.	.	.	.	2
<i>Cistus creticus</i>	24	.	.	6	6	25	33	.	9	38	.	29	2
<i>Carex divulsa</i> s.l.	.	.	.	9	3	8	33	2	6	4	9	.	2
<i>Rubia peregrina</i>	7	.	.	.	16	.	33	.	.	.	.	.	.
<i>Teucrium massiliense</i>	.	.	.	.	.	.	33	.	.	.	.	.	.
<i>Ranunculus velutinus</i>	.	.	.	.	.	.	33	.	.	.	.	.	.
<i>Carex halleriana</i>	10	12	.	.	.	.	.	36	1	.	.	.	.
<i>Filipendula vulgaris</i>	14	.	.	.	.	.	.	.	33	.	11	.	.
<i>Bellis perennis</i> + <i>sylvestris</i>	10	.	5	1	19	.	20	.	32	35	.	.	5
<i>Prunus cocomilia</i> , <i>divaricata</i> + <i>spinosa</i> s + h	3	2	2	18	3	8	.	4	17	4	32	36	3

Table II. Regional and local distribution of associations of thermophilous deciduous forest in Greece, according to relevé records from literature and own unpublished data. Association names abbreviated as in Table I.

Association	PhC	DrO	TiC	GQp	QC	CyC	LaC	SyQ	VeQ	HuQ	DiQ	GeQ	OeQ
<b>E Macedonia (incl. W Thrace)</b>													
Rodopi	X		X	X	X			X					
Cholomon				X							X		
Kerdilio				X							X		
Athos	X?		X		X								
<b>C &amp; W Macedonia</b>													
Chasia	X	X	X						X				
Voras	X	X	X	X					X				
Paiko	X	X		X					X				
Kilkis											X		
Krousia				X									
Voio					X								
<b>S Macedonia</b>													
Pieria		X			X				X				
<b>E &amp; NE Thessaly</b>													
Kato Olimbos	X	X	X	X	X					X			
Ossa			X	X	X								
Mavrovouni					X					X			
Pilio					X					X			
<b>Epirus</b>													
Konitsa area	X		X						X				
Valaorit	X								X				
Tsoumerka									X				
Timfi	X	X											

(continued)

Table II. (Continued).

Association	PhC	DrO	TiC	GQp	QC	CyC	LaC	SyQ	VeQ	HuQ	DiQ	GeQ	OeQ
<b>Peloponnisos</b>													
C Peloponnisos	X												
SE Peloponnisos (Parnon)						X						X	
W Peloponnisos													X
<b>Crete</b>													
W Crete							X						
<b>Aegean</b>													
W Aegean (Evvia)					X								

Table III. Synoptic table of the associations and subtypes of the *Fraxino orní-Ostryion*: 1, *Carpinus orientalis-Quercus frainetto* community; 2-3, *Dryopterido pallidae-Ostryetum orientalis*, 2, subtype with *Trifolium pignanti*, 3, with *Euonymus verrucosus*; 4-5, *Phillyreo latifoliae-Carpinetum orientalis*, 4, with *Melica uniflora*, 5, with *Thymus longicaulis*. Constancy values in percent. Constancy values for species diagnostic for a community type (i.e. occurring with more than double constancy and with >40% in a column) are highlighted. Species with less than 29% constancy in any column are omitted. Strata codes for woody species: t, tree; s, shrub; h, herb layer.

Community/Subtype No.	1	2	3	4	5
Number of relevés	14	11	30	13	16
Number of constant species (≥33%)	25	44	44	30	42
<i>Quercus frainetto</i> t	93	9	17	38	25
<i>Quercus frainetto</i> h	64	.	17	31	38
<i>Crataegus monogyna</i> s.l. s+h	43	.	.	15	12
<i>Campanula trachelium</i>	43	9	3	.	.
<i>Primula acaulis</i>	36	82	40	8	.
<i>Festuca heterophylla</i>	.	82	13	8	.
<i>Trifolium pignanti</i>	.	82	.	.	6
<i>Acer campestre</i> + <i>hyrcanum</i> h	36	73	20	8	.
<i>Hedera helix</i> t	.	73	3	8	.
<i>Melittis melisophyllum</i> subsp. <i>albida</i>	.	64	.	23	12
<i>Quercus ilex</i> s+t	.	55	.	23	25
<i>Luzula sylvatica</i>	.	55	.	.	.
<i>Dryopteris pallida</i>	7	55	.	8	.
<i>Abies boristi-regis</i> h	.	45	.	.	.
<i>Cyclamen hederifolium</i>	.	45	3	.	.
<i>Ostrya carpinifolia</i> t	29	82	60	23	.
<i>Selinum silaifolium</i>	.	55	57	8	6
<i>Arabis turrita</i>	.	45	60	.	.
<i>Euphorbia amygdaloides</i>	71	.	87	8	.
<i>Euonymus verrucosus</i>	7	9	70	.	.
<i>Daphne laureola</i>	.	27	63	.	.
<i>Trifolium medium</i>	.	.	63	8	6
<i>Lathyrus venetus</i>	29	27	63	31	.
<i>Sorbus torminalis</i> s+h	29	27	57	15	12
<i>Juniperus oxycedrus</i> s+h	7	36	97	46	100
<i>Teucrium chamaedrys</i>	14	9	40	15	62
<i>Leontodon cichoriaceus</i>	.	.	30	8	50
<i>Ligustrum vulgare</i>	.	.	.	54	6
<i>Campanula spatulata</i> subsp. <i>spruneriana</i>	.	18	30	38	75
<i>Achnatherum bromoides</i>	.	.	33	8	69
<i>Thymus longicaulis</i>	.	.	3	.	56
<i>Helictotrichon convolutum</i>	.	.	10	.	56

(continued)

Table III. (Continued).

Community/Subtype No.	1	2	3	4	5
Number of relevés	14	11	30	13	16
Number of constant species (≥33%)	25	44	44	30	42
<i>Quercus pubescens</i> s	7	18	20	8	56
<i>Anthemis tinctoria</i>	.	.	.	8	44
<i>Dorycnium hirsutum</i>	.	.	3	.	44
<i>Cistus creticus</i>	.	.	.	.	44
<i>Phillyrea latifolia</i> s+t	.	9	10	85	88
<i>Phillyrea latifolia</i> h	.	9	30	77	69
<i>Quercus coccifera</i> h	.	.	13	54	50
<i>Quercus coccifera</i> s+t	.	9	.	46	44
<i>Carex distachya</i>	.	.	13	38	44
<i>Crepis fraasii</i>	.	.	7	31	50
<i>Asparagus acutifolius</i>	.	9	7	31	38
<i>Poa nemoralis</i>	86	55	57	15	.
<i>Asplenium trichomanes</i>	86	36	57	23	.
<i>Ostrya carpinifolia</i> h	43	45	27	8	.
<i>Melica uniflora</i>	21	82	73	69	12
<i>Arenonia agrimonoides</i>	.	73	67	85	25
<i>Cornus mas</i>	21	64	60	62	19
<i>Silene italica</i> subsp. <i>italica</i>	.	82	87	38	81
<i>Dactylis glomerata</i> s.l.	36	82	83	31	69
<i>Cardamine graeca</i>	7	9	80	69	50
<i>Lithospermum purpureoaceruleum</i>	.	9	67	46	56
<i>Carpinus orientalis</i> s	79	9	100	77	62
<i>Luzula forsteri</i>	14	55	63	54	56
<i>Lathyrus laxiflorus</i>	.	64	63	54	38
<i>Galium mollugo</i> agg.	50	55	27	15	44
<i>Hedera helix</i> h	36	82	43	62	12
<i>Sorbus torminalis</i> h	29	45	87	54	25
<i>Quercus pubescens</i> h	7	45	87	38	62
<i>Rosa arvensis</i>	.	45	57	69	25
<i>Carpinus orientalis</i> h	21	36	77	62	50
<i>Veronica chamaedrys</i>	29	73	77	54	81
<i>Potentilla micrantha</i>	29	55	77	69	44
<i>Carpinus orientalis</i> t	86	64	100	92	81
<i>Asplenium onopteris</i>	86	55	70	69	50
<i>Fraxinus ornus</i> s	79	73	90	62	50
<i>Viola alba</i> s.l.	79	64	93	92	56
<i>Fraxinus ornus</i> t	71	73	97	77	94
<i>Fraxinus ornus</i> h	71	55	93	77	69
<i>Quercus pubescens</i> t	50	45	93	46	75
<i>Brachypodium sylvaticum</i>	43	64	80	77	44
<i>Ruscus aculeatus</i>	36	45	33	54	25
<i>Hippocrepis emerus</i> subsp. <i>emeroides</i>	21	27	70	23	50
<i>Acer monspessulanum</i> h	.	18	37	31	44
<i>Clinopodium vulgare</i>	.	36	30	8	44

(continued)

Table III. (Continued).

Community/Subtype No.	1	2	3	4	5
Number of relevés	14	11	30	13	16
Number of constant species ( $\geq 33\%$ )	25	44	44	30	42
<i>Carex flacca</i>	7	.	57	31	69
<i>Acer monspessulanum</i> t + s	.	18	30	46	19
<i>Clematis flammula</i>	.	.	37	46	38
<i>Brachypodium pinnatum</i> + <i>rupestre</i>	.	9	40	31	69
<i>Asplenium ceterach</i>	36	18	47	54	31
<i>Tanacetum corymbosum</i>	21	9	40	23	50
<i>Tamus communis</i>	43	.	10	15	31
<i>Poa trivialis</i> subsp. <i>syvicola</i>	.	27	3	15	31
<i>Cystopteris fragilis</i>	29	.	.	.	.
<i>Vincetoxicum hirundinaria</i> + <i>speciosum</i>	29	.	3	.	6
<i>Primula veris</i> subsp. <i>columnnae</i>	29	.	13	.	.
<i>Fragaria vesca</i>	36	.	.	.	.
<i>Asparagus tenuifolius</i>	29	.	.	.	.
<i>Polypodium vulgare</i> + <i>spec.</i>	29	.	23	8	.
<i>Clematis vitalba</i>	29	18	3	8	.
<i>Campanula persicifolia</i>	21	36	13	.	.
<i>Acer campestre</i> t	.	36	.	8	.
<i>Lunaria annua</i> subsp. <i>pachyrhiza</i>	.	36	.	.	.
<i>Sedum cepaea</i>	.	36	.	.	.
<i>Polystichum setiferum</i>	7	36	.	.	.
<i>Mercurialis ovata</i>	.	36	7	8	.
<i>Quercus ilex</i> h	.	36	.	23	25
<i>Silene vulgaris</i>	.	9	33	8	.
<i>Centaurea triumfettii</i>	.	.	30	8	25
<i>Torilis arvensis</i>	.	.	.	31	6
<i>Aristolochia pallida</i>	.	.	13	23	31
<i>Trifolium physodes</i>	.	.	.	8	38
<i>Pistacia terebinthus</i> s	.	.	13	.	38
<i>Anthoxanthum odoratum</i>	.	18	3	.	31
<i>Festuca spec.</i>	.	.	7	.	31
<i>Quercus cerris</i> s	.	.	.	8	31
<i>Trifolium alpestre</i>	.	.	10	.	31

Diagnostic (bold) and constant species:

Trees and tall shrubs: *Acer monspessulanum*, ***Carpinus orientalis***, ***Fraxinus ornus***, *Juniperus oxycedrus*, ***Ligustrum vulgare***, ***Phillyrea latifolia***, ***Quercus coccifera***, *Q. pubescens*, *Rosa arvensis*.

Herbs and small shrubs: ***Lithospermum purpur-oaeruleum***, *Viola alba*, *Veronica chamaedrys*.

Subtypes and related communities: Rather dense, little or not grazed woods (Table III: column 4) with *Melica uniflora*, *Aremonia agrimonoides*, *Cornus mas* and *Ligustrum vulgare*, found in C Macedonia (Voras, Paiko), Epirus (Valaorit) and W Thrace can be distinguished from more or less open, semi-deciduous, stunted and species-rich brushwoods (Table III: 5) with *Thymus longicaulis*, *Achnatherum bromoides*, *Helictotrichon convolutum* and *Quercus pubescens*. Such stands are widely distributed throughout northern mainland Greece from Epirus to Thrace, and indicate a long-lasting history of fire impact, wood pasture and irregular cutting. Raus (1980) documented heavily degraded stands of

this from E Thessaly as *Quercus coccifera*–*Carpinus orientalis* community (pseudomaquis). Little disturbed is the “*Quercetum pubescentis*” recorded by Zoller et al. (1977) from Mt. Athos but the material is too fragmentary to decide whether it matches the *Phillyreo*–*Carpinetum*, or has to be recognized as a different community.

***Dryopterido pallidae*–*Ostryetum*** (Table I, column 2; Table III)

Ecology and forest use: calcareous, rocky, mostly steep shady upper and middle slopes, aspect commonly around north, often well developed rendzina soils; due to remoteness and difficult accessibility almost no current forest use, but most stands with marks of irregular coppicing in previous times, wood pasture insignificant.

Distribution records (Figure 2): C and W Macedonia: Voras, Paiko, Chasia; S Macedonia: Pieria; NE Thessaly: Kato Olimbos; Epirus: Timfi. Probably extending further south but no records available to date. Diagnostic (bold) and constant species:

Trees and tall shrubs: ***Fraxinus ornus***, ***Ostrya carpinifolia***, ***Quercus pubescens***, ***Acer monspessulanum***, ***Carpinus orientalis***, ***Buxus sempervirens***, ***Euonymus verrucosus***, ***Hippocrepis emerus* subsp. *emeroides***, *Juniperus oxycedrus*, *Sorbus torminalis*.

Herbs and small shrubs: ***Arabis turrita***, *Aremonia agrimonoides*, ***Asplenium ceterach***, *Brachypodium sylvaticum*, *Dactylis glomerata* s.l., ***Daphne laureola***, ***Lithospermum purpur-oaeruleum***, *Melica uniflora*, *Potentilla micrantha*, *Silene italica*, *Veronica chamaedrys* s.l., *Viola alba* s.l.

Subtypes and related communities: In suboceanic climatic conditions of NE Thessaly and N Pindos stands on chiefly subacidic soils are characterized by *Trifolium pignanii*, *Festuca heterophylla*, *Melittis melissophyllum*, *Quercus ilex*, *Dryopteris pallida* and *Luzula sylvatica* (Table III: 2). On calcareous flysch in C and W Macedonia and Epirus, stands are distinguished by *Euonymus verrucosus*, *Daphne laureola*, *Lathyrus venetus* and *Hippocrepis emerus* (Table III: 3). Superficially similar are coppices dominated by *Carpinus orientalis* which occur in less exposed situations on calcareous and siliceous soils and developed from over-exploited deciduous oak forest. In NE Greece (Rodopi) such stands are not (anymore) grazed and *Quercus frainetto* is common in the tree layer (Table III: 1, *Carpinus orientalis*–*Quercus frainetto* community).

