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Analysis of the upper montane and the subalpine grassland flora of East Macedonia, Greece

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RÉSUMÉ

KARAGIANNAKIDOU, V., M. KONSTANTINOU & K. PAPADEMETRIOU (1999). Analyse de la flore supramontagneuse et subalpine des pelouses de la Macédoine orientale, Grèce. *Candollea* 54: 453-472. En anglais, résumés français et anglais.

La richesse des espèce et des genres, l'endémisme, les formes biologiques et la distribution de la flore de l'étage montagnard supérieur et subalpin des pelouses des montagnes de Pangeon, Menikio, Falakro et Orvilos (Macédoine orientale) est analysée. La dominance d'éléments balcaniques, la présence remarquable d'éléments méditerranéens ainsi que d'autres éléments chorologiques caractérisés par un ample spectre de distribution (Eurasiatique, C.S.E. Europeo-Anatolo-Caucasien) déterminent le caractère subméditerranéen de cette flore. Parmi les formes biologiques, les hémicryptophytes présentent la plus grande abondance, suivis par les chaméphytes, typiques de zones tempérées. L'analyse des taxa endémiques communs (grecques et balcaniques) démontre que les relations floristiques de ces montagnes avec le nord-est et le centre nord de la Grèce sont plus marquées qu'avec celles des autres régions du pays, allant en diminuant à mesure que l'on se dirige vers le sud. Afin de permettre des comparaisons deux à deux entre les quatre montagnes concernées par cette étude, des indices de similarité ont été calculés.

ABSTRACT

KARAGIANNAKIDOU, V., M. KONSTANTINOU & K. PAPADEMETRIOU (1999) Analysis of the upper montane and the subalpine grassland flora of East Madedonia, Greece. *Candollea* 54: 453-472. In English, French and English abstracts.

The generic and specific richness, endemism, life-forms and distribution patterns of the upper montane and subalpine grassland flora of the mountains Pangeon, Menikion, Falakron and Orvilos (East Macedonia) are analysed. The dominance of Balkan element, the remarkable presence of the Mediterranean one as well as, of other chorological elements with a wider distribution (Eurasiatic, C.S.E. Europeo-Anatolo-Caucasian) give a submediterranean character to the flora. Hemicryptophytes are the most abundant followed by Chamaephytes, typical of the flora of mild temperate zone. On the basis of shared endemic taxa (Greek, Balkan), the floristic connections of the mountains with NE and NC Greece are stronger than those with the other geographical regions of Greece, decreasing as one moves southwards. Similarity indices were also calculated for pairwise comparisons between the four mountains.

KEY-WORDS: Analysis – Grassland flora – E. Macedonia – Greece.

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Introduction

Greece is a very mountainous country with many mountain peaks exceeding 2000 m in altitude. The floristic richness, and especially, the abundance of local and regional endemics of the mountains have attracted many botanists, which has resulted in increasing knowledge of the mountain flora of Greece (STRID, 1986; STRID & KIT TAN, 1991). However, the state of floristic knowledge of many greek mountains cannot be considered as complete, as little basic data have been available. In the contrary, floristic phytogeography in the Aegean area has been thoroughly studied by RECHINGER (1950) and RECHINGER & RECHINGER-MOSER (1951), mainly based on Flora Aegea (RECHINGER 1943). Numerous studies on individual areas of plant groups, mainly by workers in Lund and Berlin, have largely confirmed the patterns established by RECHINGER. Furthermore, the phytosociological exploration of the mountains of Greece is still very limited. For the grasslands of NE Greece, in particular, which present high floristic, phytogeographical and ecological significance (RECHINGER, 1939; KITANOV, 1943; QUÉZEL & CONTANDRIOPOULOS, 1965, 1968; PAPANIKOLAOU, 1985; STRID, 1986; KARAGIANNAKIDOU & KOKKINI, 1987, 1988; KARAGIANNAKIDOU, 1988, 1991; STRID & KIT TAN 1991), even fewer phytosociological data are available (QUÉZEL, 1989; KARAGIANNAKIDOU, 1994; PAPADEMETRIOU & al., 1997; SCHREIBER, 1997). The coexistence of European and Balkan elements in their floristic composition, due to their geographical position, often leads to a complex vegetation structure, which makes very difficult and at the same time very interesting their syntaxonomic status. Besides, the phytogeography of the mountains of Northern Greece has often been the subject of scientific discussion and contention.

The present study was carried out as part of a research programme on the flora and vegetation of the subalpine grasslands of E Macedonia (Greece), initiated in 1985 by the Institute of Systematic Botany and Phytogeography of the University of Thessaloniki. Part of the programme was dedicated to the botanical exploration of the grasslands of E Macedonia.

The authors in an attempt to contribute to the better knowledge of floristic characteristics of the mountains of E Macedonia, carried out a further analysis of the flora of grasslands found in the upper montane and subalpine zones of mts Menikion, Pangeon, Falakron and Orvilos. The study is based on 547 taxa (species and subspecies) presented in KARAGIANNAKIDOU & al. (1995), where the floristic list with chorological and life-form data was presented and a primary phytogeographical approach was attempted.

Material and methods

The study was based either on our own collections (Mts Menikion and Pangeon) made at intervals during years 1985-1991 or on information from STRID (1986) and STRID & KIT TAN (1991). The nomenclature is according to STRID (1986) and STRID & KIT TAN (1991), unless otherwise stated.

All the collections are kept in the Herbarium of the Institute of Systematic Botany and Phytogeography of Thessaloniki (TAU) and in the Herbarium of the Forestry Research in Vassilika (Thessaloniki).

The determination of the specimens was based on HAYEK (1924-1933), JORDANOV & al. (1963-1982), TUTIN & al. (1964-1980), STRID (1986), STRID & KIT TAN (1991).

The chorological data were taken from PIGNATTI (1982), GREUTER & al. (1984-1986), STRID (1986), STRID & KIT TAN (1991). All the taxa were grouped into chorological categories according to TURRIL (1929), PIGNATTI (1982) and ourselves.

A list of abbreviations used in the text follows:

T-Therophyte; G-Geophyte; H-Hemicryptophyte; Ch-Chamaephyte; NP-Nanophanerophyte; Ph-Phanerophyte.

Bulb-Bulbous; Caesp-Caespitose; Frut-Fruticose; Par-Parasitic; Rept-Reptant; Rhiz-Rhizomatous; Ros-Rosulate; Scan-Scandent; Scap-Scapose; Succ-Succulent; Suffr-Suffruticose.

Ann-Annual; Bienn-Biennial; Per-Perennial; Shr-Shrub; Tr-Tree.

F-Falakron; M-Menikion; O-Orvilos; P-Pangeon.

Al-Albania; Bu-Bulgaria; Gr-Greece; Ju-former Jugoslavia.

Balk+NE – Balkan Peninsula + NE Eurasian distribution (Siberia/Russia, Caucassus, Crimea); Balk+E+SE – Balkan Peninsula + E + SE Eurasian distribution (Turkey, Aegean islands, Iran, Iraq, N + NE Anatolia); Balk+NC – Balkan Peninsula + NC European distibution (Carpathia, Moldavia, Czech, Slovakia, Hungary); Balk+NW – Balkan Peninsula + S + SW European distribution (Appennini, C + S Italy, Alps, Pyrenees).

Study area

Grasslands are the major vegetation type in Greece. Those found in the subalpine zone, above the timberline of mountains, are the only climatically determined and they are more productive than those found in the lower zones (PAPANASTASIS, 1981, 1982). The mountains Falakron, Menikion, Pangeon and Orvilos were selected along an elevation gradient in NE Greece, so that they represent major and richer grassland areas in E Macedonia (Falakron 49 ha, Menikion 51 ha, Pangeon 33 ha, Orvilos 15 ha). Grassland areas studied are situated above an altitude of 1200 m (PAPANASTASIS & al., 1986).

