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Geographical and Altitudinal Distribution of the *Lamiaceae* in Greece

By

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With 3 Figures

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Summary

KOKKINI S., KARAGIANNAKIDOU V., HANLIDOU E. & VOKOU D. 1988. Geographical and altitudinal distribution of the *Lamiaceae* in Greece. – Phyton (Austria) 28 (2): 215–228, 3 figures. – English with German summary.

Lamiaceae is a very important plant family in Greece, including a high number of endemic taxa (c. 30%), and represented very well all over the Greek territory. The horizontal and vertical distribution of its members are studied, taking into account the division of the country in fourteen phytogeographical regions. Using the Sørensen similarity index the affinities among each other are determined. The taxa are grouped into seven categories, on the basis of their chorology. Each chorological group is studied separately concerning its altitudinal distribution all over Greece and the participation of its representatives to every region.

Zusammenfassung

KOKKINI S., KARAGIANNAKIDOU, HANLIDOU E. und VOKOU D. 1988. Geographische und Höhen-Verbreitung der *Lamiaceae* in Griechenland. – Phyton (Austria) 28 (2): 215–228, 3 Abbildungen. – Englisch mit deutscher Zusammenfassung.

Lamiaceae bilden eine sehr wichtige Pflanzenfamilie Griechenlands, enthalten eine hohe Zahl endemischer Sippen (c. 30%) und sind überall in Griechenland gut

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vertreten. Die horizontale und vertikale Verbreitung der Taxa wird unter Berücksichtigung der Gliederung des Landes in vierzehn phytogeographische Regionen untersucht. An Hand des Sørensen-Ähnlichkeits-Index werden die Ähnlichkeiten der Regionen untereinander festgestellt. Die Taxa der Familie lassen sich auf Grund ihrer Areale zu sieben Gruppen ordnen. Jede chorologische Gruppe wird gesondert auf ihre Höhenverbreitung und ihren Anteil in den einzelnen Regionen untersucht.

Introduction

It is well known that Greece has an exceptionally rich flora which forms, geographically and historically, a link between the plant-life of Europe and that of Asia. This flora is composed of different phytogeographical elements variously distributed in the different areas of the country.

Aromatic plants are an important component of the Greek flora. They are represented by a high number of taxa belonging mainly to the families: *Apiaceae, Asteraceae, Lamiaceae, Lauraceae, Myrtaceae, Pinaceae* etc. *Lamiaceae* could be considered the most important family of aromatic plants in Greece, since (i) most of its members produce volatile oils, (ii) they participate in all vegetation types of the climatically different areas of the country, and (iii) many of them are endemic taxa.

The ocurrence of this well represented family all over Greece provides the tools for a detailed analysis of the horizontal and vertical distribution of its members. In consequence, we could have a better understanding of the participation of the different chorological elements of this family into the phytogeographical regions of Greece and estimate, accordingly, the degree of similarity among them.

Material and Methods

All taxa of the *Lamiaceae* family occurring in Greece are taken into account (GREUTER & al. 1986). Additionally, we have confirmed the presence of two infraspecific taxa of *Hyssopus officinalis* L., not recorded for Greece in the above mentioned check-list.

Nomenclature follows Med-Cheklist 3 (GREUTER & al. 1986). However, we have accepted *Acinos, Calamintha, Clinopodium and Micromeria* as different genera, unified in the above mentioned flora and inclusively considered as *Satureja* taxa.

The occurrence of each of these taxa in the 14 phytogeographical regions of Greece (Table 1), as defined by TURRILL 1929 and RECHINGER 1950, is noted. In the same table the climatic types prevailing in each region are recorded, based on the climatic classification of Greece by KARRAS 1973.

The altitudinal distribution of these taxa is considered in the total area of Greece as well as in each of these phytogeographical regions along an altitudinal gradient of every 300 m, from sea level up to the highest elevation. Both distributional and altitudinal data are mainly based on our own collections and field observations. About 3500 specimens of the *Lamiaceae* family, from all over Greece, are deposited in

the Institute of Systematic Botany and Phytogeography of the University of Thessaloniki (TAU). A list of the specimens examined is available upon request.