***Tilio tomentosae*–*Castanetum*** (Table I, column 3; Table IV)

Ecology and forest use: steep, often north-exposed and chiefly lower slopes and in ravines with deep brown stony soils, relatively humid conditions;

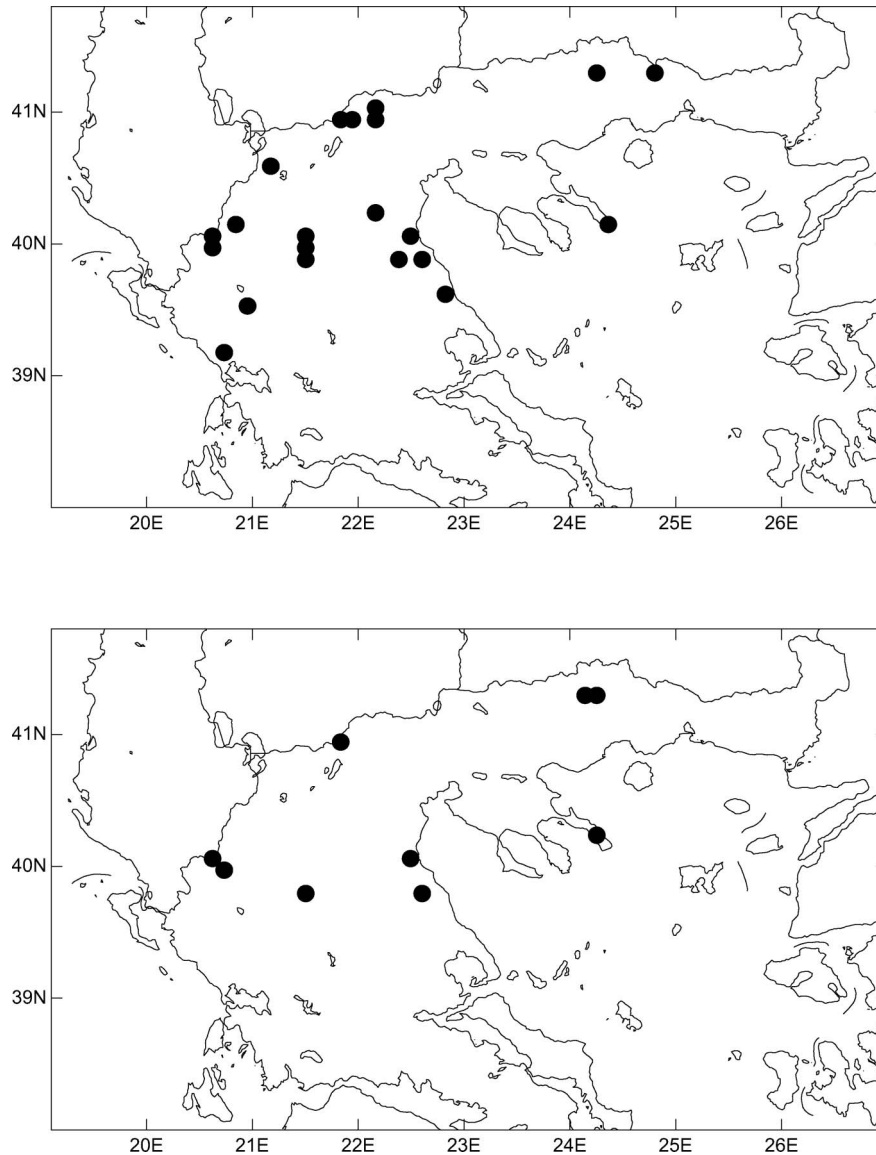


Figure 2. Above: Distribution of the *Fraxino ornī–Ostryion* communities *Phillyreo latifoliae–Carpinetum* and *Dryopterido pallidae–Ostryetum* in Greece; below: *Tilio tomentosae–Castanetum*. Each dot represents one or more relevés. Only localities with available relevés are plotted.

various types of bedrock including limestone, flysch, micaschist; stands are of little importance for forestry but have been used as irregular coppices and for wood pasture.

Distribution records (Figure 2): Epirus: near Konitsa; C and W Macedonia: Voras, Chasia; E Macedonia: Rodopi, Athos; NE Thessaly: Kato Olimbos, Ossa.

Diagnostic (bold) and constant species:

Trees and tall shrubs: ***Tilia tomentosa***, ***Acer hyrcanum***, *Fraxinus ornus*, *Hedera helix*, *Quercus petraea* subsp. *medwediewii*, *Sorbus torminalis*.

Herbs and small shrubs: *Asplenium onopteris* (+ *A. adiantum-nigrum*), ***Campanula trachelium***, ***Calamintha grandiflora***, ***Festuca drymeja***, ***Galium odoratum***, ***Lathyrus venetus***, *Melica uniflora*, ***Mycelis muralis***, *Poa nemoralis*, ***Polystichum***

***setiferum***, *Primula acaulis*, ***Pulmonaria rubra***, ***Salvia glutinosa***.

Subtypes: Stands in NE Thessaly (Kato Olimbos) and C Macedonia (Voras) with *Aremonia agrimonoides*, *Fagus sylvatica*, *Ilex aquifolium*, *Ostrya carpinifolia*, *Acer platanoides*, *Galium odoratum*, *Salvia glutinosa*, *Lunaria annua* and *Daphne laureola* indicate pronouncedly humid and relatively cool mesoclimatic conditions (Table IV: 2). Stands recorded at Mt Ossa (E Thessaly), Epirus and Chasia (W Macedonia) with *Selinum silaifolium*, *Clinopodium vulgare*, *Luzula forsteri*, *Campanula spatulata* subsp. *spruneriana*, *Poa trivialis* subsp. *sylvicola*, *Crepis fraasii* and *Silene italica* indicate more thermophytic conditions (Table IV: 3). Considerably less species-rich are formerly coppiced mixed woodlands with *Tilia tomentosa*, *Quercus frainetto*, *Q. petraea* subsp.

*medwediewii* and *Carpinus orientalis* on remote slopes in the Greek Rodopi Mts (E Macedonia) (Table IV: 1). They differ also in herb layer, revealing a subcontinental touch with *Euphorbia amygdaloides*, *Pulmonaria rubra* and *Campanula persicifolia*.

***Genisto carinalis-Quercetum petraeae*** (Table I, column 4; Table V)

Ecology and forest use: mostly steep to moderately steep slopes, micaschist soils deep, brown, loamy, acidic; 600–1000 m; generally at higher altitude than *Quercus frainetto* forest which may occur in the same areas; previously commonly coppiced but current forest management acts towards transition to forests with single-stemmed trees.

Distribution records (Figure 3): NE Thessaly: Kato Olimbos, Ossa; C Macedonia: Voras, Paiko, Krousia (Disoro); E Macedonia: Kerdilio, Cholomon, NE Chalkidiki, Rodopi; W Thrace. In NW Greece, *Quercus petraea* subsp. *medwediewii* seems to be less competitive, as no extensive stands dominated by this taxon have been recorded yet.

Diagnostic (bold) and constant species:

Trees and tall shrubs: ***Quercus petraea* subsp. *medwediewii*** (*Q. dalechampii*), ***Fagus sylvatica* s.l.**, ***Carpinus betulus***.

Herbs and small shrubs: ***Campanula persicifolia***, ***Campanula trachelium* subsp. *athoa***, ***Cystopteris fragilis***, ***Dactylis glomerata***, ***Epipactis atrorubens***, ***Euphorbia amygdaloides***, ***Hypericum***

***perforatum***, ***Poa nemoralis***, ***Potentilla micrantha***, ***Silene atropurpurea***, ***Veronica chamaedrys* s.l.**

Subtypes (Table V: 1 and 2): NE Thessalian stands (Ossa, Kato Olimbos) are recognized by species such as *Campanula spatulata* subsp. *spruneriana*, *Melittis melissophyllum*, *Hieracium bracteolatum*, *Poa trivialis* subsp. *sylvicola*, *Trifolium pignanii*, *Hypericum montbretii*, *Cardamine graeca*, *Rubus hirtus*, *Galium lacoicum*, *Doronicum orientale*, *Geocaryum capillifolium*, and *Festuca drymeja*. *Quercus petraea* woodlands in C and E Macedonia have a distinctly submediterranean-continental species composition (with *Euphorbia amygdaloides*, *Fragaria vesca*, *Festuca valesiaca*, *Campanula persicifolia*, *Silene atropurpurea*).

***Quercus frainetto-Castanetum sativae*** (Table I, column 5)

Ecology and forest use: Deep, clayey or loamy, brown micaschist soils, more rarely shallow and calcareous; chiefly in moderately sloped or ridged terrain; (150–)300–800(–1050) m a.s.l.; records include dense coppices as well as spaced groves with old-growth. *Castanea* fruit (sweet chestnut) plantations which are intensely managed differ in species composition depending on age and degree of impact. Old-growth have frequently been, and sometimes still are, roamed by domestic pigs. Many, if not all, woodlands dominated by *Castanea* are likely to originate from plantations or are the result of elimination of other co-occurring tree species.

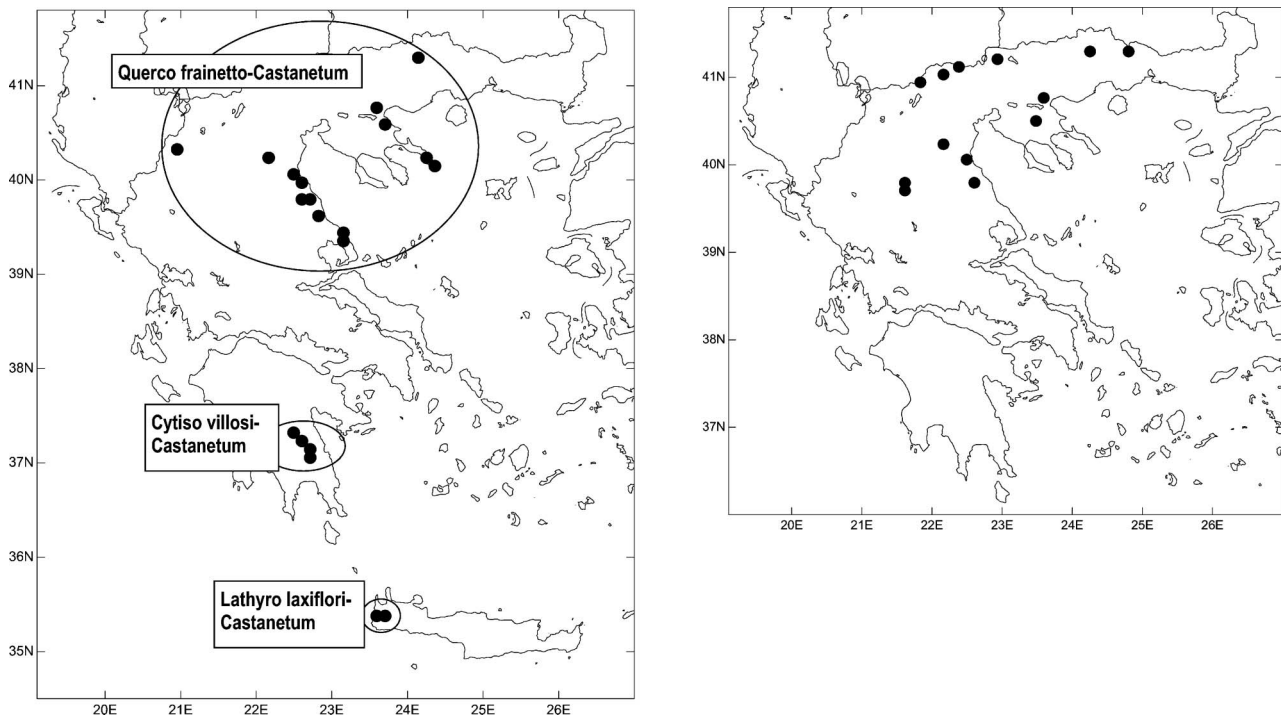


Figure 3. Distribution of the *Castanea* dominated associations (left) and the *Genisto carinalis-Quercetum petraeae* (right). Each dot represents one or more relevés. Only localities with available relevés are plotted.

Table IV. Synoptic table of the subtypes of the association *Tilio tomentosae-Castanetum*: 1, subtype with *Euphorbia amygdaloides*; 2, with *Aremonia agrimonoides*; 3, with *Selinum silaifolium*. Constancy values in percent. Constancy values for species diagnostic for a community type (i.e. occurring with more than double constancy and with >40% in a column) are highlighted. Species with less than 30% constancy in any column are omitted. Strata codes for woody species: t, tree; s, shrub; h, herb layer.

Subtype No.	1	2	3
Number of relevés	21	9	13
Number of constant species ( $\geq 33\%$ )	29	66	61
<i>Euphorbia amygdaloides</i>	76	22	8
<i>Carpinus orientalis</i> s	62	11	15
<i>Acer hyrcanum</i> h	57	11	31
<i>Fragaria vesca</i>	52	.	.
<i>Quercus frainetto</i> t	52	.	8
<i>Carpinus orientalis</i> t	52	11	15
<i>Campanula persicifolia</i>	43	11	.
<i>Tanacetum corymbosum</i>	33	.	8
<i>Fraxinus ornus</i> h	62	78	8
<i>Asplenium trichomanes</i>	43	33	.
<i>Physospermum cornubiense</i>	38	67	8
<i>Aremonia agrimonoides</i>	.	100	8
<i>Fraxinus ornus</i> t	38	89	38
<i>Ostrya carpinifolia</i> h	19	78	.
<i>Lunaria annua</i> subsp. <i>pachyrhiza</i>	.	78	.
<i>Fagus sylvatica</i> h	14	78	.
<i>Galium odoratum</i>	5	78	23
<i>Salvia glutinosa</i>	5	78	.
<i>Ostrya carpinifolia</i> t	24	78	8
<i>Abies borisii-regis</i> h	.	67	.
<i>Fagus sylvatica</i> t	10	67	.
<i>Acer platanoides</i> t	10	56	.
<i>Viola reichenbachiana</i>	.	56	15
<i>Ilex aquifolium</i> s	.	56	.
<i>Daphne laureola</i>	.	44	.
<i>Rosa arvensis</i>	10	44	.
<i>Sanicula europaea</i>	10	44	.
<i>Polygonatum odoratum</i>	.	44	.
<i>Dryopteris filix-mas</i>	.	44	.
<i>Arabis turrita</i>	10	33	.
<i>Sambucus nigra</i>	.	33	.
<i>Milium effusum</i>	.	33	.
<i>Acer platanoides</i> h	5	33	15
<i>Geum urbanum</i>	.	33	.
<i>Luzula sylvatica</i>	.	33	.
<i>Abies borisii-regis</i> t	.	33	.
<i>Neottia nidus-avis</i>	.	33	.
<i>Acer campestre</i> h	10	33	8
<i>Rubus hirtus</i>	.	89	85
<i>Polystichum setiferum</i>	5	89	46
<i>Calamintha grandiflora</i>	.	78	46
<i>Mycelis muralis</i>	24	78	69
<i>Castanea sativa</i> h	14	67	69
<i>Pteridium aquilinum</i>	24	67	85
<i>Lathyrus laxiflorus</i>	.	67	77
<i>Festuca drymeja</i>	.	67	69
<i>Melittis melissophyllum</i> subsp. <i>albida</i>	.	67	92
<i>Castanea sativa</i>	10	56	85
<i>Scutellaria altissima</i> + <i>columnae</i>	.	56	77
<i>Cephalanthera longifolia</i>	.	56	69
<i>Clematis vitalba</i>	10	56	31
<i>Calystegia silvatica</i>	.	44	23
<i>Geranium robertianum</i>	5	33	38

(continued)

Table IV. (Continued).