The four mountains are located in E Macedonia. Menikion runs from a NW to SE direction, bordered by mt Brondous to the north and by the plains of Serres to the south and Drama to the east. Mount Pangeon is located southern of the other mountains in the borders between the prefectures of Kavala and Serres. Mount Falakron is situated in the northwestern part of the city of Drama, whereas Orvilos northwest of mts Menikion and Falakron and in the north of mt Brondous (Fig. 1).

The highest peaks of the investigated mountains are shown in Table 1, where information about the geological substrate of the mountains is, also, given. It must be noted that the geological substrate of the studied grasslands is mainly constituted of marbles (KOCKEL & al., 1977; STRID, 1986).

The climate can be generally described as transitional between mediterranean and continental with a relatively short dry summer period, followed by a wet long winter (BALAFOUTIS, 1977). The complicated topography of the mountains together with paucity of information from the area of study means that the local variations in climate cannot be described. However, data about total annual rainfall, taken by the closest meteorological stations, are given in Table 1 (BALAFOUTIS, 1977). For the subalpine grasslands of mt Menikion, particularly, the mean annual temperature is given as 8.4°C, whereas the total annual rainfall at an altitude of 1500 m is 940 mm (PAPANASTASIS, 1981, 1982).

Results and discussion

Analysis of the flora

A total of 547 Tracheophytes (401 species and 146 subspecies) represent the flora of the studied grasslands, the majority occuring in Pangeon (360) and Falakron (307). Menikion follows

with 234 and Orvilos with 197 taxa. Among 547 Tracheophytes, 15 belong to Pteridophyta and 532 to Spermatophyta. Gymnosperms constitute 1.1%, Monocotyledones 17.0% and Dicotyledones 79.2% of the whole flora (KARAGIANNAKIDOU & al., 1995).

Fifty four families of Spermatophyta and five families of Pteridophyta constitute the studied flora. As it concerns richness of taxa, families exceeding 8 taxa are shown in Table 2. It should be also mentioned that 5 families are represented by 7 taxa, 2 by 6, 5 by 5, 4 by 4, 6 by 3, 4 by 2 and 15 by 1 taxon. *Asteraceae, Poaceae, Caryophyllaceae, Lamiaceae, Fabaceae, Rosaceae, Scrophulariaceae, Liliaceae, Brassicaceae* and *Apiaceae*, which show the highest generic and specific richness, are also among the richest families of the Greek (VOLIOTIS 1967, 1976, 1981, 1987, PAVLIDES 1982, 1985, GEORGIADIS & al. 1986, CHRISTODOULAKIS 1986) and Balkan flora (TURRILL 1929). Families with more than 10 taxa contain 374 taxa, whereas the other ones contain 173 taxa. This means that 22% of the total number of families contain 69% of the total number of taxa.

The generic representation of the 59 families is quite variable. Only two families contain more than 20 genera, 7 have 10 or more and three families have 6-9 genera. Sixteen families have 2-4 genera and the rest are unigeneric. As far as it concerns the specific representation of the families, *Asteraceae* with 40 and *Poaceae* with 39 species are the richest. Five families have 20-25 species and three families 14-18 species (Table 2).

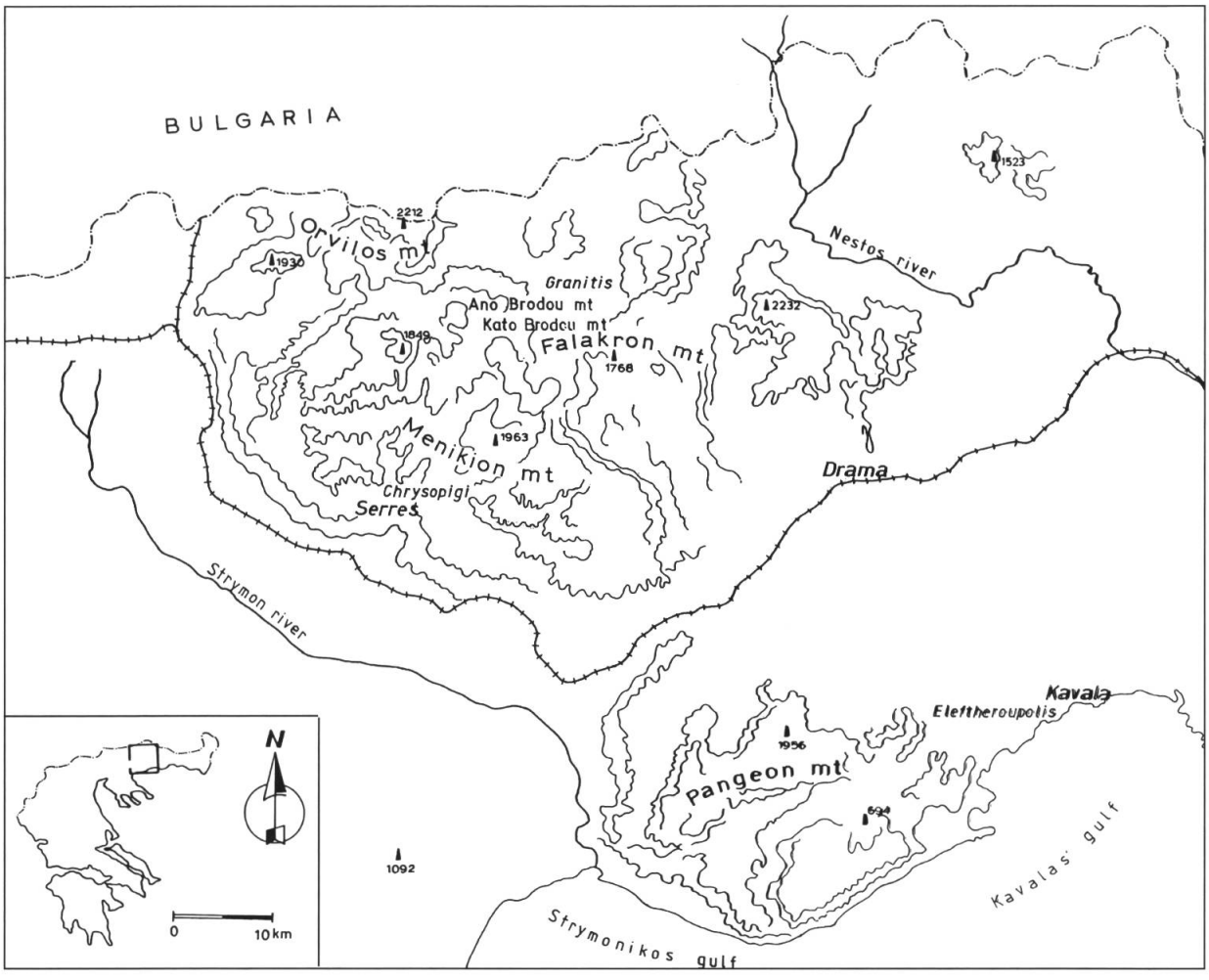

Fig. – 1. Map of East Macedonia.

Mountains	*Menikion*	*Pangeon*	*Falakron*	*Orvilos*
Highest peaks	Karagioz lofos 1963 m, Karpa 1800 m	Pilaftepe 1956 m, Avgo 1833 m	Summit 2232 m, Chionotrypa 2111 m, Kastalka 2035 m	Ali Bodus 2212 m
Geological substrate	Marbles, siliceous rocks, gneisses	Marbles, greenschists, amphibolites	Limestones, dolomites	Marbles
Climatic data				
Meteorological station	Chrysopigi (41°10'N 23°34'E) alt. 610 m	Eleftheroupolis (40°55'N 24°16'E) alt. 50 m	Granitis (41°16'N 23°55'E) alt. 820 m	Drama (41°09'N 24°09'E) alt. 130 m
Total annual rainfall	P: 723 mm	P: 750 mm	P: 745 mm	P: 698 mm

Table 1. – Geo-climatic data for the studied mountains.

Families	**Genera**	**Species**	**Subspecies**	**Total Number of taxa**	**Percentage (%)**
Asteraceae	25	40	21	61	11,15
Poaceae	23	39	7	46	8,41
Caryophyllaceae	10	25	18	43	7,86
Lamiaceae	14	21	17	38	6,95
Fabaceae	14	25	11	36	6,58
Rosaceae	11	25	3	28	5,12
Scrophulariaceae	9	20	4	24	4,39
Liliaceae	11	18	5	23	4,20
Brassicaceae	13	14	7	21	3,84
Apiaceae	12	6	10	16	2,93
Crassulaceae	3	14	–	14	2,56
Rubiaceae	3	8	5	13	2,38
Saxifragaceae	1	9	2	11	2,01
Campanulaceae	3	9	–	9	1,65
Orchidaceae	6	9	–	9	1,65
Ranunculaceae	6	8	1	9	1,65
Violaceae	1	9	–	9	1,65
Aspleniaceae	2	5	3	8	1,46
Total	147	304	114	418	76,44

Table 2. – Families with the greatest specific richness of the upper montane and the subalpine grassland flora of the studied mountains (number of taxa ≥ 8).

There are 31 families with only one genus each and 15 of them are monospecific. The unigeneric families with the greatest number of species are *Saxifragaceae* with *Saxifraga* respesented by 9 species, *Violaceae* with *Viola* represented by 9 species and *Hypericaceae* with *Hypericum* represented by 7 species. In the whole number of families the largest genera are: *Silene* (13), *Sedum* (11), *Dianthus* (10), *Hieracium* (10), *Allium* (9), *Thymus* (9), *Asplenium* (7), *Carex* (7), *Centaurea* (7), *Festuca* (7) and *Galium* (7).

Life-form spectra

It is well known that the prevailing climatic conditions in an area are highly correlated with the amounts of life-forms, whereas the floristic analysis of the vegetation from a life-form point of view is widely used as a criterion for describing it (RAUNKIAER, 1934).

Analytical life-form spectra for each mountain show remarkable resemblances (Fig. 2). This is probably due to similar climatic conditions, as well as to similar latitude. The Hemicryptophytes (mostly Hscap and Hcaesp forms) are always the dominant life-form, followed by the Chamaephytes (mainly Chsuffr form). All other life-forms (Therophytes, Geophytes and Nanophanerophytes) are relatively scarse. The differences between the four mountains are small, but

it seems that the highest concentration of Chamaephytes is found in Orvilos and the lowest in Pangeon. This is probably connected with their geographical position. Orvilos lies northern, whereas Pangeon southern than the other three mountains. In addition, Pangeon is not far distanst from the sea as Orvilos (Fig. 1). SCHREIBER (1997), who analyses the beech forests and subalpine grasslands in Falakron and Pangeon notices the high hemicryptophytic percentage and the fairly high chamaephytic one in combination with the reduced percentage of Therophytes. Based on this analysis and on climatic data from the Falakron and Pangeon, he believes that the NE mountain ranges in NE Greece are found in the limits of the mediterranean zone.

A comparison with other mountains of N Greece shows a similarity in the proportions of the main life-forms. The differences existing between the proportions of Therophytes and Chamaephytes among the mountains can be attributed to different altitude, geological substrate and altitudinal vegetation belt. For instance the calcareous rocks increase more the influence of dry period in plants than other kinds of rocks, such as the igneous rocks (GANIATSAS, 1939, VOLIOTIS, 1967, 1976, 1987; PAVLIDES, 1982, 1985; KARAGIANNAKIDOU, 1988, 1991).

A further comparison to S Greece and the Islands shows differences, concerning mainly the proportions of Therophytes (ECONOMIDOU, 1969; CHRISTODOULAKIS, 1986; GEORGIADIS & al., 1986 etc.). In mt Killini (NE Peloponnisos, S Greece), for which a complete floristic and phytogeographical analysis exists (DIMOPOULOS & GEORGIADIS, 1992, DIMOPOULOS, 1993), Hemicryptophytes are dominant followed by Therophytes. The therophytic percentage is evidently higher than in our study area, whereas the chamaephytic is fairly lower. The percentage of Geophytes is slightly higher in mt Killini.

Hemicryptophytes and Chamaephytes are more abundant in the grasslands of subalpine and alpine region of the Alps (E. & S. PIGNATTI, 1975; OZENDA, 1981), compared to our area of study, which is mainly constituted of marbles. This can be explained by the higher level of Hemicryptophytes and Chamaephytes typical of the flora in cold climates.

If we take the correlation between climatic zones and percentages of life-forms into account, the predominance of Hemicryptophytes in our study area is considered as representative of a mild temperate climate and the vegetation is ecologically equivalent to the temperate vegetation zone (RAUNKIAER, 1934; EMBERGER, 1967). However, we consider this interpretation as oversimplified because in a mediterranean mountain, a vertical succession of bioclimates is observed, having as a result the distinction of successive vegetation stages from its foot up to the highest peaks. Therophytes are the predominant life-form to Thermo- and Mesomediterranean vegetation stages, whilst as the altitude increases and the bioclimatic conditions change, the remarkable predominance of Hemicryptophytes and Chamaephytes is evident in the other stages (Oromediterranean and Altimediterranean vegetation belt) (GANIATSAS, 1967; OZENDA, 1975). Chamaephytes include mostly the typical ones among which a considerable number is high mountain plants protected during the winter by a snow covering.

In the studied grasslands, the clear dominance of perennials in relation to annuals, biennials, shrubs and trees is observed (Fig. 3). STRID (1993) refers, that grass-like plants are somewhat more prominent in the mountain flora (and vegetation) of the northern regions of Greece than in the southern, where relatively high percentages of annuals, woody/suffruticose and spiny taxa, are met.

Similar observations to the above can be made for the life-form spectra of the 18 richest families (Table 3), which are, clearly, the most dominant in the studied flora. These families seem to be better adapted to temperate climatic conditions. Their high hemicryptophytic character is related to the better representation of these families to areas with cold winters, as mts Menikion, Pangeon, Falakron and Orvilos are. The percentage of Phanerophytes (Phcaesp 1,2%, NP 2,6%) is very small or absent and is mainly restricted to the family *Rosaceae,* which is known to consist of woody species. All *Liliaceae* and *Orchidaceae* taxa are mainly Geophytes (Gbulb 6,9%, Grhiz 1,7%), which belong to Monocotyledones having the majority of the Geophytes. The families