Subtype No.	1	2	3
Number of relevés	21	9	13
Number of constant species ( $\geq 33\%$ )	29	66	61
<i>Clinopodium vulgare</i>	10	22	100
<i>Selinum silaifolium</i>	.	22	100
<i>Luzula forsteri</i>	14	11	100
<i>Galium laconicum</i> + <i>pseudaristatum</i>	5	33	100
<i>Campanula spatulata</i> subsp. <i>spruneriana</i>	.	22	92
<i>Sorbus domestica</i>	14	.	92
<i>Poa trivialis</i> subsp. <i>sylvicola</i>	.	.	92
<i>Hieracium bracteolatum</i>	.	33	92
<i>Chamaecytisus austriacus</i>	5	22	85
<i>Crepis fraasii</i>	.	.	85
<i>Silene italica</i>	.	11	85
<i>Brachypodium sylvaticum</i>	24	33	85
<i>Hypericum montbretii</i>	.	.	77
<i>Quercus petraea</i> subsp. <i>medwediewii</i> s	14	22	77
<i>Cyclamen hederifolium</i> + spec.	.	33	69
<i>Ruscus aculeatus</i>	5	33	69
<i>Cardamine graeca</i>	.	22	69
<i>Silene viridiflora</i>	.	22	69
<i>Prunella vulgaris</i>	.	.	62
<i>Lathyrus niger</i>	19	.	62
<i>Campanula sparsa</i>	14	.	62
<i>Doronicum orientale</i>	.	11	54
<i>Trifolium pignanii</i>	.	11	46
<i>Vicia tenuifolia</i>	5	.	38
<i>Hieracium racemosum</i>	19	11	38
<i>Tilia tomentosa</i> t	100	100	92
<i>Poa nemoralis</i>	95	67	69
<i>Asplenium adiantum-nigrum</i> + <i>onopteris</i>	95	100	85
<i>Fraxinus ornus</i> s	86	100	92
<i>Tilia tomentosa</i> s	81	67	85
<i>Tilia tomentosa</i> h	76	89	69
<i>Sorbus torminalis</i>	71	67	100
<i>Quercus petraea</i> subsp. <i>medwediewii</i> t	67	44	92
<i>Campanula trachelium</i>	67	56	77
<i>Cornus mas</i>	67	22	69
<i>Melica uniflora</i>	62	100	92
<i>Lathyrus venetus</i>	62	89	100
<i>Hedera helix</i> h,s,t	57	100	92
<i>Potentilla micrantha</i>	52	67	85
<i>Primula acaulis</i>	52	78	85
<i>Viola alba</i> s.l.	52	56	69
<i>Veronica chamaedrys</i>	38	56	100
<i>Dactylis glomerata</i> s.l.	38	33	77
<i>Quercus petraea</i> subsp. <i>medwediewii</i> h	33	56	92
<i>Corylus avellana</i> s + h	33	44	23
<i>Tamus communis</i>	24	44	38
<i>Lapsana communis</i>	29	22	38
<i>Solidago virgaurea</i>	.	22	38
<i>Origanum vulgare</i>	.	.	31
<i>Galium aparine</i>	10	22	31
<i>Digitalis laevigata</i>	.	11	31
<i>Vicia grandiflora</i>	.	.	31
<i>Trifolium ochroleucon</i>	.	.	31
<i>Leontodon cichoriaceus</i>	.	.	31

Distribution records (Figure 3): W Macedonia: Voio; S Macedonia: Pieria; NE and E Thessaly: Kato Olimbos, Ossa, Mavrovouni, Pilio; E Macedonia: Rodopi, NE Chalkidiki, Athos. *Castanea* groves are rather common in suboceanic regions on the

Table V. Synoptic table of the subtypes of the association *Genista carinalis-Quercetum petraeae*: 1, subtype with *Campanula spatulata*; 2, with *Euphorbia amygdaloides*. Constancy values in percent. Constancy values for species diagnostic for a community type (i.e. occurring with more than double constancy and with >40% in a column) are highlighted. Species with less than 30% constancy in any column are omitted. Strata codes for woody species: t, tree; s, shrub; h, herb layer.

Subtype No.	1	2
Number of relevés	14	76
Number of constant species ( $\geq 33\%$ )	52	43
<i>Campanula spatulata</i> subsp. <i>spruneriana</i>	100	5
<i>Silene italica</i>	100	38
<i>Melittis melissophyllum</i> subsp. <i>albida</i>	86	21
<i>Hieracium bracteolatum</i>	86	.
<i>Poa trivialis</i> subsp. <i>sylvicola</i>	86	7
<i>Trifolium pignanti</i>	79	.
<i>Hypericum montbretii</i> + <i>spruneri</i>	79	14
<i>Cardamine graeca</i>	71	17
<i>Rubus hirtus</i>	71	7
<i>Galium laconicum</i> + <i>pseudaristatum</i>	71	4
<i>Doronicum orientale</i>	64	1
<i>Geocaryum capillifolium</i>	64	7
<i>Trifolium ochroleucon</i>	64	5
<i>Vicia tenuifolia</i> + <i>dalmatica</i>	64	9
<i>Anthoxanthum odoratum</i>	64	22
<i>Festuca heterophylla</i>	64	32
<i>Anthemis tinctoria</i> s.l.	57	26
<i>Symphytum bulbosum</i>	57	12
<i>Cephalanthera longifolia</i>	50	21
<i>Festuca drymeja</i>	50	.
<i>Origanum vulgare</i>	50	.
<i>Leontodon cichoriaceus</i>	50	11
<i>Crepis fraasii</i>	50	.
<i>Poa bulbosa</i>	50	7
<i>Castanea sativa</i> h	43	17
<i>Hedera helix</i> h	43	9
<i>Mycelis muralis</i>	43	20
<i>Phlomis samia</i>	43	4
<i>Tamus communis</i>	43	12
<i>Solidago virgaurea</i>	36	.
<i>Geranium lucidum</i>	36	12
<i>Silene viridiflora</i>	36	8
<i>Vicia grandiflora</i>	36	21
<i>Poa nemoralis</i>	43	91
<i>Euphorbia amygdaloides</i>	.	80
<i>Galium mollugo</i> agg.	29	72
<i>Fragaria vesca</i>	14	66
<i>Festuca valesiaca</i>	.	55
<i>Campanula persicifolia</i>	.	54
<i>Fraxinus ornus</i> h	21	51
<i>Genista carinalis</i>	21	47
<i>Trifolium alpestre</i>	21	46
<i>Rosa arvensis</i>	14	45
<i>Silene atropurpurea</i>	7	45
<i>Aremonia agrimonoides</i>	21	43
<i>Fagus sylvatica</i> s	14	38
<i>Carpinus orientalis</i> h	7	38
<i>Teucrium chamaedrys</i>	7	38
<i>Primula acaulis</i>	14	36
<i>Silene coronaria</i>	14	34
<i>Helleborus odoratus</i> subsp. <i>cyclophyllus</i>	.	34
<i>Thymus sibthorpii</i>	.	33
<i>Scutellaria columnae</i>	.	32

(continued)

Table V. (Continued).

Subtype No.	1	2
Number of relevés	14	76
Number of constant species ( $\geq 33\%$ )	52	43
<i>Physospermum cornubiense</i>	7	32
<i>Quercus frainetto</i> t	7	32
<i>Quercus frainetto</i> h	7	30
<i>Quercus petraea</i> subsp. <i>medwediewii</i> t	100	100
<i>Quercus petraea</i> subsp. <i>medwediewii</i> h	100	99
<i>Dactylis glomerata</i> s.l.	93	89
<i>Veronica chamaedrys</i> s.l.	93	87
<i>Luzula forsteri</i>	100	59
<i>Potentilla micrantha</i>	93	63
<i>Clinopodium vulgare</i>	93	55
<i>Lathyrus laxiflorus</i>	93	50
<i>Sorbus torminalis</i>	86	46
<i>Viola alba</i> s.l.	79	51
<i>Melica uniflora</i>	71	37
<i>Galium aparine</i>	71	36
<i>Asplenium adiantum-nigrum</i> + <i>onopteris</i>	71	61
<i>Chamaecytisus</i> div. spec.	71	39
<i>Brachypodium sylvaticum</i>	64	63
<i>Lapsana communis</i>	57	34
<i>Pteridium aquilinum</i>	50	29
<i>Silene vulgaris</i>	43	47
<i>Cornus mas</i>	36	43
<i>Sorbus domestica</i>	36	33
<i>Fraxinus ornus</i> s	29	43
<i>Rubus canescens</i>	21	38
<i>Crataegus monogyna</i> s.l.	29	37
<i>Hypericum perforatum</i>	14	32
<i>Campanula trachelium</i> subsp. <i>athoa</i>	21	32

Greek mainland. They occur also on the W Aegean island of Evvia, but no phytosociological records have been published.

Diagnostic (bold) and constant species:

Trees and tall shrubs: ***Castanea sativa***, *Hedera helix*, ***Teline monspessulana***.

Herbs and small shrubs: *Brachypodium sylvaticum*, ***Calystegia silvatica***, *Campanula spatulata* subsp. *spruneriana*, *Clinopodium vulgare*, ***Crocus veluchensis***, ***Digitalis laevigata***, *Doronicum orientale*, ***Lathyrus alpestris***, *Lathyrus laxiflorus*, ***Lithospermum purpurocaeruleum***, *Luzula forsteri*, *Primula acaulis*, ***Prunella vulgaris***, *Pteridium aquilinum*, ***Rubus hirtus***, *Veronica chamaedrys* s.l., *Viola alba* s.l.

Subtypes: As knowledge on variation in *Castanea* woodland vegetation in Greece is still rather fragmentary, only one association is distinguished here on the northern mainland. It is distinguished from Peloponnesian *Castanea* stands by mesophilous species such as *Rubus hirtus*, *Primula acaulis*, *Galium laconicum*, *Melittis melissophyllum*, *Hieracium bracteolatum*, *Festuca heterophylla*, *Physospermum cornubiense* and *Helleborus odoratus* subsp. *cyclophyllus*.

***Cytiso villosae-Castanetum sativae*** (Table I, column 6)

Ecology and forest use: Schistose soils in flysch and micaschist areas, 980–1270 m a.s.l., slopes moderate, often terraced; spacious groves of trees with thick trunks, established for sweet chestnut production, partly abandoned.

Distribution records (Figure 3): Peloponnisos: Parnon.

Diagnostic (bold) and constant species:

Trees and tall shrubs: ***Castanea sativa***, ***Cytisus villosus***.

Herbs and small shrubs: ***Achillea ligustica***, ***Aristolochia elongata***, ***Bromus sterilis***, ***Campanula spatulata*** subsp. *spruneriana*, ***Campanula stenophon***, ***Clinopodium vulgare***, ***Dactylis glomerata***, ***Doronicum orientale***, ***Elymus panormitanus***, ***Epilobium lanceolatum***, ***Euphorbia oblongata***, ***Hypericum vesiculosum***, ***Lathyrus grandiflorus***, ***Leontodon cichoriaceus***, ***Luzula forsteri***, ***Muscari comosum***, ***Orchis mascula***, ***Ornithogalum nutans***, ***Poa trivialis*** subsp. *sylvicolam*, ***Potentilla micrantha***, ***Pteridium aquilinum***, ***Ranunculus gracilis***, ***Ranunculus psilostachys***, ***Rumex tuberosus***, ***Saxifraga graeca***, ***Sedum amplexicaule*** subsp. *temuifolium*, ***Silene atropurpurea***, ***Silene viridiflora***, ***Trifolium ochroleucon***, ***Trifolium physodes***, ***Trifolium pignanti***, ***Veronica chamaedrys*** s.l., ***Vicia lathyroides***, ***Vicia melanops***.

Subtypes: Mesic stands near Kastanitsa are recognized by a larger number of hygrophilous species.

***Lathyro laxiflori*–*Castanetum sativae*** (Table I, column 7)

Ecology and forest use: Moderately deep siliceous soils on lower slopes and along streams cut in phyllite–quartzite regions, 350–800 m a.s.l.; the groves consist of old-growth and occur as small patches in suitable locations surrounded by maquis or evergreen wood. They are maintained for sweet chestnut harvesting, or as abandoned pasture woods. Distribution records (Figure 3): W Crete.

Diagnostic (bold) and constant species:

Trees and tall shrubs: ***Castanea sativa***, ***Platanus orientalis***.

Herbs and small shrubs (selected): ***Aetheorhiza bulbosa*** subsp. *microcephala*, ***Allium subhirsutum***, ***Anthoxanthum odoratum***, ***Arisarum vulgare***, ***Aristolochia sempervirens***, ***Arum creticum***, ***Brachypodium retusum***, ***Charybdis maritima***, ***Crepis fraasii***, ***Cyclamen creticum***, ***Hypericum empetrifolium***, ***Hypericum hircinum*** subsp. *albimontanum*, ***Lecokia cretica***, ***Luzula forsteri***, ***Oenanthe pimpinelloides***, ***Piptatherum miliaceum***, ***Poa trivialis*** subsp. *sylvicola*, ***Pteridium aquilinum***, ***Pulicaria odora***, ***Ranunculus paludosus***, ***Ranunculus velutinus***, ***Rubia peregrina***, ***Scaligeria napiformis***, ***Selaginella denticulata***, ***Tamus***

***communis***, ***Teucrium massiliense***, ***Tolpis virgata***, ***Trifolium repens***.

Subtypes: No attempt was made to distinguish subtypes. The Cretan *Castanea* woodlands are easily distinguished from those of the mainland, as only few plant species of submediterranean distribution extend to Crete.

Table VI. Synoptic table of the subtypes of the association *Symphyto ottomani*–*Quercetum frainetto*: 1, subtype with *Silene coronaria*; 2, with *Fragaria vesca*, 3, with *Genista carinalis*. Constancy values in percent. Constancy values for species diagnostic for a community type (i.e. occurring with more than double constancy and with >40% in a column) are highlighted. Species with less than 30% constancy in any column are omitted. Strata codes for woody species: t, tree; s, shrub; h, herb layer.