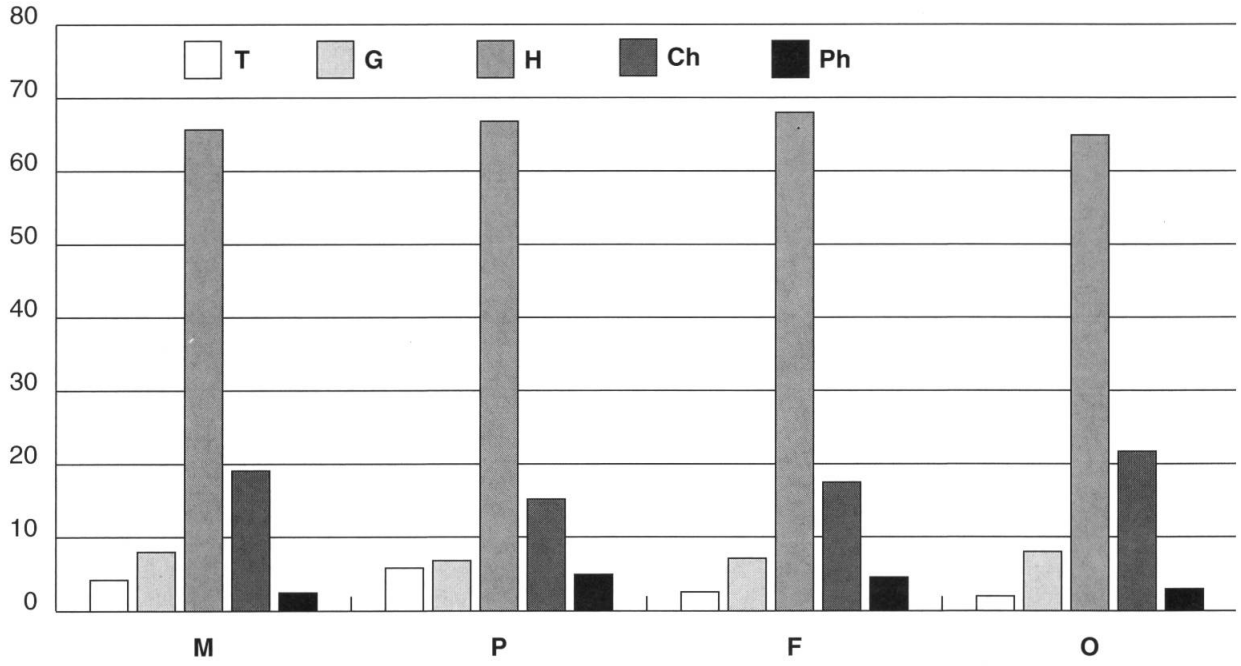

Fig. 2. – Life-form spectra of the upper montane and the subalpine grassland flora of mountains Menikion **(M),** Pangeon **(P),** Falakron **(F)** and Orvilos **(O). T** = Therophyte; **G** = Geophyte; **H** = Hemicryptophyte; **Ch** = Chamaephyte; **Ph** = Phanerophyte.

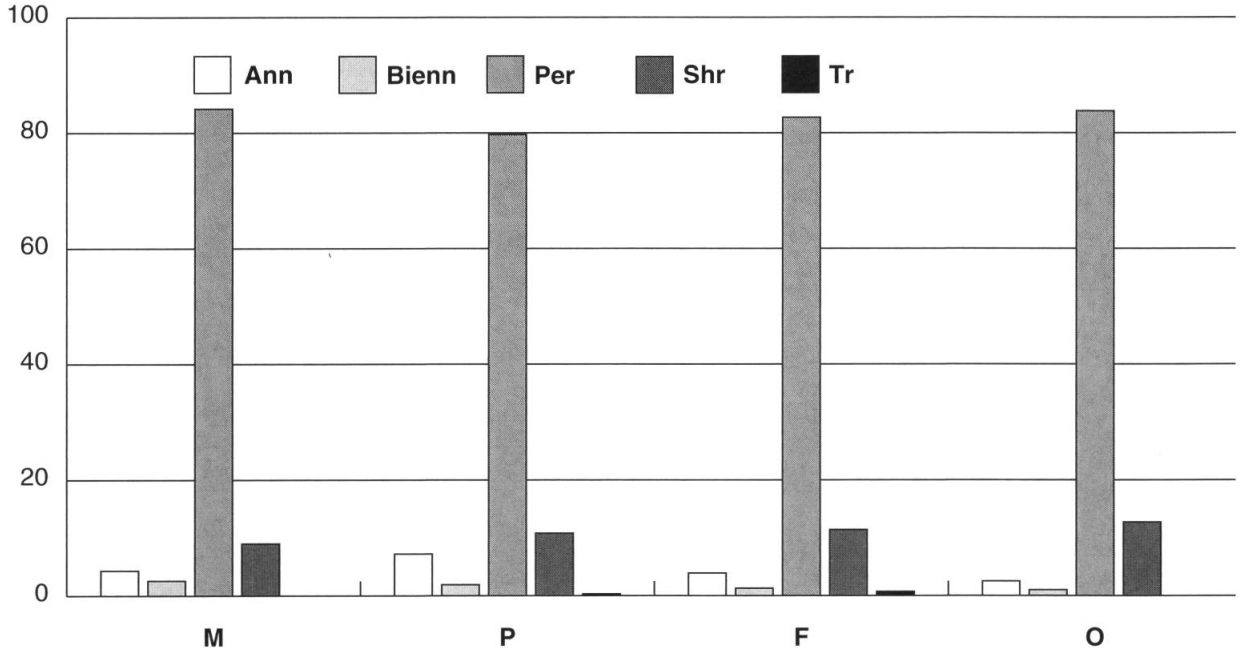

Fig. 3. – Duration of life of the upper montane and the subalpine grassland flora of mountains Menikion **(M),** Pangeon **(P),** Falakron **(F)** and Orvilos **(O). Ann** = Annual; **Bienn** = Biennal; **Per** = Perennial; **Shr** = Shrub; **Tr** = Tree.

Lamiaceae, Caryophyllaceae, Fabaceae and *Brassicaceae* consist predominatly of Chamaephytes and Hemicryptophytes while *Apiaceae* and *Poaceae* mainly of Hemicryptophytes (Table 3).

Chorological analysis

Each species was attributed to a chorological element, according to its actual distribution. By means of this distribution, 16 general categories have been distinguished (Table 4) and lead to the following conclusions:

The endemic element (Balkan, Greek) is of primary importance for the characterization of the studied grassland flora and was investigated in detail. Balkan endemics dominate, mostly in Orvilos and Menikion. Greek endemics are represented by much lower percentages, with a better representation in Pangeon.

Taxa widespread in the Mediterranean region (Eurimedit., N.NE. Medit. Mont.) are well represented. This is also decisive to a high degree for the characterization of the studied flora. Submediterranean-Subatlantic category participates with a very small percentage.

Eurosiberian and Central European species with south-east distribution are rarer than those distributed further in Anatolia and Caucassus. The latter are considerably better represented on the grasslands of Orvilos and Falakron. The Anatolian element is well represented both in the NE and in S Greece (Crete and Peloponnisos STRID, 1993, 1995) indicating that the southern and northern migration routes are of roughly equal importance.

Taking a narrower view of the Anatolian element, a number of Anatolian taxa occurs in the North East and sometimes also in the North Central regions, but not elsewhere in Greece. These are: *Cerastium banaticum* subsp. *banaticum, Dianthus pinifolius* subsp. *pinifolius, Silene supina, Sedum grisebachii, Bruckenthalia spiculifolia, Thymus sibthorpii, Bromus cappadocicus* subsp. *cappadocicus* etc.

The Circumboreal taxa show higher percentages than the Arctic-Alpine ones. The latter are very rare in our study area, especially if compared to the Alps, where OZENDA (1994) refers that among 200 endemic taxa, 150 are Arctic-Alpine. According to STRID (1993, 1995) strictly Arctic-Alpine species are rare in Greece and generally restricted to some of the highest mountain tops in the northern parts of the country. Several Arctic-Alpine or Boreal taxa, as well as taxa of the Alps and Carpathians, have their sounthernmost occurrences on high mountains in NC Greece, whereas others extend southwards to the Rhodopi mountains. Some of them are: *Achillea millefolium, Campanula persicifolia, Chenopodium foliosum, Carex digitata, Hypericum maculatum, Rosa pimpinellifolia, Veronica chamaedrys* subsp. *chamaedrys,* etc.

A somewhat smaller group of such widespread taxa extend southwards to Mts Falakron and/or Olymbos and may have scattered occurrences on other limestone mountains in Northern Greece. We could mention the taxa *Poa molinerii, Peucedanum officinale, Linum perenne* subsp. *alpinum, Koeleria eriostachya, Dryas octapetala* etc.

It can be noted that taxa of Northern origin – in a wide sense – (Europ., Euras. etc.), dominate in the studied flora. The predominance of Northern taxa characterize the flora of other mountains in Northern Greece, too (VOLIOTIS, 1967, 1976, 1987, PAVLIDES, 1982, 1985; STRID, 1986, 1993; KARAGIANNAKIDOU 1988, 1991; ATHANASIADIS & DROSSOS, 1990), whereas a remarkable decrease is observed, if compared to those of South Greece and the Islands (ECONOMIDOU, 1969; CHRISTODOULAKIS, 1986; GEORGIADIS & al., 1986, DIMOPOULOS, 1993). For example, in the flora of mt Killini (NE Peloponnisos, S Greece) the Mediterranean group dominates, being decisive for the formation of the flora, which is indisputably mediterranean (DIMOPOULOS & GEORGIADIS, 1992).

STRID (1993) refers, also, in mountain flora of Greece, that there is a fairly large element of regional and local endemics restricted to limestone. Many of these taxa occur in the calcareous mountains of NE Greece (Athos, Pangeon, Falakron, Orvilos), often extending to SW Bulgaria

Families	Life form categories*																		Total number of taxa
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Asteraceae	41	2	4	11	–	–	1	–	–	–	1	–	–	1	–	–	–	–	61
Poaceae	1	43	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	46
Caryophyllaceae	8	22	1	1	–	–	8	–	–	–	–	–	–	2	1	–	–	–	43
Lamiaceae	13	–	–	–	–	1	23	–	–	–	–	–	–	1	–	–	–	–	38
Fabaceae	15	3	–	3	–	1	12	–	–	–	1	–	–	1	–	–	–	–	36
Rosaceae	5	–	–	4	–	1	1	–	–	1	–	–	–	–	–	–	5	11	28
Scrophulariaceae	7	–	1	–	–	1	–	–	–	–	–	–	–	5	–	–	–	–	24
Liliaceae	–	–	–	–	–	–	–	–	–	–	1	22	–	–	–	–	–	–	23
Brassicaceae	7	1	–	1	–	–	11	–	–	–	–	–	–	1	–	–	–	–	21
Apiaceae	13	–	1	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	16
Crassulaceae	5	–	–	–	–	–	–	9	–	–	–	–	–	–	–	–	–	–	14
Rubiaceae	12	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	13
Saxifrageceae	8	–	1	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	11
Campanulaceae	7	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	9
Orchidaceae	–	–	–	–	–	–	–	–	–	–	2	7	–	–	–	–	–	–	9
Ranunculaceae	8	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	9
Violaceae	6	–	–	2	–	–	–	–	–	–	–	–	–	1	–	–	–	–	9
Aspleniaceae	–	–	–	8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
Total	166	71	9	31	–	5	60	9	–	1	7	29	–	13	1	–	5	11	418
Percentage (%)	39,7	17	2,2	7,4	–	1,2	17,4	2,2	–	0,2	1,7	6,9	–	3,1	0,2	–	1,2	2,6	100

* 1 = Hscap, 2 = Hcaesp, 3 = Hbienn, 4 = Hros, 5 = Hscand, 6 = Hrept, 7 = Chsuffr, 8 = Chsucc, 9 = Chfrut, 10 = Chrept, 11 = Grhiz, 12 = Gbulb, 13 = Tpar, 14 = Tscap, 15 = Tcaesp, 16 = Phscap, 17 = Phcaesp, 18 = NP.

Table 3. – Analytical life–form spectra of families with the greatest specific richness.

	Menikion		Pangeon		Falakron		Orvilos	
Chorological categories	*Total number of taxa*	*%*	*Total number of taxa*	*%*	*Total number of taxa*	*%*	*Total number of taxa*	*%*
1. Cosmop.-Subcosmop.	13	5,6	25	6,9	13	4,2	7	3,6
2. Circumbor.	12	5,1	24	6,7	18	5,9	6	3,0
3. Euras.	25	10,7	40	11,1	37	12,1	17	8,6
4. Balkan	70	29,9	84	23,3	74	24,1	66	33,5
5. N. NE. Medit.-Mont.	19	8,1	34	9,4	23	7,5	19	9,5
6. Eurimedit.	11	4,7	21	5,8	13	4,2	9	4,6
7. Geek, Greek-Anat.	10	4,3	22	6,1	5	1,6	7	3,6
8. Europ.	10	4,3	20	5,6	22	7,2	9	4,6
9. Europ.-Caucas.	7	3,0	10	2,8	14	4,6	4	2,0
10. Eurosib.	7	3,0	9	2,5	11	3,6	3	1,5
11. S. Europ.	9	3,8	11	3,1	12	3,9	10	5,1
12. C.S.E. Europ.	7	3,0	3	0,8	7	2,3	3	1,5
13. C.S.E. Europ.-Anat.-Caucas.	25	10,7	38	10,6	40	13,0	29	14,7
14. S.E. Europ.-Pontic	6	2,6	12	3,3	10	3,3	6	3,0
15. Submedit.-Subatlant.	2	0,8	5	1,4	4	1,3	1	0,5
16. Arctic-Alp.	1	0,4	2	0,6	4	1,3	1	0,5
Total	234	100360	100	307	100	197	100	

Table 4. – Chorological spectra of the upper montane and the subalpine grassland flora of the studied mountains.

and to Olympos. The list includes the following: *Carum rigidulum* subsp. *palmatum, Centaurea pangea, Chondrilla urumoffii, Taraxacum aznavourii, Campanula orphanidea, Arenaria filicaulis* subsp. *teddii, Dianthus gracilis* subsp. *drenowskianus, Verbascum humile* etc.

By the composition of the chorological elements of the species, as found by different researchers in different areas of N Greece, it seems that there is a great mid-european and balkan influence not only in the igneous mountains (Bella Voda, Chortiatis, Cholomon, Lailias, Vermion, Vertiscos, Prespa, Voras) but the same also happens on the calcareous mountains (Menikion, Pageon, Falakron, Orvilos, Olympos) (KARAGIANNAKIDOU, 1991; KARAGIANNAKIDOU & al., 1995).

SCHREIBER (1997) based on chorological spectra of subalpine grassland and beech forest associations in Pangeon and Falakron, supports that the limit between mediterranean and mideuropean floristic regions is found between the grasslands and the beech forests because the European-Eurasiatic elements are more abundant in the beech forests whereas the Balkan and Mediterranean elements are more abundant in the grasslands. If compared to the grassland flora of alpine and subalpine regions of Alps (E. & S. PIGNATTI, 1975; OZENDA, 1981), south-eastern and south European montane species are more abundant in our study area. The same occurs for the Eurasiatic and European species.

Without reducing the significance of the other chorological categories, it must be pointed out that a large number of the families constituting the studied grassland flora are characterized by an increased Balkan element (Table 5). These families like *Asteraceae, Caryophyllaceae, Poaceae, Fabaceae, Scrophulariaceae* etc. are among the richest in number of species in Balkan flora and contain the richest genera with the largest number of Balkan and Greek endemic taxa (TURILL, 1929). In addition, the families *Saxifragaceae, Rubiaceae, Campanulaceae, Ranunculaceae, Orchidaceae, Violaceae, Aspleniaceae* etc., being significant members of the Balkan and Greek flora, should be mentioned for their increased number of Northern taxa.