Subtype No.	1	2	3
Number of relevés	10	9	28
Number of constant species ( $\geq 33\%$ )	35	28	22
<i>Silene coronaria</i>	90	.	25
<i>Potentilla micrantha</i>	80	22	11
<i>Luzula forsteri</i>	70	22	7
<i>Cornus mas</i> s+h	70	11	14
<i>Juniperus oxycedrus</i> (+ <i>communis</i> ) s+h	60	.	11
<i>Hypericum montbretii</i> + <i>spruneri</i>	60	.	25
<i>Myosotis sylvatica</i> s.l.	50	11	4
<i>Quercus petraea</i> subsp. <i>medwediewii</i> h	50	22	.
<i>Campanula persicifolia</i>	50	22	14
<i>Festuca heterophylla</i>	50	.	4
<i>Silene italica</i> s.str.	50	.	25
<i>Symphytum ottomanum</i>	50	.	.
<i>Physospermum cornubiense</i>	50	22	.
<i>Silene viridiflora</i>	50	.	.
<i>Viola riviniana</i> + <i>sieheana</i>	40	.	.
<i>Aremonia agrimonoides</i>	40	.	.
<i>Primula veris</i> subsp. <i>columnae</i>	40	.	.
<i>Vicia grandiflora</i>	40	.	14
<i>Vinca herbacea</i> + <i>major</i>	30	.	.
<i>Digitalis lanata</i>	30	.	.
<i>Oenanthe pimpinelloides</i>	30	.	.
<i>Knautia arvensis</i> agg.	30	.	.
<i>Acer campestre</i> h	30	.	4
<i>Lathyrus venetus</i>	30	11	.
<i>Sorbus domestica</i>	70	67	21
<i>Euphorbia amygdaloides</i>	50	67	7
<i>Quercus petraea</i> subsp. <i>medwediewii</i> t	50	33	.
<i>Asplenium trichomanes</i>	10	89	36
<i>Sorbus torminalis</i> s+h	30	78	14
<i>Fragaria vesca</i>	10	78	18
<i>Viola alba</i> s.l.	10	67	21
<i>Campanula trachelium</i>	20	67	4
<i>Silene vulgaris</i>	10	56	11
<i>Primula acaulis</i>	.	44	.
<i>Carpinus orientalis</i> t	.	44	7
<i>Digitalis viridiflora</i>	10	33	.
<i>Trifolium alpestre</i>	20	44	54
<i>Festuca valesiaca</i>	.	22	89
<i>Teucrium chamaedrys</i>	30	11	79
<i>Genista carinalis</i>	20	11	64
<i>Carex halleriana</i>	.	.	61
<i>Thymus sibthorpii</i>	.	22	54
<i>Fraxinus ornus</i> t	.	11	43
<i>Silene gigantea</i>	.	11	39

(continued)

Table VI. (Continued).

Subtype No.	1	2	3
Number of relevés	10	9	28
Number of constant species ( $\geq 33\%$ )	35	28	22
<i>Phleum phleoides</i>	60	11	79
<i>Quercus frainetto</i> t	100	100	100
<i>Quercus frainetto</i> s	70	22	89
<i>Quercus frainetto</i> h	70	78	96
<i>Carpinus orientalis</i> s	80	89	75
<i>Fraxinus ornus</i> s + h	80	89	100
<i>Brachypodium sylvaticum</i>	100	67	57
<i>Veronica chamaedrys</i> s.l.	90	67	64
<i>Dactylis glomerata</i> s.l.	70	67	82
<i>Asplenium adiantum-nigrum</i> + <i>onopteris</i>	70	89	75
<i>Lathyrus niger</i>	70	56	46
<i>Poa nemoralis</i>	60	89	43
<i>Galium mollugo</i> agg.	50	78	96
<i>Sedum cepaea</i>	40	33	43
<i>Campanula linguata</i>	50	11	32
<i>Corylus avellana</i>	40	33	11
<i>Tamus communis</i>	30	33	14
<i>Crataegus monogyna</i> s.l.	30	56	25
<i>Melica uniflora</i>	30	33	.
<i>Ruscus aculeatus</i>	40	22	18
<i>Silene atropurpurea</i>	20	33	29
<i>Hieracium bauhini</i> , <i>cymosum</i> + <i>piloselloides</i>	30	.	29
<i>Anthemis tinctoria</i> s.l.	30	11	29
<i>Chamaecytisus austriacus</i> + spec.	30	.	36
<i>Dorycnium herbaceum</i>	10	11	32
<i>Quercus pubescens</i> t + s	.	22	32

### *Symphyto ottomani-Quercetum frainetto* (Table I, column 8; Table VI)

Ecology and forest use: Moderate to mostly steep slopes in all expositions with brown siliceous soils over gneiss, micaschist or granitic bedrock, 150–870 m; almost all documented stands show traces of former coppicing; wood pasture is insignificant.

Distribution records (Figure 4): E Macedonia and W Thrace: Rodopi.

Diagnostic (bold) and constant species:

Trees and tall shrubs: *Quercus frainetto*, *Carpinus orientalis*, *Fraxinus ornus*.

Herbs and small shrubs: *Asplenium adiantum-nigrum*, *Brachypodium sylvaticum*, ***Campanula linguata***, ***Carex halleriana***, *Dactylis glomerata* s.l., ***Phleum phleoides***, ***Scabiosa ochroleuca***, ***Securigera varia***, *Sedum cepaea*, *Veronica chamaedrys* s.l.

Subtypes: The *Symphyto ottomani-Quercetum* is rather poorly defined by differential species. It is distinguished from the other Greek *Quercus frainetto* associations chiefly by the absence of species such as *Lathyrus laxiflorus*, *Galium laconicum*, *Rosa arvensis*, *Doronicum orientale*, *Trifolium ochroleucon*, *Leontodon cichoriaceus*, and *Geocaryum capillifolium*.

Records from NW Xanthi (W Thrace) (Table VI: 1) are distinguished by *Silene coronaria*, *Potentilla*

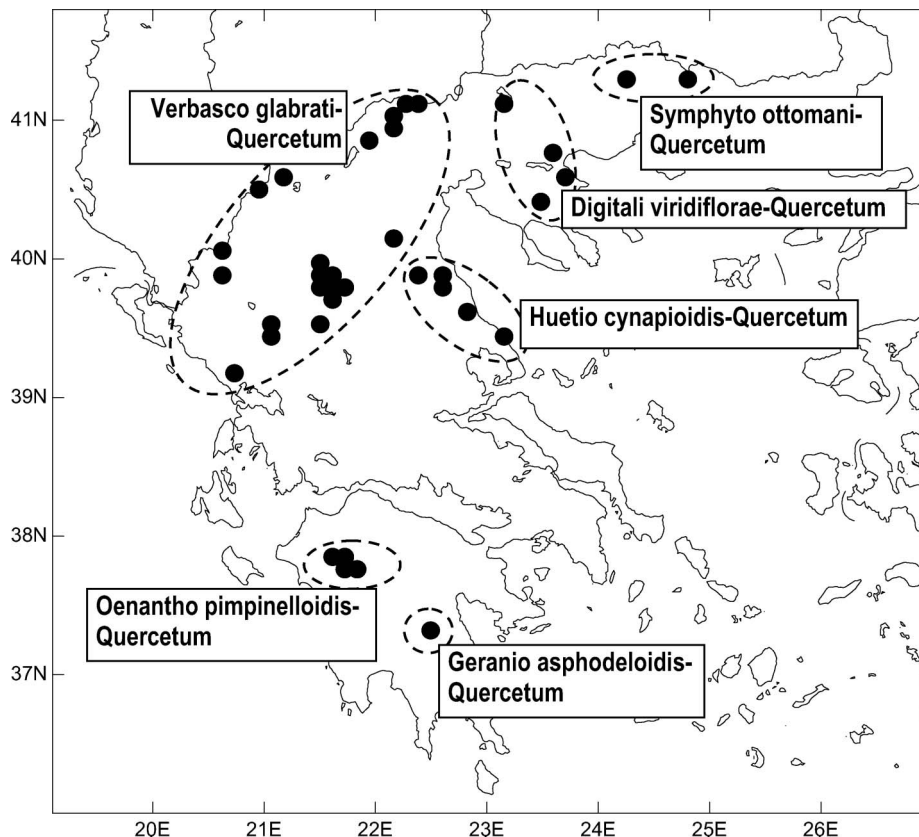


Figure 4. Distribution of the *Quercus frainetto* dominated associations. Each dot represents one or more relevés. Only localities with available relevés are plotted.

*micrantha*, *Cornus mas*, *Luzula forsteri*, *Campanula lingulata*, the name-giving *Symphytum ottomanum*, and *Silene viridiflora*, suggesting less pronounced subcontinental climatic conditions than in the Nestos area NNE of Drama (E Macedonia). Here, two subtypes exist of which one (Table VI: 2; with *Fragaria vesca*, *Campanula trachelium* and *Primula acaulis*) occurs on soils with better water supply than the other which is differentiated by species such as *Genista carinalis*, *Carex halleriana*, *Thymus sibthorpii*, *Festuca valesiaca* and *Teucrium chamaedrys* which avoid full shade and tolerate drier conditions (Table VI: 3).

Table VII. Synoptic table of the subtypes of the association *Verbascum glabratum-Quercetum frainetto*: 1, subtype with *Aira elegantissima*; 2, with *Ruscus aculeatus*; 3, without differential taxa; 4, with *Fraxinus ornus*; 5, subtype with *Galium laconicum*; 6, subtype with *Elymus hispidus*. Constancy values are in percent. Constancy values for species diagnostic for a community type (i.e. occurring with more than double constancy and with >40% in a column) are highlighted. Species with less than 28% constancy in any column are omitted. Strata codes for woody species: t, tree; s, shrub; h, herb layer.

Subtype No.	1	2	3	4	5	6
Number of relevés	15	13	13	11	45	29
Number of constant species (≥33 %)	55	36	22	61	50	82
<i>Aira elegantissima</i>	73	31	23	.	7	.
<i>Trifolium arvense</i>	47	.	23	18	4	3
<i>Poa nemoralis</i>	40	.	8	.	18	.
<i>Cardamine graeca</i>	40	15	15	.	11	.
<i>Crepis setosa</i>	33	8	.	.	.	.
<i>Arenaria leptoclados</i> + <i>serpyllifolia</i>	33	.	.	.	2	3
<i>Rumex acetosella</i>	33	.	.	.	.	.
<i>Dianthus</i> spec.	33	.	.	.	2	.
<i>Hieracium pilosella</i>	33	.	.	.	.	.
<i>Trifolium striatum</i>	33	.	.	.	.	3
<i>Cerastium</i> spec.	40	46	.	.	.	.
<i>Carex distachya</i>	13	92	31	.	.	.
<i>Catapodium rigidum</i>	7	85	.	9	.	.
<i>Ruscus aculeatus</i>	.	85	38	9	18	7
<i>Hedera helix</i> h	.	77	38	9	.	.
<i>Cardamine hirsuta</i>	.	69	.	.	18	17
<i>Sherardia arvensis</i>	.	62	.	.	.	.
<i>Hedera helix</i> s + t	.	54	.	.	.	.
<i>Asplenium onopteris</i>	7	46	23	9	2	.
<i>Rosa sempervirens</i> s	.	38	.	.	.	.
<i>Campanula trachelium</i>	.	31	15	.	9	3
<i>Crataegus orientalis</i> s + h	.	31	.	9	.	.
<i>Crucianella latifolia</i>	.	31	.	.	.	.
<i>Gastridium</i> spec.	.	31	.	.	.	.
<i>Helleborus odoratus</i> subsp. <i>cyclophyllus</i>	13	.	38	18	7	.
<i>Ferulago sylvatica</i>	13	.	.	100	11	14
<i>Fraxinus ornus</i> s + t	7	.	.	91	4	7
<i>Cotinus coggygria</i> s + h	.	.	15	82	27	24
<i>Trifolium aurantiacum</i>	.	.	.	73	.	.
<i>Echinops ritro</i>	.	.	15	64	16	7
<i>Vicia laeta</i>	13	.	.	64	16	17

(continued)

Table VII. (Continued).

Subtype No.	1	2	3	4	5	6
Number of relevés	15	13	13	11	45	29
Number of constant species (≥33 %)	55	36	22	61	50	82
<i>Lithospermum purpureoaceruleum</i>	7	.	8	64	13	7
<i>Asparagus acutifolius</i>	7	8	8	55	7	14
<i>Tamus communis</i>	.	.	.	55	22	3
<i>Trifolium echinatum</i> + <i>leucanthum</i>	.	.	.	55	.	3
<i>Acer monspessulanum</i> h	.	15	.	55	13	7
<i>Vicia cassubica</i>	.	.	8	45	11	.
<i>Paliurus spina-christi</i>	.	8	.	45	.	.
<i>Acer monspessulanum</i> s + t	.	.	.	36	2	.
<i>Dictamnus albus</i>	.	.	.	36	11	31
<i>Lathyrus aphaca</i>	.	.	.	36	.	7
<i>Colutea arborescens</i> s + h	.	.	.	36	7	3
<i>Trifolium pignanti</i>	13	.	.	.	42	31
<i>Scutellaria columnae</i>	.	15	8	.	33	3
<i>Filipendula vulgaris</i>	7	.	.	36	16	90
<i>Crocus</i> spec.	.	15	.	9	24	86
<i>Muscari neglectum</i>	.	.	8	9	27	79
<i>Elymus hispidus</i> subsp. <i>barbulatus</i>	.	.	.	9	7	79
<i>Quercus pubescens</i> h	.	.	.	.	13	69
<i>Danthonia alpina</i>	.	.	.	.	.	69
<i>Ranunculus neapolitanus</i>	.	.	.	.	18	66
<i>Quercus pubescens</i> s + t	.	31	.	27	16	66
<i>Quercus cerris</i> h	.	.	.	27	31	62
<i>Agrimonia eupatoria</i>	.	.	15	.	13	59
<i>Lathyrus digitatus</i>	.	.	.	.	13	59
<i>Luzula multiflora</i>	7	.	8	.	4	59
<i>Dorycnium herbaceum</i>	.	.	8	27	.	52
<i>Euphorbia apios</i>	7	.	8	.	20	48
<i>Alyssum murale</i>	.	.	.	.	.	48
<i>Cerastium brachypetalum</i>	27	.	8	.	13	45
<i>Arabis sagittata</i>	.	.	.	.	7	45
<i>Sanguisorba minor</i>	7	.	23	.	.	45
<i>Briza media</i>	7	.	.	.	9	45
<i>Iris sintenisii</i>	.	.	.	.	16	41
<i>Phleum bertolonii</i>	7	.	.	.	7	41
<i>Quercus trojana</i> h	.	.	.	9	4	38
<i>Oenanthe pimpinelloides</i>	.	.	31	.	22	38
<i>Agrostis castellana</i>	.	.	23	.	4	38
<i>Phleum montanum</i> + <i>phleoides</i>	13	.	.	18	24	38
<i>Polygala nicaeensis</i> subsp. <i>mediterranea</i>	.	.	.	.	.	38
<i>Anthericum liliago</i>	.	.	.	.	2	34
<i>Fragaria viridis</i>	.	.	.	.	4	34
<i>Cephalanthera rubra</i>	.	.	.	.	20	34
<i>Pyrus communis</i> , <i>pyraster</i> + <i>spinosa</i> h	.	.	.	.	7	34
<i>Prunus cocomilia</i> , <i>divaricata</i> + <i>spinosa</i> h	.	.	.	.	20	34
<i>Verbascum glabratum</i>	67	46	23	55	64	10
<i>Euphorbia amygdaloides</i>	53	.	8	55	47	7
<i>Stachys scardica</i>	53	.	8	.	44	83
<i>Trifolium alpestre</i>	47	.	8	.	49	48
<i>Symphytum bulbosum</i>	40	.	8	.	87	69
<i>Physospermum cornubiense</i>	40	.	.	18	53	52
<i>Genista carinalis</i>	47	.	.	.	20	48
<i>Carpinus orientalis</i> s + h	13	46	69	82	13	.
<i>Phillyrea latifolia</i> s	7	62	23	100	2	.
<i>Rosa gallica</i>	.	.	.	91	33	97

(continued)

Table VII. (Continued).

Subtype No.	1	2	3	4	5	6
Number of relevés	15	13	13	11	45	29
Number of constant species ( $\geq 33\%$ )	55	36	22	61	50	82
<i>Quercus cerris</i> t	.	.	8	55	42	72
<i>Trifolium physodes</i>	.	15	.	55	11	52
<i>Galium mollugo</i> agg.	20	15	.	9	64	93
<i>Sorbus domestica</i>	47	.	15	45	49	79
<i>Sorbus torminalis</i>	40	.	8	73	49	62
<i>Carex flacca</i> subsp. <i>serrulata</i>	40	.	15	100	78	100
<i>Brachypodium pinnatum</i> + <i>rubestri</i>	40	.	.	82	58	90
<i>Crepis fraasii</i>	.	62	8	64	53	86
<i>Juniperus oxycedrus</i> s + h	67	.	62	91	69	90
<i>Quercus frainetto</i> t	100	100	100	100	100	83
<i>Quercus frainetto</i> s	87	.	54	64	80	79
<i>Quercus frainetto</i> h	100	54	85	82	96	90
<i>Veronica chamaedrys</i> s.l.	73	100	92	91	82	76
<i>Campanula spatulata</i> subsp. <i>spruneriana</i>	67	54	69	64	84	83
<i>Luzula forsteri</i>	67	85	100	82	96	83
<i>Lathyrus laxiflorus</i>	60	54	69	91	84	83
<i>Potentilla micrantha</i>	80	85	54	27	67	14
<i>Leontodon cichoriaceus</i>	80	38	31	27	64	100
<i>Poa trivialis</i> subsp. <i>sylvicola</i>	67	23	31	55	69	72
<i>Silene italica</i> s.str.	87	.	23	45	69	69
<i>Dactylis glomerata</i> s.l.	93	15	46	100	89	93
<i>Thymus longicaulis</i>	67	38	15	36	33	69
<i>Geocaryum capillifolium</i>	33	62	23	9	64	79
<i>Crataegus monogyna</i> s.l. s + h	27	62	23	45	60	76
<i>Trifolium ochroleucon</i>	27	62	31	36	38	72
<i>Viola alba</i> s.l.	27	46	31	91	53	93
<i>Fraxinus ornus</i> h	20	31	38	82	53	62
<i>Brachypodium sylvaticum</i>	27	8	77	45	71	45
<i>Clinopodium vulgare</i>	27	8	46	55	60	41
<i>Hypericum montbretii</i> + <i>sprumeri</i>	27	38	8	45	29	69
<i>Poa bulbosa</i>	73	46	31	18	24	21
<i>Cornus mas</i> s + h	.	54	23	73	38	28
<i>Silene viridiflora</i>	.	23	85	27	38	62
<i>Arenonia agrimonoides</i>	7	23	38	36	42	38
<i>Melittis melissophyllum</i> subsp. <i>albida</i>	.	54	23	55	49	34
<i>Anthemis tinctoria</i> s.l.	53	.	.	.	27	59
<i>Cynosurus echinatus</i>	53	54	23	9	22	31
<i>Doronicum orientale</i>	53	.	.	.	36	3
<i>Hieracium</i> spec.	33	46	.	.	13	.
<i>Cistus creticus</i>	27	.	31	.	7	10
<i>Lotus corniculatus</i>	33	.	8	.	7	38
<i>Galium aparine</i>	33	.	15	.	31	45
<i>Carpinus orientalis</i> t	7	38	15	55	.	.
<i>Pteridium aquilinum</i>	.	38	46	.	18	.
<i>Cephalanthera longifolia</i>	20	23	.	64	36	31
<i>Tanacetum corymbosum</i>	13	.	.	64	11	34
<i>Dorycnium hirsutum</i>	7	.	31	45	27	62
<i>Ptilostemon strictus</i>	20	.	15	27	62	41
<i>Bellis perennis</i>	20	.	23	.	33	48
<i>Anthoxanthum odoratum</i>	73	8	8	.	38	79
<i>Festuca heterophylla</i>	60	.	31	.	56	38
<i>Rubus canescens</i>	53	8	31	9	62	93
<i>Galium laconicum</i>	47	.	15	36	60	.
<i>Lathyrus niger</i>	40	.	31	36	58	14
<i>Selinum silaifolium</i>	33	.	.	45	49	17

(continued)

Table VII. (Continued).

Subtype No.	1	2	3	4	5	6
Number of relevés	15	13	13	11	45	29
Number of constant species ( $\geq 33\%$ )	55	36	22	61	50	82
<i>Loranthus europaeus</i>	7	54	38	.	16	59
<i>Rosa arvensis</i>	13	23	38	9	24	3
<i>Achnatherum bromoides</i>	20	.	31	82	33	52
<i>Hieracium bauhini</i> + <i>piloselloides</i>	53	.	38	.	33	34
<i>Trifolium campestre</i>	60	62	38	36	7	17
<i>Myosotis arvensis</i>	47	15	8	.	9	24
<i>Silene coronaria</i>	40	.	8	.	27	14
<i>Asphodeline liburnica</i>	33	23	.	.	7	.
<i>Festuca circummediterranea</i>	47	.	.	.	13	24
<i>Trifolium tenuifolium</i>	33	.	23	.	2	.
<i>Teucrium chamaedrys</i>	.	.	.	36	13	28
<i>Acanthus spinosus</i>	.	.	8	36	20	31
<i>Epipactis helleborine</i> + <i>spec.</i>	.	.	.	9	22	31
<i>Thlaspi tymphaeum</i>	.	.	.	.	4	31
<i>Viola riviniana</i> + <i>sieheana</i>	.	.	.	.	7	28
<i>Quercus trojana</i> t	.	.	.	18	2	28
<i>Helictotrichon convolutum</i>	7	.	.	.	.	28
<i>Linum flavum</i> subsp. <i>albaticum</i>	.	.	.	.	.	28

**Verbascum glabrati-Quercetum frainetto** (Table I, column 9; Table VII)

Ecology and forest use: Siliceous, more or less steep brown loamy or sandy-loamy soils on micaschist, flysch, and other schistose non-calcareous bedrock; in slightly to moderately sloped terrain, especially on middle and upper slopes in all expositions, and on ridges, 320–1200 m; both coppices and old-growth pasture woods with single-stemmed trees have been recorded.

Distribution records (Figure 4): Epirus: near Konitsa, Valaorit, Tsoumerka; W Macedonia: between Kastoria and Florina, Chasia; C and S Macedonia: Paiko, Voras, Pieria.

Diagnostic (bold) and constant species:

Trees and tall shrubs: ***Quercus frainetto***, ***Cornus mas***, ***Cotinus coggygria***, ***Juniperus oxycedrus***, ***Quercus cerris***.

Herbs and small shrubs: ***Agrostis castellana***, ***Campylopusis spatulata*** subsp. *spruneriana*, ***Carex flacca*** subsp. *serrulata*, ***Crepis fraasii***, ***Dactylis glomerata*** s.l., ***Danthonia alpina***, ***Dictamnus albus***, ***Echinops ritro***, ***Elymus hispidus*** subsp. *barbulatus*, ***Euphorbia apios***, ***Filipendula vulgaris***, ***Geocaryum capillifolium***, ***Iris sintenisii***, ***Lathyrus laxiflorus***, ***Luzula forsteri***, ***Ptilostemon strictus***, ***Rosa gallica***, ***Silene viridiflora***, ***Stachys scardica***, ***Verbascum glabratum***, ***Veronica chamaedrys*** s.l.

Subtypes: Variation within the *Verbascum glabrati-Quercetum frainetto* is complex and due to the plant geographical situation, altitude, soil moisture, and use history. A group of three subtypes with *Rosa gallica*, *Carex flacca*, *Quercus cerris*, *Sorbus domestica* and *Sorbus torminalis* occurs on loamy acidic schistose

soils (Table VII: 4–6). They are widespread throughout the range of the association and are represented by coppices and old-growth pasture woods. Most distinct in species composition are stands from the W Macedonian Chasia mountain range (Table VII: 6; with *Elymus hispidus* subsp. *barbulatus*, *Filipendula vulgaris*, *Stachys scardica*, *Danthonia alpina*). These heliophilous taxa are favoured by regular coppicing and also to a certain degree by wood pasture. *Quercus cerris* and *Q. trojana* are rather frequent in the undergrowth and canopy. Widespread in Macedonia and Epirus are dense coppiced stands on deep soils distinguished from the former by the lack of heliophilous differential species and the occurrence of *Verbascum glabratum*, *Euphorbia amygdaloides*, *Galium laconicum* and *Lathyrus niger* (Table VII: 5). Similar but at lower altitudes and on drier flysch soils in Epirus (near Konitsa) occur mixed *Quercus frainetto*–*Fraxinus ornus* forests with *Ferulago sylvatica* and *Cotinus coggygria* (Table VII: 4). Again distributed from Epirus to W Macedonia, but on lighter, more sandy soils, occurs a variety distinguished by *Ruscus aculeatus*, *Hedera helix* and *Pteridium aquilinum* which is best represented in old-growth woodlands (Table VII: 2–3). The deciduous mistle *Loranthus europaeus* grows typically in such non-coppiced oak trees. At somewhat lower altitudes (400–500 m) species such as *Carex distachya*, *Asplenium onopteris* and *Rosa sempervirens* resemble the field layer of evergreen woodland (Table VII: 2). Irregular coppices which are particularly influenced by wood pasture have been documented from various regions (Chasia, Tsoumerka, Paiko, Voras) and are in fact more common than the available number of relevés suggest (Table VII: 1). They are distinguished by numerous annual species such as *Aira elegantissima*, *Trifolium arvense*, *T. striatum*, *T. tenuifolium*, *Cynosurus echinatus*, *Myosotis arvensis*, and by heliophilous plants of base-impooverished soils such as *Rumex acetosella*.

***Huetio cynapioidis*–*Quercetum frainetto*** (Table I, column 10; Table VIII)

Ecology and forest use: Moderate to steep slopes of all expositions as well as flat and ridged tracts, moderately deep brown sandy-loamy soils in gneiss and micascist regions, rarely on calcareous sandy soil, 300–1120 m; old-growth pasture woods roamed by domestic pigs and brushwood or stunted forest degraded by irregular cutting and browsing.

Distribution records (Figure 4): E Thessaly and adjacent SE Macedonia: Pilio, Mavrovouni, Kato Olimbos.

Diagnostic (bold) and constant species:

Trees and tall shrubs: *Quercus frainetto*, ***Fagus sylvatica* s.l.**

Constant species: *Anthoxanthum odoratum*, *Campanula spatulata* subsp. *spruneriana*, *Clinopodium*

Table VIII. Synoptic table of the subtypes of the association *Huetio*–*Quercetum frainetto*: 1, subtype with *Juniperus oxycedrus*; 2, subtype with *Galium laconicum*. Constancy values are in percent. Constancy values for species diagnostic for a community type (i.e. occurring with more than double constancy and with >40% in a column) are highlighted. Species with less than 33% constancy in any column are omitted. Strata codes for woody species: t, tree; s, shrub; h, herb layer.

Subtype No.	1	2
Number of relevés	17	26
Number of constant species (≥33 %)	37	52
<i>Juniperus oxycedrus</i> s + h	65	.
<i>Arenonia agrimonoides</i>	53	15
<i>Fraxinus ornus</i> h	41	4
<i>Quercus pubescens</i> t + s	41	.
<i>Quercus coccifera</i> s + h	41	.
<i>Cornus mas</i> s + h	41	.
<i>Galium laconicum</i> + <i>pseudaristatum</i>	18	100
<i>Clinopodium vulgare</i>	35	85
<i>Melitis melissophyllum</i> subsp. <i>albida</i>	29	81
<i>Hieracium bracteolatum</i>	6	77
<i>Trifolium ochroleucon</i>	29	69
<i>Selinum silaifolium</i>	24	69
<i>Verbascum aphantulum</i>	.	69
<i>Anthemis tinctoria</i> s.l.	6	69
<i>Helleborus odoratus</i> subsp. <i>cyclophyllus</i>	18	65
<i>Hypericum montbretii</i> + <i>spruneri</i>	12	62
<i>Rubus hirtus</i>	12	58
<i>Fagus sylvatica</i> h	.	54
<i>Hieracium</i> subgen. <i>Pilosella</i> spec.	24	54
<i>Erica arborea</i> s + h	18	50
<i>Vicia grandiflora</i>	24	50
<i>Physospermum cornubiense</i>	6	50
<i>Crocus veluchensis</i>	6	46
<i>Phlomis samia</i>	18	42
<i>Crataegus monogyna</i> s.l. s + h	6	42
<i>Lathyrus niger</i>	.	42
<i>Quercus frainetto</i> t	100	100
<i>Silene italica</i> s. str.	94	88
<i>Luzula forsteri</i>	88	96
<i>Veronica chamaedrys</i> s.l.	88	96
<i>Campanula spatulata</i> subsp. <i>spruneriana</i>	88	96
<i>Lathyrus laxiflorus</i>	82	73
<i>Quercus frainetto</i> s	71	96
<i>Doronicum orientale</i>	71	88
<i>Dactylis glomerata</i> s.l.	71	96
<i>Quercus frainetto</i> h	71	85
<i>Symphytum bulbosum</i>	65	50
<i>Brachypodium sylvaticum</i>	59	31
<i>Pteridium aquilinum</i>	59	81
<i>Geocaryum capillifolium</i>	59	58
<i>Poa trivialis</i> subsp. <i>sylvicola</i>	53	81
<i>Cyclamen hederifolium</i>	53	77
<i>Trifolium pignatii</i>	53	77
<i>Anthoxanthum odoratum</i>	53	92
<i>Vicia cracca</i> agg.	53	81
<i>Crepis fraasii</i>	53	58
<i>Potentilla micrantha</i>	53	96
<i>Poa bulbosa</i>	47	58
<i>Bellis perennis</i>	41	35
<i>Leontodon cichoriaceus</i>	41	62
<i>Festuca heterophylla</i>	41	73
<i>Sorbus torminalis</i>	35	58
<i>Viola alba</i> s.l.	35	31

(continued)

Table VIII. (Continued).

Subtype No.	1	2
Number of relevés	17	26
Number of constant species ( $\geq 33\%$ )	37	52
<i>Galium aparine</i>	35	35
<i>Hedera helix</i> h	35	4
<i>Rosa arvensis</i>	35	27
<i>Cardamine graeca</i>	24	46
<i>Platanthera chlorantha</i>	29	42
<i>Origanum vulgare</i>	29	42
<i>Ranunculus neapolitanus</i>	29	38
<i>Cistus creticus</i>	18	38
<i>Geranium lucidum</i>	24	35

*vulgare*, *Cyclamen hederifolium*, *Dactylis glomerata* s.l., *Doronicum orientale*, ***Dorycnium graecum***, *Festuca heterophylla*, ***Galium laconicum***, *Hieracium bracteolatum*, *Lathyrus laxiflorus*, *Luzula forsteri*, *Melittis melissophyllum* subsp. *albida*, *Poa trivialis* subsp. *sylvicola*, *Potentilla micrantha*, *Pteridium aquilinum*, *Selinum silaifolium*, *Silene italica* s.str., *Trifolium ochroleucon*, *Trifolium pignanti*, ***Verbascum aphen-  
tulum***, *Veronica chamaedrys* s.l., *Vicia tenuifolia*.