As a result, the floristic character of the studied vegetation is clearly neither balkan nor mediterranean but an intermediate one, characterized as submediterranean.

Endemism

Further analysis based on the distribution ranges of endemic taxa (Greek, Balkan) was carried out in order to give an interpretation of the affinities and influences on the grassland flora of the four mountains and, furthermore, of E. Macedonia.

Of the 547 Tracheophytes of the studied flora, 25.9% are Balkan endemics and 5.5% are Greek endemics (KARAGIANNAKIDOU & al., 1995). It may be noted that the families *Asteraceae, Caryophyllaceae* and *Fabaceae* are particularly well represented among the endemics.

The term "Greek, Greek Anatolian" used in the text for Greek endemics includes taxa confined to the limits of Greece, as well as a small number of taxa with a limited extension in Anatolia. This group of species with eastern distribution is small, including *Allium stamineum, Galium asparagifolium, Omphalodes luciliae, Pimpinella tragium* subsp. *polyclada* and *Thesium brachyphyllum*.

The group of Greek endemics comprising 30 taxa is shown in Table 6, where their distribution in the four mountains, as well as in the main geographical regions of Greece, is also shown. The largest number of Greek endemics is found in mt Pangeon (22). Only five of them, which are *Arenaria filicaulis* subsp. *teddii, Centaurea pangea, Silene multicaulis* subsp. *genistifolia, Stachys pangea* and *Taraxacum aznavourii,* are exclusively confined to it. The numbers of Greek endemics are significantly decreased in the other three mountains and only two are exclusively confined to Orvilos (*Chamaecytisus albus, Dianthus simulans*). The large number of Greek endemics in Pangeon is probably due to its geographical position and the great geomorphological differentiation, compared to the other three mountains, in relation to its more limited area, resulting in greater biotope diversity. The grasslands of the studied mountains share only a small number of endemics (two or three). For example, only 3 endemic taxa are common to the three of them. These are: *Chamaecytisus eriocarpus* (P, F, O), *Alyssum montanum* subsp. *montanum* var. *graecum* (M, P, F) and *Scabiosa triniifolia* (M, P, O). Some of the endemics show a dis-

	Chorological categories																
Families	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**Total number of taxa**
Asteraceae	1	4	–	26	2	1	3	5	4	1	3	4	6	1	–	–	61
Poaceae	5	5	7	14	2	2	–	1	–	3	2	–	4	1	–	–	46
Caryophyllaceae	2	1	3	21	3	1	4	1	–	1	1	–	3	2	–	–	43
Lamiaceae	–	–	4	7	7	4	3	1	1	–	3	–	8	–	–	–	38
Fabaceae	4	–	1	10	1	3	4	1	1	–	1	–	6	3	1	–	36
Rosaceae	2	3	4	–	6	–	–	–	–	3	1	2	3	2	1	1	28
Scrophulariaceae	–	1	1	8	2	2	1	3	–	1	2	–	3	–	–	–	24
Liliaceae	2	–	2	3	1	2	3	1	1	1	2	1	2	1	1	–	23
Brassicaceae	–	1	–	6	6	1	1	3	–	–	1	–	2	–	–	–	21
Apiaceae	–	–	2	5	2	1	2	–	–	1	–	–	3	–	–	–	16
Crassulaceae	–	–	–	1	2	2	–	2	–	1	1	–	2	1	1	1	14
Rubiaceae	–	–	3	6	–	–	2	1	–	–	–	–	1	–	–	–	13
Saxifragaceae	–	–	–	2	1	1	–	1	1	–	–	–	4	–	–	1	11
Campanulaceae	–	–	3	2	2	–	–	–	–	–	–	2	–	–	–	–	9
Orchidaceae	1	1	–	1	–	1	–	–	3	1	–	–	–	–	–	1	9
Ranunculaceae	1	–	3	1	–	–	–	–	–	–	–	–	–	4	–	–	9
Violaceae	–	–	1	2	–	1	–	1	1	2	–	–	1	–	–	–	9
Aspleniaceae	3	3	1	–	–	–	–	–	–	–	–	1	–	–	–	–	8
Total	21	19	35	115	37	22	23	21	12	15	17	10	48	15	4	4	418
Percentage (%)	5,9	4,5	8,4	27,5	8,9	5,3	5,5	5,0	2,9	3,6	4,1	2,4	11,5	3,6	0,9	0,9	100

Table 5. – Analytical chorological spectra of the families with the highest specific richness (for numbers of chorological categories see Table 4).

Greek endemics	M	P	F	O	NC/EC	Pi (S,N)	Ste	Pe	Ae	An	Cr	Io
Allium macedonicum	–	*	–	*	*	–	–	–	–	–	–	–
All. sphaerocephalon subsp. *trachypus*	*	–	–	–	*	*	*	*	–	–	–	*
All. stamineum	*	–	–	–	*	–	–	–	–	*	–	–
Allyssum montanum subsp. *montanum* var. *graecum*	*	*	*	–	*	*	*	–	*	–	–	–
Arenaria filicaulis subsp. *teddii*	–	*	–	–	–	–	–	–	–	–	–	–
Asperula aristata subsp. *thessala*	*	–	–	–	*	*	*	*	*	–	–	–
Astragalus hellenicus	–	*	–	–	–	–	*	*	–	–	–	–
Centaurea pangea	–	*	–	–	–	–	–	–	–	–	–	–
Chamaecytisus albus	–	–	–	*	–	–	–	–	–	–	–	–
Ch. austriacus	–	*	–	–	*	*	*	–	–	–	–	–
Ch. eriocarpus	–	*	*	*	–	–	–	–	–	–	–	–
Dianthus simulans	–	–	–	*	–	–	–	–	–	–	–	–
Hypericum athoum	–	*	–	–	–	–	–	–	*	–	–	–
Galium aspragifolium	*	*	–	–	–	–	*	–	*	*	–	–
Omphalodes luciliae subsp. *scopulorum*	–	*	–	–	*	–	*	*	–	*	–	–
Pimpinella tragium subsp. *tragium*	–	–	*	*	*	*	*	*	*	–	–	–
P. tragium subsp. *polyclada*	–	*	–	–	*	*	*	*	–	*	–	–
Pterocephalus perennis subsp. *perennis*	–	*	–	–	*	*	*	*	–	–	–	–
Rumex kerneri x obtusifolius	–	*	*	–	*	*	–	–	–	–	–	–
Rhamnus saxatilis subsp. *prunifolius*	–	*	–	–	*	*	*	*	–	–	*	–
*Salvia teddii**	–	*	–	–	–	–	–	–	–	–	–	
Scabiosa triniifolia	*	*	–	*	*	*	–	–	–	–	–	–
Silene multicaulis subsp. *genistifolia*	–	*	–	–	–	–	–	–	–	–	–	–
S. thessalonica subsp. *thessalonica*	–	*	–	*	*	–	–	–	*	–	–	–
Stachys pangea	–	*	–	–	–	–	–	–	–	–	–	–
Taraxacum copidophylloides	–	*	–	–	*	*	*	–	–	–	–	–
T. aznavourii–	*	–	–	–	–	–	–	–	–	–	–	
Thesium brachyphyllum	*	–	–	–	–	*	–	–	–	*	–	–
Thymus leucotrichus	*	*	–	–	*	*	*	*	–	–	*	–
Verbascum pangeum	*	*	–	–	–	–	–	–	–	–	–	–
Total	10	22	5	7	16	13	13	9	6	5	2	1

Table 6. – Distribution range of Greek endemics of the upper montane and the subalpine grassland flora of the studied mountains (the geographical regions of Greece are according to STRID, 1986).

continuity in their distribution in Greece. For example, *Allium sphaerocephalon* subsp. *trachypus* occurs in Menikion in NE Greece, but also in EC Greece, Pi (N & S), Ste and Pe, an area very close to the Ionian Sea (see Table 6). The disjunct distribution of other Greek endemics, too, suggests old phytogeographical connections between grasslands of E Macedonia and other regions of Greece. The most extensively distributed Greek endemics are: *Pimpinella tragium* subsp. *tragium, P. tr.* subsp. *polyclada*, *Alyssum montanum* subsp. *montanum* var. *graecum, Thymus leucotrichus, Rhamnus saxatilis* subsp. *prunifolius* (STRID, 1986; STRID & KIT TAN, 1991).

Balkan endemics constitute an important phytogeographical element in the four mountains and particularly in Orvilos. Under the term "Balkan endemics" except the taxa restricted to the Balkan peninsula or parts of it, constituting 25,9% of the whole flora, are classified also those taxa distributed in Balkan peninsula but their distribution is either extended into a limited zone of adjacent countries (Balkan subendemics). The group of Balkan endemics and subendemics is represented by 182 taxa, constituting 39,7% of the whole flora.

The Balkan sub-categories with respect to their distribution range in each mountain are shown in Table 7. Among Balkan endemics restricted to the Balkan peninsula or parts of it, 18 taxa (19,8%) from Menikion, 18 (14,1%) from Pangeon, 20 (16,9%) from Falakron and 23 (24%) from Orvilos are distributed in Bulgaria. Much smaller percentages are distributed in former Jugoslavia and even smaller percentages in Albania. The group of Balkan subendemics is represented by smaller numbers. Balkan element with NE and especially with E and SE distribution, are the most abundant and more informative in elucidating the phytogeographical pattern. The

species that belong to this group are thought to have been present on the mountains before these became isolated. Past migrations in combination with climatic and geological changes could explain the presence of most of these species on these mountains. It should be mentioned that Balkan element with E distribution is more prominent in Pangeon and Falakron than Orvilos and Menikion, indicating a stronger Anatolian influence (Table 7).

The presence of both Eastern and Balkan elements in the studied grasslands, in combination with the poor representation of Balkan element with NW and NC distribution, confirm the hypothesis that plants have migrated mainly in two directions. The northern direction, which is of greater significance and the eastern one with smaller significance.

The floristic connections of the four mountains with the main geographical regions of Greece, using the total number of Balkan endemics and subendemics, and the Greek endemics, separately, are shown in Tables 8 and 9. As it can be seen, the numbers of shared endemics between the mountains and the regions of NE and NC Greece are the greatest, indicating stronger floristic connections with them. The connections turn weaker as moving southwards in the following order: NPi, SPi, Ste, Pe, EC, Ae. At last, very few mountainous species are distributed on Crete and Ionian islands. The connections of mountains Orvilos and Falakron with NPi, SPi, Ste, EC, Pe and Ae appear to be weaker than the ones of Menikion and Pangeon with the same regions.

This fact could be assigned to geological events that occurred during the paleogeographic evolution of Greece. In early Miocene, N Greece was unified with Sterea Hellas, Peloponnisos, Crete, the Aegean region and W. Anatolia, forming a single land-mass. The present distribution ranges of Greek endemics, such as *Alyssum montanum* subsp. *montanum* var. *graecum, Pimpinella tragium* subsp. *tragium* etc., support this (see Table 6). Furthermore, the occurrence of certain species in Menikion, Pangeon, Falakron and Orvilos, which are mainly distributed in Anatolia, indicates that they could possibly have migrated from Anatolia to the Greek mainland. Examples of such species are: *Daphne oleoides* (C Asiat.-Medit.), *Rosa pulverulenta* (Medit.-Anat.), *Pimpinella tragium* subsp. *polyclada* (Gr, Anat., Iran), *Omphalodes luciliae* subsp. *scopulorum* (Gr, Anat.), *Scabiosa columbaria* subsp. *balcanica* (Balk + E).

Floristic similarities between the individual mountains

There are various similarity indices used for results referring to correlation of vegetation data. Floristic similarity indices generally reflect geographical proximity and biotope similarity (SÖRENSEN 1948, ELLENBERG 1956, BRAUN-BLANQUET 1964, van der MAAREL & LEERTOUWER 1967, WHITTAKER 1967, DIERSCHKE 1974).

Occurrence or non-occurrence of the 547 taxa was scored for the studied mountains. The total number of taxa is for Menikion 234, for Pangeon 360, for Falakron 307 and for Orvilos 197 (Table 10). Species numbers reflect differences in altitude, area and biotope diversity of the mountains but also differences in the degree of floristic exploration. The species number for mountain Orvilos is undoubtedly too low because it is referred only to the part belonging to the greek territory, which has a small area.

In the present study similarity indices were calculated for pair-wise comparisons between the four mountains. The index used is

$$CC = \frac{c}{a+b-c} \cdot 100\ (\%)\ \text{(JACCARD, 1902)}$$

where a is the total number of taxa on one mountain, b is the total number of taxa on the other and c is the number of shared taxa. The results are shown in table 10; here similarity indices vary from 26,30%, to 41,61%. The highest similarity index was observed between Pangeon and Falakron with Falakron-Orvilos and Menikion-Pangeon coming next. The lowest index was calcula-

	Menikion		Pangeon		Falakron		Orvilos	
Balkan categories	*Total number of taxa*	*%*	*Total number of taxa*	*%*	*Total number of taxa*	*%*	*Total number of taxa*	*%*
1. Balkan (within the peninsula)	28	29,2	33	25,8	27	22,9	27	28,1
2. Gr–Bu	18	19,8	18	14,1	20	16,9	23	24,0
3. Gr–Ju	4	4,2	4	3,1	1	0,8	6	6,3
4. Gr–Ju–Bu	5	5,2	10	7,8	10	8,5	6	6,3
5. Gr–Ju–Al	3	3,1	5	3,9	3	2,5	1	1,0
6. Gr–Al–Bu	–	–	1	0,8	1	0,8	1	1,0
7. Balkan + NE	11	11,5	10	7,8	9	7,6	7	7,3
8. Balkan+ E + SE	13	13,5	22	17,2	20	16,9	12	12,5
9. Balkan + NC	5	5,2	8	6,3	6	5,1	1	1,0
10. Balkan + NW	3	3,1	9	7,0	7	5,9	3	3,1
11. Balkan (within the peninsula and parts thereof)	5	5,2	8	6,3	14	11,9	9	9,4
Total	96	100	128	100	118	100	96	100

Table 7. – Analytical balkan spectra of the studied flora for each mountain.

Geographical regions of Greece	M	P	F	O	Total number of taxa	Percentage (%)
NE	10	18	5	5	38	27,33
NC	6	11	3	4	24	18,46
Pi (N, S)	6	8	3	2	19	14,61
Ste	5	10	2	1	18	13,84
Ae	3	4	2	2	11	8,46
Pe	3	6	1	–	10	7,69
EC	4	3	1	1	9	6,92
An	3	3	–	–	6	4,31
Cr	1	2	–	–	3	2,30
Io	1	–	–	–	1	0,76

Table 8. – Greek endemics shared between the studied mountains and the main geographical regions of Greece as well as in Anatolia (the geographical regions of Greece are according to STRID, 1986).

	Geographical regions									
Mountains	**NE**	**NC**	**NPi**	**SPi**	**Ste**	**Pe**	**EC**	**Ae**	**Cr**	**Io**
Menikion	137	99	65	55	58	42	39	30	6	8
Pangeon	121	89	62	54	50	34	32	26	4	8
Falakron	100	61	38	34	34	23	17	13	3	3
Orvilos	78	54	30	28	28	19	16	18	3	2

Table 9. – Balkan endemics shared between the studied mountains and the main geographical regions of Greece (the geographical regions are according to STRID, 1986).