Subtypes: Typically, the *Huetio cynapioidis-Quercetum frainetto* is represented in E Thessaly by mesic pasture woods with single-stemmed old-growth, characterized by species such as *Galium laconicum*, *Melittis melissophyllum*, *Hieracium bracteolatum* and *Verbascum aphen-  
tulum* (Table VIII: 2). Brushwood with stunted trees has been documented from Mavrovouni and Kato Olimbos and is distinguished by undergrowth of *Juniperus oxycedrus*, *Quercus coccifera*, *Q. pubescens* and other woody species that tolerate browsing (Table VIII: 1).

***Digitalis viridiflorae-Quercetum frainetto*** (Table I, column 11; Table IX)

Ecology and forest use: Slightly sloped to very steep terrain in quartzitic and micaschist areas; schistose soils are moderately acidic, loamy to sandy-loamy; 350–1040 m; locally prevalent are coppices with or without wood pasture.

Distribution records (Figure 4): E Macedonia: Cholomon (Chalkidiki), Kerdilio, Kilkis.

Diagnostic (bold) and constant species:

Trees and tall shrubs: *Quercus frainetto*, *Crataegus monogyna* s.l., ***Fagus sylvatica*** s.l.

Herbs and small shrubs: ***Aristolochia pallida***, ***Asperula purpurea*** subsp. *apiculata*, ***Cephalanthera longifolia***, ***Cruciata laevipes***, *Dactylis glomerata* s.l., ***Digitalis viridiflora***, ***Fragaria vesca***, ***Helleborus odoratus*** subsp. *cyclophyllus*, ***Hieracium bracteolatum***, *Luzula forsteri*, ***Muscari neglectum***, ***Platanthera chlorantha***, ***Primula veris*** subsp. *columnae*, ***Ranunculus rumelicus***, *Rubus canescens*, ***Sedum hispanicum***, *Symphytum*

Table IX. Synoptic table of the subtypes of the association *Digitalis viridiflorae-Quercetum frainetto*: 1, subtype with *Anthemis tinctoria*; 2, with *Helleborus odoratus* subsp. *cyclophyllus*. Constancy values are in percent. Constancy values for species diagnostic for a community type (i.e. occurring with more than double constancy and with >40% in a column) are highlighted. Species with less than 30% constancy in any column are omitted. Strata codes for woody species: t, tree; s, shrub; h, herb layer.

Subtype No.	1	2
Number of relevés	38	74
Number of constant species ( $\geq 33\%$ )	69	50
<i>Anthemis tinctoria</i> s.l.	92	28
<i>Poa bulbosa</i>	87	27
<i>Moenchia mantica</i>	87	7
<i>Phleum montanum</i> + <i>phleoides</i>	84	19
<i>Genista carinalis</i>	84	7
<i>Hieracium bauhini</i> , <i>cymosum</i> + <i>piloselloides</i>	74	14
<i>Vicia tetrasperma</i> agg.	68	24
<i>Trifolium ochroleucon</i>	63	20
<i>Asperula purpurea</i> ssp. <i>apiculata</i>	61	22
<i>Myosotis ramosissima</i>	61	11
<i>Sedum hispanicum</i>	61	16
<i>Potentilla micrantha</i>	61	27
<i>Vicia hirsuta</i> agg.	58	14
<i>Valerianella</i> div.spec.	55	14
<i>Cerastium brachypetalum</i>	55	3
<i>Cardamine hirsuta</i>	55	24
<i>Cruciata pedemontana</i>	50	5
<i>Rorippa thracica</i>	50	24
<i>Myosotis sylvatica</i> s.l.	50	22
<i>Erica arborea</i>	45	19
<i>Verbascum phoeniceum</i>	45	9
<i>Acinos graveolens</i>	42	3
<i>Vicia grandiflora</i>	42	19
<i>Hypericum montbretii</i> + <i>spruneri</i>	39	5
<i>Lathyrus sphaericus</i>	39	9
<i>Orlaya daucoides</i>	37	9
<i>Carlina vulgaris</i> + <i>frigida</i>	37	3
<i>Lathyrus nissolia</i>	37	4
<i>Centaurea triumfettii</i>	37	12
<i>Vicia sativa</i> s.l.	34	1
<i>Saxifraga bulbifera</i> + <i>graeca</i>	32	7
<i>Rumex acetosella</i>	32	1
<i>Helleborus odoratus</i> subsp. <i>cyclophyllus</i>	18	66
<i>Arenonia agrimonoides</i>	18	62
<i>Verbascum nigrum</i>	29	58
<i>Viola alba</i> s.l.	21	57
<i>Lathyrus laxiflorus</i>	16	57
<i>Pteridium aquilinum</i>	16	57
<i>Platanthera chlorantha</i>	21	53
<i>Silene vulgaris</i>	16	53
<i>Primula veris</i> subsp. <i>columnae</i>	24	49
<b><i>Digitalis viridiflora</i></b>	24	42
<i>Cruciata laevipes</i>	11	41
<i>Campanula trachelium</i>	5	36
<i>Geum urbanum</i>	5	34
<i>Fagus sylvatica</i> h	16	32
<i>Prunus cocomilia</i> , <i>divaricata</i> + <i>spinosa</i> h	13	32
<i>Poa angustifolia</i>	13	30
<i>Quercus frainetto</i> t	100	100
<i>Quercus frainetto</i> s	100	99
<i>Quercus frainetto</i> h	100	89
<i>Luzula forsteri</i>	100	76
<i>Silene italica</i> s.str.	97	61

(continued)

Table IX. (Continued).

Subtype No.	1	2
Number of relevés	38	74
Number of constant species (≥33 %)	69	50
<i>Veronica chamaedrys</i> s.l.	97	76
<i>Muscari neglectum</i>	97	66
<i>Anthoxanthum odoratum</i>	97	49
<i>Dactylis glomerata</i> s.l.	97	96
<i>Thymus longicaulis</i> + <i>sibthorpii</i>	95	32
<i>Festuca circummediterranea</i> + <i>valesiaca</i>	92	31
<i>Trifolium alpestre</i>	89	34
<i>Leontodon cichoriaceus</i>	89	61
<i>Galium mollugo</i> agg.	89	97
<i>Chamaecytisus hirsutus</i> + <i>polytrichus</i>	87	41
<i>Hieracium bracteolatum</i>	76	55
<i>Juniperus oxycedrus</i> s+h	76	46
<i>Cephalanthera longifolia</i>	71	73
<i>Aristolochia pallida</i>	66	69
<i>Geocaryum capillifolium</i>	66	42
<i>Fragaria vesca</i>	66	80
<i>Galium aparine</i>	63	51
<i>Crataegus monogyna</i> s.l. s+h	63	73
<i>Rubus canescens</i>	63	86
<i>Vicia cracca</i> agg.	58	64
<i>Poa nemoralis</i>	55	49
<i>Doronicum orientale</i>	53	54
<i>Silene coronaria</i>	50	46
<i>Campanula persicifolia</i>	50	35
<i>Rosa arvensis</i>	47	64
<i>Clinopodium vulgare</i>	47	55
<i>Poa trivialis</i> ssp. <i>sylvicola</i>	45	51
<i>Quercus coccifera</i> s+h	42	26
<i>Asplenium adiantum-nigrum</i> + <i>onopteris</i>	42	38
<i>Festuca heterophylla</i>	42	45
<i>Sorbus domestica</i> s+h	39	38
<i>Symphytum bulbosum</i>	39	72
<i>Brachypodium sylvaticum</i>	39	58
<i>Viola reichenbachiana</i>	39	68
<i>Trifolium pignanii</i>	37	41
<i>Ranunculus rumelicus</i>	34	19
<i>Trifolium medium</i> agg.	32	32
<i>Tamus communis</i>	24	38
<i>Cyclamen hederifolium</i>	26	38
<i>Teucrium chamaedrys</i>	29	30
<i>Cardamine graeca</i>	26	30
<i>Physospermum cornubiense</i>	16	31

*bulbosum*, *Verbascum nigrum* subsp. *abietinum*, *Veronica chamaedrys* s.l., *Vicia tenuifolia*, *Viola reichenbachiana*.

Subtypes: Mesic, rather dense woods with *Helleborus odoratus* subsp. *cyclophyllus*, *Aremonia agrimonoides*, *Verbascum nigrum*, *Viola alba*, *Lathyrus laxiflorus* and *Pteridium aquilinum* (Table IX: 2) may be distinguished from more open stands with considerable, if historical, grazing pressure (Table IX: 1). The latter are recognized by species such as *Anthemis tinctoria*, *Poa bulbosa*, *Genista carinalis*, *Thymus sibthorpii*, and many annuals.

***Geranio asphodeloidis-Quercetum frainetto*** (Table I, column 12; Table X column 1)

Table X. Synoptic table of the associations and subtypes of the Peloponnesian *Quercus frainetto* associations: 1, *Geranio asphodeloidis-Quercetum frainetto*; 2-4, *Oenanthe pimpinelloidis-Quercetum frainetto*, 2, subtype with *Arbutus unedo*, 3, without differential taxa; 4, with *Poa bulbosa*. Constancy values in percent. Constancy values for species diagnostic for a community type (i.e. occurring with more than double constancy and with >40% in a column) are highlighted. Species with less than 30% constancy in any column are omitted. Strata codes for woody species: t, tree; s, shrub; h, herb layer.

Community/Subtype No.	1	2	3	4
Number of relevés	14	22	37	5
Number of constant species (≥33 %)	49	37	29	35
<i>Festuca circummediterranea</i>	100	.	.	.
<i>Galium mollugo</i> agg.	100	.	.	.
<i>Juniperus oxycedrus</i> s+h	86	.	.	.
<i>Campanula spatulata</i> subsp. <i>spruneriana</i>	86	18	27	20
<i>Geranium asphodeloides</i>	86	.	3	.
<i>Castanea sativa</i> h	79	.	.	.
<i>Platanthera chlorantha</i>	79	.	.	.
<i>Orchis mascula</i> agg.	71	.	.	.
<i>Doronicum orientale</i>	71	9	.	.
<i>Trifolium pignanii</i>	71	.	.	.
<i>Arrhenatherum elatius</i>	71	.	.	.
<i>Chamaespartium sagittale</i>	64	.	.	.
<i>Dorycnium herbaceum</i>	50	.	.	.
<i>Abies cephalonica</i> h	50	.	.	.
<i>Viola alba</i> s.l.	50	27	19	.
<i>Cruciata laevipes</i>	43	.	.	.
<i>Orchis provincialis</i>	43	14	11	.
<i>Prunus avium</i> h	43	.	5	.
<i>Castanea sativa</i> t	43	.	.	.
<i>Rosa canina</i> s+h	36	.	.	.
<i>Lathyrus niger</i>	36	5	.	.
<i>Prunus cocomilia</i> , <i>divaricata</i> + <i>spinosa</i> h	36	5	3	.
<i>Fragaria vesca</i>	36	.	.	.
<i>Arbutus unedo</i> s+h	.	86	14	.
<i>Melittis melissophyllum</i> subsp. <i>albida</i>	.	68	24	.
<i>Asplenium onopteris</i>	29	55	.	.
<i>Brachypodium rupestre</i>	.	45	16	.
<i>Sorbus torminalis</i> s+h	.	41	8	20
<i>Asparagus acutifolius</i>	.	41	11	.
<i>Polypodium vulgare</i>	7	36	.	.
<i>Phillyrea latifolia</i> s+h	.	32	14	.
<i>Quercus ilex</i> h	.	32	5	.
<i>Poa bulbosa</i>	36	5	35	100
<i>Cerastium brachypetalum</i>	.	5	14	100
<i>Bellis perennis</i>	.	.	3	100
<i>Aira elegantissima</i>	7	.	11	100
<i>Galium divaricatum</i>	.	.	3	80
<i>Trifolium campestre</i>	7	.	27	80
<i>Psilurus incurvus</i>	.	.	5	80
<i>Veronica arvensis</i>	.	.	.	60
<i>Sherardia arvensis</i>	.	.	8	60
<i>Petrorhagia dubia</i>	.	.	3	60
<i>Vulpia myuros</i>	.	.	3	60
<i>Anthemis arvensis</i>	.	.	3	40
<i>Crepis commutata</i>	.	.	.	40
<i>Trifolium spec.</i>	.	.	5	40
<i>Trifolium arvense</i>	.	.	.	40
<i>Cerastium glomeratum</i>	.	.	3	40
<i>Cyclamen hederifolium</i> + <i>peloponnesiacum</i>	100	77	27	.
<i>Erica arborea</i> s+h	93	100	30	.
<i>Cephalanthera longifolia</i>	64	45	8	.

(continued)

Table X. (Continued).

Community/Subtype No.	1	2	3	4
Number of relevés	14	22	37	5
Number of constant species ( $\geq 33\%$ )	49	37	29	35
<i>Lathyrus digitatus</i>	57	32	11	20
<i>Quercus coccifera</i> s+h	43	36	5	.
<i>Digitalis ferruginea</i>	36	36	19	.
<i>Crepis fraasii</i>	36	36	3	.
<i>Hedera helix</i> h	36	32	8	.
<i>Achnatherum bromoides</i>	.	86	57	20
<i>Phlomis samia</i>	21	82	73	20
<i>Symphytum bulbosum</i>	14	77	59	.
<i>Trifolium ochroleucon</i>	21	41	62	.
<i>Asphodelus ramosus</i>	.	23	65	40
<i>Cynosurus echinatus</i>	.	14	46	100
<i>Arenonia agrimonoides</i>	93	68	62	20
<i>Lathyrus laxiflorus</i>	64	86	89	20
<i>Rubus sanctus</i>	50	91	73	20
<i>Thymus longicaulis</i>	.	77	51	40
<i>Loranthus europaeus</i>	.	64	81	100
<i>Trifolium physodes</i>	14	59	92	80
<i>Oenanthe pimpinelloides</i>	.	50	81	100
<i>Quercus frainetto</i> t	100	100	100	100
<i>Quercus frainetto</i> s	100	41	70	.
<i>Quercus frainetto</i> h	86	91	100	100
<i>Potentilla micrantha</i>	100	100	84	60
<i>Dactylis glomerata</i> s.l.	100	77	97	80
<i>Brachypodium sylvaticum</i>	100	86	95	40
<i>Luzula forsteri</i>	100	95	84	80
<i>Pteridium aquilinum</i>	93	86	89	100
<i>Veronica chamaedrys</i> s.l.	86	77	89	100
<i>Clinopodium vulgare</i>	79	55	35	40
<i>Carex distachya</i>	64	50	84	100
<i>Silene italica</i> subsp. <i>peloponnesiaca</i>	64	68	73	80
<i>Anemone blanda</i>	43	32	68	40
<i>Poa trivialis</i> subsp. <i>syvicola</i>	43	41	89	100
<i>Leontodon cichoriaceus</i>	36	64	95	100
<i>Crataegus monogyna</i> s.l. s+h	36	64	54	20
<i>Elymus panormitanus</i>	21	23	38	.

Ecology and forest use: Loamy, base-poor micaceous soils, rarely calcareous, in slightly to moderately sloped terrain, preferably on lower slopes, 960–1300 m; previously coppiced stands, now commonly developed to single-stemmed trees with thin trunks and coppice-stools.

Distribution records (Figure 4): SE Peloponnissos: N Parnon.

Diagnostic (bold) and constant species:

Trees and tall shrubs: *Quercus frainetto*, *Castanea sativa*, *Erica arborea*, *Juniperus oxycedrus*, ***Pinus nigra***.

Herbs and small shrubs: *Arenonia agrimonoides*, ***Arrhenatherum elatius***, *Brachypodium sylvaticum*, *Campanula spatulata* subsp. *spruneriana*, ***Chamaespantium sagittale***, *Clinopodium vulgare*, *Cyclamen peloponnesiacum*, *Dactylis glomerata* s.l., *Doronicum orientale*, ***Euphorbia rigida***, *Festuca circummediterranea*, ***Genista acanthoclada***, ***Geranium asphodeloides***, *Luzula forsteri*, ***Orchis mascula***, *Platanthera chlorantha*, *Potentilla micrantha*, *Pteridium*

*aquilinum*, ***Rubia tenuifolia***, *Trifolium pignanti*, *Veronica chamaedrys* s.l.

Subtypes: Further subdivision of the scarce and geographically restricted data does not seem reasonable.

#### ***Oenanthe pimpinelloides*–*Quercetum frainetto*** (Table I, column 13; Table X)

Ecology and forest use: Moderately deep to deep brown soils and ranker, loamy–sandy, derived from conglomerate, moderately sloped or flat tracts and dry ravines and streambeds; 320–870 m; more or less spacious pasture wood with old-growth trees.

Distribution records (Figure 4): W Peloponnissos: Foloï (Ilía).

Diagnostic (bold) and constant species:

Trees and tall shrubs: *Quercus frainetto*, ***Erica arborea***, ***Arbutus unedo***.

Herbs and small shrubs: ***Anemone blanda***, ***Asphodelus ramosus***, *Brachypodium sylvaticum*, ***Carex distachya***, *Dactylis glomerata* s.l., ***Digitalis ferruginea***, ***Elymus panormitanus***, *Lathyrus laxiflorus*, *Leontodon cichoriaceus*, ***Loranthus europaeus***, *Luzula forsteri*, ***Oenanthe pimpinelloides***, ***Phlomis samia***, *Poa trivialis* subsp. *syvicola*, *Potentilla micrantha*, *Pteridium aquilinum*, *Silene italica* subsp. *peloponnesiaca*, ***Achnatherum bromoides***, ***Trifolium physodes***, *Veronica chamaedrys* s.l.

Subtypes: Mesic woods in depressions and on northern slopes of ravines, often with thick leaf litter layer, without much grazing impact, are distinguished by *Arbutus unedo*, *Melittis melissophyllum*, *Asplenium onopteris*, *Brachypodium rupestre* and *Sorbus torminalis* (Table X: 2). Stands in flat or slightly inclined terrain are similar but the mentioned species are missing (Table X: 3). More open stands along forest tracks or with severe grazing impact have impoverished soils with patchy leaf litter layer. They are distinguished by numerous annuals such as *Cerastium brachypetalum*, *Aira elegantissima*, *Galium divaricatum*, *Trifolium campestre*, *Psilurus incurvus*, *Veronica arvensis*, *Sherardia arvensis*, and others (Table X: 4). Somewhat similar (with *Oenanthe pimpinelloides*) is the *Geranio peloponnesiaci*–*Quercetum frainetto* described by Barbero and Quézel (1976) which occurs on flysch and schist in N Peloponnissos (Achaia, SE Korinthos). Our association from Ilía differs in the absence of undergrowth species such as *Carpinus orientalis*, *Fraxinus ornus*, *Ostrya carpinifolia*, and *Hippocrepis emerus*. As no recent data from N Peloponnissos are available and due to obvious taxonomic errors in the original table, we prefer to exclude the *Geranio peloponnesiaci*–*Quercetum* from the present account. However, this association may well be the third *Quercus frainetto* community in S Greece.

## Discussion

### *Differentiation of the Quercion frainetto associations*

The six vicarious associations of *Quercus frainetto* forests in Greece occur almost exclusively on siliceous soils on flysch, gneiss, micaschist, conglomerate or granite. The range of elevation is between 150 and 1300 m, with the lowest sites in the north-east (*Symphyto ottomani-Quercetum*) and the highest in the south (*Geranio asphodeloidis-Quercetum*), corresponding to the north-south temperature gradient. Konstantinidis et al. (2002) found a range of precipitation between 615 and 1200 mm and sub-humid overall bioclimatic conditions in *Quercion frainetto* locations throughout mainland Greece. The principal differences in species composition among the six associations correspond to a regional pattern (Figure 4). Other floristic gradients observed are related to local topography, elevation, soil moisture, human impact and use history. Such variation is recognized here on subtype level. Konstantinidis et al. (2002) ignored the samples of *Quercus frainetto* forests published in previous studies and distinguished only two vicarious associations in Greece, based on merely 39 relevés, from 7 sites, plus 5 relevés of a *Quercus petraea* subsp. *medwediewii* (*Q. dalechampii*) community. Our analysis of *Quercus frainetto* forest vegetation is based on 406 relevés from numerous sites. Although we consider the present classification on a national scale a substantial progress compared to previous attempts (Dafis 1973; Horvat et al. 1974; Konstantinidis et al. 2002), the known variation is still fragmentary. No samples are available for extensive regions, and the assumed transient areas between associations are tentative. The geographical gaps are recommended for further study.

The principal variation in species composition of *Castanea sativa* forests in Greece suggests a geographical differentiation reflecting climatic gradients and, perhaps, isolation effects, rather than differences in local abiotic factors. The soils are more or less acidic and indiscriminately developed from siliceous bedrock. The water supply is generally better than in *Quercus frainetto* forests. Our classification in two associations on the Greek mainland is certainly provisional as not all core areas of *Castanea* distribution that should be considered are represented. There is a lack of thoroughly investigated local studies. *Castanea* forests in Greece were recently studied by Konstantinidis et al. (2008). According to these authors, local silvicultural effects are said to be most important in explaining the floristic composition. Somewhat self-contradictory, they distinguish three vicarious communities or community groups in northern, central and southern mainland Greece, respectively. The association names put forward by Konstantinidis et al. (2008)

are invalid for nomenclatural reasons (Weber et al. 2000).

### *Circumscription of the alliances in Greece*

The alliances *Fraxino orni-Ostryion* (in the geobotanical literature of the Balkans commonly referred to as *Ostryo-Carpinion orientalis* or *Carpinion orientalis* but see annotation 1 below) and *Quercion frainetto* have often been interpreted as representative for “submediterranean” and “continental” bioclimatic conditions, respectively (Oberdorfer 1948; Horvat et al. 1974). However, the present analysis confirms that the two alliances have many species in common and co-occur in most of the submediterranean domain in mainland Greece. Zoller et al. (1977) and Bergmeier (1990) noticed that soil and topography, hence bedrock and local climate, are crucial factors determining local variation in thermophilous deciduous forest vegetation. Our study demonstrates (Figure 1) that soil and topographic conditions are indeed more important than a macro-climatic gradient for explaining the variation in the data set. Plant communities of the *Fraxino orni-Ostryion* occur chiefly on calcareous stony soils, whilst *Quercion frainetto* woods grow almost invariably on siliceous soils. Degraded stunted woods of the latter may be rich in *Carpinus orientalis* and resemble *Fraxino orni-Ostryion* woodlands. As *Fraxino orni-Ostryion* and *Quercion frainetto* differ chiefly in habitat ecology (soil, local climate) they are not suitable to define plant geographical zones in the southern Balkans.

Differential species of the *Fraxino orni-Ostryion* in Greece are *Quercus pubescens*, *Acer monspessulanum*, *Ostrya carpinifolia*, *Lithospermum purpureocaeruleum*, *Hippocrepis emerus* subsp. *emeroides*, *Arabis turrata*, *Euonymus verrucosus*, *Daphne laureola* and *Lathyrus venetus*, and also, to a limited extent, *Carpinus orientalis* and *Fraxinus ornus*. The *Quercion frainetto* is recognized by *Quercus frainetto*, *Q. petraea* subsp. *medwediewii*, *Geocaryum capillifolium*, *Symphytum bulbosum*, *Trifolium pignanti*, *Doronicum orientale*, *Phlomis samia*, as well as many species restricted to one or few communities such as *Helleborus odoratus* subsp. *cyclophyllus*, *Elymus panormitanus*, *Rosa gallica*, *Verbascum glabratum*, and *Ptilostemon strictus*.

### *Greek thermophilous deciduous forest from a broader perspective*

Many widespread species of the southern European submediterranean zone (and supra-Mediterranean belt) underpin the close geographical relation of the Greek thermophilous deciduous forests with their counterparts from Spain to Italy. Among those species are common, e.g. *Luzula forsteri*, *Potentilla micrantha*, *Rubus canescens*, *Viola alba*, *Silene italica*,

*Rosa arvensis*, *Festuca heterophylla*, *Trifolium ochroleucon*, *Juniperus oxycedrus*, *Sorbus torminalis*, and *Primula acaulis*. Therefore, in the phytosociological analysis, most thermophilous deciduous forests of the southern Balkans belong to the order *Quercetalia pubescentis* (except for the Cretan stands which are devoid of most submediterranean and Balkanic species).

The *Quercion frainetto* is the most common and widespread alliance of the *Quercetalia pubescentis* in Greece. In total, it extends from the central and southern Balkans to western Anatolia. In Italy, its counterpart is the *Teucro siculi-Quercion cerridis* Ubaldi 1988 which, like the *Quercion frainetto* associations, occurs chiefly on non-calcareous soils (Biondi et al. 2001; Blasi et al. 2002, 2004). The *Teucro siculi-Quercion*, however, comprises mainly *Quercus cerris* woodlands, while *Q. frainetto* is rarely the dominant tree. In the *Quercion frainetto*, it is vice versa.

In contrast to the northern Balkans, the northern Mediterranean and northern Anatolia, *Castanea* forests of the Greek mainland are commonly included in the *Quercion frainetto*. *Castanea* and *Quercus frainetto* forests share species such as *Doronicum orientale*, *Trifolium pignantii*, *Symphytum bulbosum* and *Campanula spatulata* subsp. *spruneriana* which are infrequent or absent from most *Castanea* forests further north. As elsewhere, the distribution of *Castanea sativa* was much extended by early plantations and subsequent naturalization. The Cretan occurrences in the *Lathyro laxiflorae-Castanetum*, for instance, are almost certainly not native.

The alliance *Fraxino orni-Ostryion* is widespread from peninsular Italy and Sicily through the Balkans, reaching northward Austria and the southern Alps (Poldini 1988; Blasi et al. 2001, 2004; Willner & Grabherr 2007). In Italy, it is represented by four suballiances (Blasi et al. 2004), of which two show striking coenological and floristic similarities with the two associations distinguished in Greece. The more thermophilous and xerophytic *Phillyreo latifoliae-Carpinetum orientalis* corresponds to the *Lauro-Quercenion pubescentis* Ubaldi 1995 of southern and central Italy. The more mesophytic *Dryopterido pallidae-Ostryetum carpinifoliae* is related to the *Laburno anagyroidis-Ostryenion carpinifoliae* occurring along the Apennine chain. In the Map of the Natural Vegetation of Europe (Bohn et al. 2000/2003) the Balkanic and Apennine *Ostrya*-rich forest units form a subgroup of the submediterranean and supra-Mediterranean thermophilous mixed forests (Doniřa et al. 2003). Clearly, the ecological similarities on both sides of the Adriatic Sea are accompanied by dissimilarities due to distribution preferences of “Balkan” and “Italic” species, respectively. In his survey of the *Fraxino orni-Ostryion* (“*Ostryo-Carpinion*”) in south-east Europe and the Apennine

peninsula, Poldini (1988) distinguished three vicarious suballiances, with the *Syringo-Carpinion* Jakucs 1959 in the east Balkanic-Aegean sector. However, almost all relevés available to him at that time represent secondary deciduous and semi-evergreen scrub, so-called *šiblyak* and *pseudomaquis*. Such data were of little value to define the west-east floristic gradient within the *Fraxino orni-Ostryion* (Bergmeier 1990). Nevertheless, the concept of three vicarious suballiances may be maintained, with many chiefly Balkanic taxa such as *Lathyrus laxiflorus*, *Leontodon cichoriaceus*, *Campanula spatulata* subsp. *spruneriana*, *Cardamine graeca* differentiating the eastern unit, *Syringo-Carpinion*. Within this, however, and in parallel with the Italian concept (Blasi et al. 2004), the ecological gradient of water supply deserves more attention in future studies.

#### Synopsis of syntaxa

1. *Quercetalia pubescentis* Doing-Kraft ex Scamoni & Passarge 1959
  - 1.1. *Quercetalia pubescentis* Klika 1933
    - 1.1.1. *Fraxino orni-Ostryion* Tomažič 1940 (see annotation 1 below)
 

syn.: *Carpinion orientalis* Ht. ex Horvat 1958, *Ostryo-Carpinion orientalis* Horvat 1959

Lectotypus (Willner et al. 2005): *Quercus lanuginosae-Ostryetum carpinifoliae* Horvat 1938

      - 1.1.1.1. *Phillyreo latifoliae-Carpinetum orientalis* Bergmeier ass. nov.
 

Holotypus hoc loco (see annotation 2)
      - 1.1.1.2. *Dryopterido pallidae-Ostryetum carpinifoliae* Bergmeier 1990
 

Holotypus: Bergmeier 1990, *Phytocoenologia* 18: 262, tab. 14, rel. 8 (“Niederer Olymp[. . .]Siliána-Kerbtal”)
      - 1.1.2. *Quercion frainetto* nom. mut. propos. = *Quercion confertae* Ht. ex Horvat 1958 (see annotation 3)
 

[Incl. *Melitto-Quercion* Barbero et al. in Barbero & Quézel 1976 (see annotation 4)]
      - 1.1.2.1. *Genisto carinalis-Quercetum petraeae* Bergmeier ass. nov.
 