Mountains	Total number of taxa	Number of common taxa		Similarity index (%)	
Menikion	234	M-P	145	M-P	32,29
Pangeon	360	P-F	196	P-F	41,61
Falakron	307	F-O	133	F-O	35,85
Orvilos	197	M-F	115	M-F	26,99
		P-O	116	P-O	26,30
		M-O	93	M-O	27,51

Table 10. – Total number of taxa in each mountain, number of shared taxa and similarity indices between the four mountains.

ted between Pangeon and Orvilos. Falakron sharing 196 plant species with Pangeon is more similar floristically with it than with Menikion or Orvilos. The phytogeographical affinities among the studied areas decrease in following order: Pangeon → Falakron → Orvilos → Menikion. The four mountains in North East Greece form a distinct group having high floristic similarity, most probably because these mountains have the same climate, geological substrate and are very close to each other. STRID (1993) notes that in the North East Greece, Falakron and Athos (limestone mountains) are more similar to a small group of mountains in the North Central, including Olympos (also limestone) than to the three non- calcareous mountains (Belles, Brondous and Rhodopi), which are geographically closer.

Endangered and threatened plant taxa

In Southern Europe, a very rich floristically area, there is a high percentage of threatened or rare species (Woodland 1991). Greece, geographically located in this part of Europe, possesses a particularly rich and diverse flora, which is also very rich in endemics, especially on the mountains and the islands of the Aegean and Ionian Sea. Many plant taxa of the greek flora are under threat and its protection and conservation should be a priority.

Various organizations (IUCN/1982, CITES/1982, Council of Europe/1982, ERDL/1991, WCMC/1993) published catalogues estimating the number of greek endemic taxa and the number of Extinct, Endangered, Vulnerable and Rare ones, resulting in different estimations of the number of Greek endemic taxa, as well as the numbers of taxa under various categories. These numbers should not be regarded as absolute. Besides, the "Flora Hellenica" project shows that the number of species and subspecies of the greek flora, as well as the numbers of endemic and rare taxa are in constant change. There is still much work to be done, especially, on collecting and comparing all the existing data so as to be a basis established for the conservation in general, and for the conservation and protection of individual species in particular.

No less than 520 of the endemic species of Greece have been classified as rare or threatened in December 1986 printout form of the Conservation Monitoring Centre at Kew. However, the nature and extent of the threat is only known in rather vague and general terms and information both published and unpublished is scattered.

STRID & KIT TAN (1992) believes that many "threatened" species in the Greek flora are in fact under no immediate threat. Many of them are at risk simply on account of their rarity. In spite of this rarity and regardless of severe pressure on the environment, the number of documented cases of extinction in the Greek flora is yet minimal.

In the studied flora 15 taxa have been found belonging to one of the categories of the Red Data Book (IUCN 1982). Category including the greatest number of taxa is that of rare (R=9), comprising 4 endemic and 5 non endemic taxa. The endemic taxa are: *Centaurea pangea* Greuter & Papan., *Hypericum athoum* Boiss. & Orph., *Allium macedonicum* Rahar. and *Dactylorhiza kalopissii* Erich Nelson. The non-endemic taxa are: *Sempervirum kindingeri* Adamovic, *Fritilaria dremovskii* Degen. & Stoy. *Haplophillum balcanicum* Vandas, *Thesium brachyphyllum* Boiss. and *Viola perinensis* W. Becker. The other categories are represented by small numbers of taxa, as following: Insufficiently known (K) – *Salvia teddii* Turrill, *Stachys pangea* Phitos, Vulnerable (V) – *Omphalodes luciliae* subsp. *scopulorum* Boiss, *Viola delphinantha* Boiss., Indeterminate (I) – *Galium asparagifolium* Boiss. & Heldr., Neither threatened nor rare (nt) – *Rhamnus prunifolius* Sibth. & Smith, *Paronychia rechingeri* Chandhri.

The following taxa must be referred, particularly on account of their rarity and that their populations reduce: *Dryas octopetala* L., *Sorbus pinnatifida* (Sm.) Dull, *Androsace villosa* L., *Saxifraga ferdinandi-coburgi* Kellerer & Sund, *Erythronium dens-canis* L., *Gentiana verna* subsp. *balkanica* Pritchard, *Saxifraga stribrnyi* (Velen.) Podp. etc.

The ecological value of the above the timberline grasslands of mountains of North East Greece must be estimated through the criteria of diversity, rarity, area and ecological fragility.

Emphasis must be given to the rare, threatened or endangered plant species of the above the timberline grasslands, which present a high degree of dependence on the ecological characteristics of their habitats.

The necessity of ecological evaluations carried out in all the greek mountains must be emphasized, since they constitute very useful tools for conservation and management of wildlife mountainous areas, as well as for the Environmental Impact Assessment studies which must precede the construction of any work (roads, ski centres).

The above the timberline vegetation complex of mountains of North East Greece has been incorporated in Natura 2000 as Sites of Community Importance (SCI) in order to be designated as special Area of Conservation (SAC) according to the principles of the Council Directive 92/43/EEC.

Conclusions

The analysis of the upper montane and the subalpine grassland flora of mountains Pangeon, Menikion, Falakron and Orvilos (E Macedonia) lead us to the following conclusions:

- Balkan element dominates in the studied flora. With respect to Balkan endemics restricted to the peninsula or parts of it a stronger phytogeographical affinity with Bulgaria and Jugoslavia is observed. Among the Balkan subendemics those with NE and E + SE distribution are more dominant. This fact in conjuction with the geographical distribution of Balkan endemics in the Balkan peninsula (TURRIL, 1929) and Strid's remarks (1986) that the presence of Balkan + NE and Balkan + E + SE elements is considerably stronger in the N than in the S Greece indicates that the floristic connections of NE Greece and therefore mountains Menikion, Pangeon, Falakron and Orvilos were mainly due to a N, NE migration route.
- Eventhough the studied flora presents a strong balkan character, the remarkable presence of Mediterranean element (Eurimedit., N.NE Medit.-Mont.), as well as of Eurasiatic and C.S.E. Europeo-Anatolo-Caucasian elements suggest that it should be characterized neither as balkan nor as mediterranean but as an intermediate one, submediterranean.
- The floristic connections of the four mountains with various geographical regions of Greece, turn weaker as moving southern in the following order NE, NC, Pi (N,S), Ste, Ae, Pe, EC, Cr, Io. Stronger connections exist with NE and NC Greece.
- The studied grassland flora in the four mountains are closely related, maybe due to geographical proximity, similar ecological conditions or similar geologic substrates. It should be noticed that these mountains consist largely of limestones, which is known to support a distinctive flora. The geographical affinity decreases in the following order P $\rightarrow$ F $\rightarrow$ M $\rightarrow$ O, as a result of the calculation of similarity indices for pair-wise comparisons between the mountains.
- The life-form spectra of mountains Pangeon, Menikion, Falakron and Orvilos show a predominance of Hemicryptophytes (particularly Hscap & Hcaesp), followed by Chamaephytes (especially Chsuffr) and a decreased number of Phanerophytes, which is typical of the ecological environment of temperate zone. Furthermore, this is demonstrated by the clear dominance of perennial herbs.
- The families *Asteraceae, Poaceae, Caryophyllaceae, Lamiaceae, Fabaceae, Rosaceae, Scrophulariaceae, Liliaceae, Brassicaceae, Apiaceae* show the highest generic and specific richness and contain the highest number of endemic taxa.

– Ecological evaluations of the natural potential of all greek mountains are absolutely necessary for the selection of representative natural sites with priority for conservation and protection.

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