Holotypus: Zoller et al. 1977, *Bauhinia* 6(1), tab. 10, rel. 2

syn.: *Quercus dalechampii*-Gesellschaft (Raus 1980; Bergmeier 1990; Theodoropoulos et al. 1995; Petermann 1999; Konstantinidis et al. 2002); *Quercetum montanum* (Dafis 1973; Theodoropoulos 1991) nom. illeg. (art. 34)
      - 1.1.2.2. *Quercus frainetto-Castanetum sativae* Zoller et al. 1977

- Lectotypus (designated here): Zoller et al. 1977, *Bauhinia* 6(1), tab. 9, rel. 3 (“oberhalb Karyé (Athos)”)
- 1.1.2.3. *Cytiso villosi–Castanetum sativae* Barbero & Quézel 1976 em. (see annotation 5)  
Lectotypus (designated here): Barbero & Quézel 1976, *Ecol. Medit.* 2: 27, table 9, rel. 10 (“Aghios-Petros” [Mt. Parnon])
- 1.1.2.4. *Symphyto ottomani–Quercetum frainetto* Gamisans & Hebrard 1980  
Holotypus: Gamisans & Hebrard 1980, *Doc. Phytosoc.* 5: table 7, rel. 13 (“entre Stavroupolis et Xanthi à 20.2 km de Xanthi” [Thrace])
- 1.1.2.5. *Verbascio glabrati–Quercetum frainetto* Gamisans & Hebrard 1979  
Holotypus: Gamisans & Hebrard 1979, *Doc. Phytosoc.* 4: table 7, rel. 5 (“12 km après Kastoria vers Florina”)  
syn.: *Quercetum confertae–cerris macedonicum* Oberdorfer ex Barbero & Quézel 1976 p. p. nom. illegit. (art. 34)
- 1.1.2.6. *Huetio cynapioidis–Quercetum frainetto* Raus ex Raus ass. nov.  
Holotypus: Raus 1980, *Bot. Jahrb. Syst.* 101, table 3, rel. 1 (“nordöstl. Élafos/Mavrovouni”) (see annotation 6)  
syn.: *Quercetum confertae–cerris macedonicum* Oberdorfer ex Barbero & Quézel 1976 p. p. nom. illegit. (art. 34)
- 1.1.2.7. *Digitali viridiflorae–Quercetum frainetto* Gamisans & Hebrard 1980  
Holotypus: Gamisans & Hebrard 1980, *Doc. Phytosoc.* 5: table 8, rel. 7 (“route forestière, à 9.3 km de Kastanochorion” [Kerdilio])  
syn.: “*Huetio–Quercetum frainetto*” sensu Theodoropoulos (1991)
- 1.1.2.8. *Geranio asphodeloidis–Quercetum frainetto* Bergmeier ass. nov.  
Holotypus hoc loco (see annotation 7)  
syn.: *Cytiso villosi–Castanetum* Barbero & Quézel 1976 p.p.
- 1.1.2.9. *Oenantho pimpinelloidis–Quercetum frainetto* Bergmeier & Dimopoulos ass. nov.  
Holotypus hoc loco (see annotation 8)
2. *Carpino–Fagetea* Jakucs 1967
- 2.1. *Fagetalia sylvaticae* Pawłowski in Pawłowski et al. 1928
- 2.1.1. *Tilio platyphylli–Acerion pseudoplatani* Klika 1955
- 2.1.1.1. *Tilio tomentosae–Castanetum* Dafis 1973  
Lectotypus (Bergmeier 1990: 271): Dafis 1966, att. table, rel. 106 ([Forestry Department of] “Arnaia” [NE Chalkidiki]) (see annotation 9)

3. *Quercetea ilicis* Br.-Bl. ex A. Bolòs 1950, *Veg. Comarc. Barcel.*: 146
- 3.1. *Quercetalia ilicis* Br.-Bl. ex Molinier 1934, *Annal. Mus. Hist. Nat. Marseille* 27: 189
- 3.1.1. *Erico–Quercion ilicis* Brullo, Di Martino & Marcenò 1977, *Veg. Pantelleria*: 45
- 3.1.1.1. *Lathyro laxiflori–Castanetum sativae* Brullo et al. 2004 nom.corr. hoc loco (see annotation 10)  
Lectotypus (Brullo et al. 2004, *Coll. Phytosoc.* 28: 404): Barbero & Quézel 1980, *Ecol. Medit.* 5: table 6, rel. 17, (“1 km après Agia Irini”)  
syn.: *Lathyro stenolobi–Castanetum sativae* Brullo et al. 2004, *Coll. Phytosoc.* 28: 404 (art. 43); *Oenantho pimpinelloidis–Quercetum brachyphyllae castanetosum sativae* Barbero & Quézel 1980, *Ecol. Medit.* 5: 197 (art. 5)

#### Nomenclatural annotations

##### Annotation 1:

The name *Fraxino orni–Ostryion* Tomažič 1940 antedates the hitherto commonly used names *Carpinion orientalis* Horvat 1958 and *Ostryo–Carpinion orientalis* Ht. ex Horvat 1959. The latter two fall into synonymy after the lectotypification of Tomažič’ name by Willner et al. (2005) (see also Willner & Grabherr 2007).

##### Annotation 2:

Typus relevé (holotype) of the *Phillyreo latifoliae–Carpinetum orientalis* Bergmeier ass. nov.

Relevé code: Bergmeier 2001–154 (10889); 21 June 2001; N Greece, Paiko, above (= NE) Konstantia (E Aridea); lat–long co-ordinates 41°00’32”N 22°11’17”E, 430 m asl, exposition NW, slope 15°, dense coppiced forest, oak trunks 18 cm diameter, *F. ornus/Carpinus orientalis* 10 cm diam., multi-stemmed, not grazed; cover tree layer 90%, shrub layer 30%, herb layer 10%, no bryophyte layer, height trees 6–10 m, height shrubs 2.5 m; plot size 100 m<sup>2</sup>.

*Carpinus orientalis* t2 4, *Carpinus orientalis* s1 2a, *Carpinus orientalis* h +, *Fraxinus ornus* t2 3, *Fraxinus ornus* s1 1, *Fraxinus ornus* h +, *Juniperus oxycedrus* s1 +, *Juniperus oxycedrus* h 2m, *Phillyrea latifolia* s1 1, *Phillyrea latifolia* s2 1, *Phillyrea latifolia* h 2m, *Quercus frainetto* t1 2a, *Quercus frainetto* h +, *Quercus coccifera* t3 +, *Quercus coccifera* s1 1, *Quercus coccifera* h 1, *Quercus pubescens* h +, *Asplenium onopteris* 1, *Cardamine graeca* 1, *Carex distachya* 1, *Ligustrum vulgare* 1, *Luzula forsteri* 1, *Melica uniflora* 1, *Viola alba* 1, *Aremonia agrimonoides* +, *Asplenium ceterach* +, *Brachypodium rupestre* +, *Brachypodium sylvaticum* +, *Clematis flammula* +, *Cornus mas* +, *Hippocrepis emerus* subsp.

*emeroides* +, *Lathyrus laxiflorus* +, *Limodorum abortivum* +, *Lithospermum purpureocaeruleum* +, *Poa nemoralis* +, *Potentilla micrantha* +, *Rosa arvensis* +, *Ruscus aculeatus* +, *Sorbus torminalis* h +, *Trifolium medium* +, *Veronica chamaedrys* +, *Tanacetum corymbosum* r.

#### Annotation 3:

The name *Quercus conferta* Kit. is used in the taxonomic literature of the last decades only as synonym of *Quercus frainetto* Ten. The name of the alliance *Quercion confertae* which was validated by Horvat (1958) is updated here to *Quercion frainetto* (following art. 45 ICPN, nomen mutatum propositum), a name which has much been in use in geobotanical literature since Horvat et al. (1974: 235).

#### Annotation 4:

The alliance *Melitto-Quercion* was suggested by Barbero and Quézel (1976) and Bonin and Gamisans (1976) to comprise the southernmost *Quercus frainetto* forests of southern Greece (Peloponnisos) and southern Italy. The difference in species composition with “mediterranean” species in the *Melitto-Quercion* and “continental-balkanic” species in the *Quercion frainetto* was stressed. However, floristic differences between *Melitto-Quercion* and *Quercion frainetto* are hardly more pronounced than between associations in each alliance. In fact, the two syntaxa are clear biogeographical vicariants, and the former may be maintained as suballiance within a widely circumscribed *Quercion frainetto*.

#### Annotation 5:

The *Cytiso villosi-Castanetum* as circumscribed by Barbero and Quézel (1976, table 9, rels 1–16) includes relevés of woodlands dominated by *Castanea sativa*, *Quercus frainetto*, or *Ostrya carpinifolia*. The association is emended here to be restricted to *Castanea* groves of southern mainland Greece with Peloponnisos.

#### Annotation 6:

The name of the *Huetio-Quercetum frainetto* was coined by Raus (1977) as nomen nudum (art. 2 ICPN, Weber et al. 2000) and published in Raus (1980) together with a relevé table but without indication of a nomenclatural type (articles 3o and 5 ICPN). The name is validated by Thomas Raus with the missing element (holotype) selected and published here (see synopsis).

#### Annotation 7:

Typus relevé (holotype) of the *Geranio asphodeloidis-Quercetum frainetto* Bergmeier ass. nov.

Relevé code Bergmeier 1996–170 (25323); 21 May 1996; Greece, Peloponnese, Mt. Parnon, Aj. Petros in the direction of Kariés, S of the road;

lat–long co-ord. 37°18'45"N 22°31'51"E; 1200 m asl, aspect W, slope 25°, schist; old oak coppice with a few single-stemmed oaks; cover tree layer 55%, shrub layer 5%, herb layer 15%, no bryophyte layer, height highest trees 14 m, highest shrubs 2 m; plot size 250 m<sup>2</sup>.

*Quercus frainetto* t 4, *Quercus frainetto* s +, *Pteridium aquilinum* 2a, *Luzula forsteri* 2a, *Geranium asphodeloides* 1, *Galium violaceum* 1, *Erica arborea* s 1, *Dorycnium herbaceum* 1, *Doronicum orientale* 1, *Dactylis glomerata* subsp. *hispanica* 1, *Cyclamen peloponnesiacum* 1, *Brachypodium sylvaticum* 1, *Veronica chamaedrys* subsp. *chamaedryoides* 1, *Potentilla micrantha* 1, *Lathyrus laxiflorus* +, *Lathyrus digitatus* +, *Festuca jeanpertii* +, *Cruciata laevipes* +, *Clinopodium vulgare* +, *Chamaespartium sagittale* +, *Chamaecytisus hirsutus* +, *Aremonia agrimonoides* +, *Trifolium pignanti* +, *Trifolium alpestre* +, *Silene italica* subsp. *peloponnesiaca* +, *Sanguisorba minor* +, *Rubus canescens* +, *Poa nemoralis* +, *Orchis mascula* +, *Juniperus oxycedrus* s r, *Dactylorhiza romana* r, *Carex distachya* r, *Trifolium ochroleucon* r, *Platanthera chlorantha* r, *Pinus nigra* t r.

#### Annotation 8:

Typus relevé (holotype) of the *Oenanthe pimpinelloidis-Quercetum frainetto* Bergmeier & Dimopoulos ass. nov.

Relevé code: Bergmeier & Dimopoulos 1998–141; Greece, Peloponnisos, Province Ilía, Forest of Foloí, S of Koumanis, lat–long co-ordinates 37°46'06"N 21°45'19"E; 10 June 1998; 720 m a.s.l., aspect W, slope 5°; old-growth oak forest, cover tree layer 75%, shrub layer 10%, herb layer 50%, mosses around trunk bases, almost closed leaf litter layer, height trees to 22 m, shrubs to 3 m; plot size 400 m<sup>2</sup>.

*Quercus frainetto* t 4, *Quercus frainetto* s 2a, *Quercus frainetto* h 2b, *Pteridium aquilinum* 3, *Anemone blanda* 1, *Aremonia agrimonoides* 1, *Asphodelus ramosus* 1, *Brachypodium sylvaticum* 1, *Dactylis glomerata* 1, *Elymus panormitanus* 1, *Loranthus europaeus* 1, *Phlomis samia* 1, *Poa trivialis* subsp. *sylvicola* 1, *Carex distachya* +, *Cyclamen hederifolium* +, *Cynosurus echinatus* +, *Lathyrus laxiflorus* +, *Leontodon cichoriaceus* +, *Melittis melissophyllum* subsp. *albida* +, *Oenanthe pimpinelloides* +, *Poa bulbosa* +, *Potentilla micrantha* +, *Rubus canescens* +, *Symphytum bulbosum* +, *Trifolium campestre* +, *Trifolium ochroleucon* +, *Trifolium physodes* +, *Veronica chamaedrys* +, *Limodorum abortivum* r, *Silene italica* subsp. *peloponnesiaca* r.

#### Annotation 9:

The *Tilio-Castanetum* has been assigned to the alliance *Quercion frainetto* by Dafis (1973) and Petermann (1999), and to the *Tilio-Acerion* Klika 1955 by Bergmeier (1990). In view of the full floristic range, as far as currently known this association shows similarities with *Fraxino orní-Ostryion*,

*Quercion frainetto*, and *Tilio–Acerion*. We are aware that mesic mixed forests with *Tilia* in Greece show more affinities to *Quercetalia pubescentis* than to *Fagetalia*. Pending a survey of such forests of the southern Balkans, we prefer to stress the specific floristic status of the *Tilio–Castanetum* in keeping it separate from the *Fraxino ornī–Ostryion* as well as from the *Quercion frainetto*, whilst we refrain, for the time being, from formally describing a third alliance before knowing its full coenological range.

#### Annotation 10:

The name *Lathyro stenolobi–Castanetum sativae* coined by Brullo et al. (2004: 404) for Cretan *Castanea* groves is based on a table published by Barbero and Quézel (1980) under the name *Oenanthro pimpinelloidis–Quercetum brachyphyllae castanetosum sativae*. The latter name was invalidly published as no nomenclatural type was designated. *Lathyrus stenolobus* is present in the original table although it is a southern Anatolian taxon which does not occur in Crete. It is not quite clear which taxon had been mistaken as *L. stenolobus*. The only other *Lathyrus* species which occurs, though rarely, in Cretan *Castanea* groves (and is even exclusive to this kind of forest in Crete) is *L. laxiflorus*, a taxon which is morphologically entirely different. The wetland endemic *Lathyrus neurolobus* that bears a somewhat similar name occurs at springs which are sometimes associated with *Castanea* groves but is not a constituent of the forest vegetation (Bergmeier & Abrahamczyk 2007). As no younger valid name is available, the name *Lathyro stenolobi–Castanetum sativae* is corrected here to *Lathyro laxiflori–Castanetum sativae*, following ICPN article 43.

#### Conservation issues

Thermophilous deciduous oak and mixed oak woodlands are represented in 54 out of 359 Greek Natura 2000 sites (Bergmeier et al. 2004; Petermann 2005). A total of about 80,000 ha is situated in the Natura 2000 network, but in the process of designation little attention has been paid to thermophilous deciduous woodland, which is present in only five sites with proportions exceeding 25% of the surface area. The Annex of the Habitats Directive lists only three types of thermophilous deciduous forest to which Greek stands belong: 9250, *Quercus trojana* woodlands; 9260, *Castanea sativa* woods; 9280, *Quercus frainetto* woods. Other types have been neglected during the compilation process.

Forestry is generally not restricted in Greek Natura 2000 sites although forestry and conservation aims may not be congruent. Principal conservation efforts should focus on old-growth non-coppiced woodland with thick single-stemmed trees. Such

stands have been recorded in Ilía (Dimopoulos & Bergmeier 2004), southern Pindos (Valaoritis, Tsoumerka), W Macedonia (Chasia), E Thessaly, and E Macedonia (Athos peninsula), and they represent the associations *Oenanthro pimpinelloidis–Quercetum frainetto*, *Verbascum glabrati–Quercetum frainetto*, *Huetio cynapioidis–Quercetum frainetto*, *Quercus frainetto–Castanetum*, *Tilio tomentosae–Castanetum* and *Dryopterido pallidae–Ostryetum*. We are not aware of old-growth stands of any of the other associations. Effective conservation management should pay special attention to a balanced grazing regime in order to allow rejuvenation.

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