In addition, data were taken from: BADEN 1984, BOTHMER 1967, 1981, 1985, CHRISTODOULAKIS 1986, DAVIS 1982, GEORGIADIS & al. 1986, GREUTER 1975, 1979, GREUTER & RECHINGER 1967, GREUTER & al. 1983, HALÁCSY 1902, HANSEN 1982, IATROU 1986, IETSWAART 1980, KARAGIANNAKIDOU & KOKKINI 1987, KOKKINI 1983, KOKKINI & BABALONAS 1982, PAPANICOLAOU & KOKKINI 1982, PAVLIDES 1986, PERSSON 1981, PHITOS 1966, QUEZEL & CONTANDRIOPOULOS 1968, RECHINGER 1939, 1943, 1949, 1950, 1961, STRID 1965, 1980, STRID & FRANZÉN 1982, VOLIOTIS 1984.

The chorological data were taken from DAVIS 1982, GARCKE 1972, GREUTER & al. 1986, PIGNATTI 1982 and TUTIN & al. 1972. All taxa are grouped into seven categories, viz. endemics (END), mediterranean (MED), submediterranean (SUBMED), balkan (BALK), european (EUR), eurasiatic (EURAS), boreal (BOR) and tropical (TROP). The contribution of each of these chorological elements all over Greece and in every one of the 14 phytogeographical regions was studied as well as their altitudinal distribution in the whole of the country.

Finally, the phytogeographical regions are compared to each other by using the Sørensen similarity index (SØRENSEN 1984).

Results

The *Lamiaceae* family is represented in Greece by 320 taxa belonging to 35 genera (Table 2). About 50% of the total number of taxa correspond to only five generea, namely *Stachys* (58 taxa), *Thymus* (34), *Teucrium* (25), *Salvia* (24) and *Scutellaria* (20). In contrary, six genera are monospecific: *Coridothymus, Melittis, Melissa, Moluccela, Prasium* and *Rosmarinus;* another eight are represented by only two taxa: *Clinopodium, Galeobdolon, Glechoma, Hyssopus, Lavandula, Leonurus, Lycopus* and *Thymbra.*

Their distribution is characterized by a quite variable pattern. Some of them are restricted only in northern Greece, such as *Galeopsis, Galeobdolon, Glechoma, Hyssopus.* Others appear mainly in southern Greece, like *Coridothymus, Origanum, Molucella, Thymbra,* while some others, with a wider distribution both in northern and southern Greece, are peculiarly absent from insular areas, such as Crete and Cyclades. Such taxa belong to the genera *Leonurus, Lycopus, Melittis, Thymus* (with the exception of *T. leucotrichus* HALÁCSY subsp. *leucotrichus* occurring also in Mt Lefka Ori in Crete).

From Table 1 it can be seen that the richest in number of taxa phytogeographical region is that of Peloponnisos, Sterea, Eptanissa (no 7) with 143 taxa (44.7% of the total), followed by Makedonia (no 11) with 132 taxa (41.2%). The poorest one is that of the islands of Limnos and Ag. Evstratios with only 11 taxa (3.5%).

As far as the altitudinal distribution of the *Lamiaceae* members all over Greece is concerned, it can be seen from Fig. 3 that they are almost equally distributed from sea level up to 1500 m, their number decreasing gradually further on. This does not hold, however, for all phytogeographical regions,

Table 1. Climatic characteristics of the 14 phytogeographical regions of Greece and quantitative contribution of the different chorological elements of the *Lamiaceae* family in each of them.

PHYTOGEOGRAPHICAL REGIONS	CLIMATIC TYPES		CHOROLOGICAL ELEMENTS							
	HUMID	ARID SEMIARID	TOTAL NO OF TAXA	END	MED	BALK	SUBMED	EUR	EURAS	BOR	TROP
				92	76	66	17	11	51	6	1
1. Kithira, Crete, Rhodos, Karpathos	$B_1s_2B_2b_4'$ $C_2s_2B_2b_4'$ $C_2s_2B_3b_4'$	$C_1sB_3b_4'$ C_1sB_3a' $C_1dB_3b_4'$ C_1dB_3a' DdB_3b_4' DdB_3a'	91	33	39	5	2	1	9	1	1
2. Cyclades		DdB_3b_4' DdB_3a'	49	6	31	3	1	-	8	-	-
3. East Aegean islands (Kos, Ikaria, Samos, Chios, Lesvos)		$C_1sB_3b_4'$ $C_1dB_3b_4'$ C_1dB_3a' DdB_3b_4' DdB_3a'	85	7	51	6	3	2	14	2	-
4. West Aegean (East coasts of the mainland and islands up to 40° latitude Evoia, Sporades)		DdB_3b_3' DdB_3b_4' DdB_3a'	98	22	38	17	7	1	11	2	-
5. Limnos, Ag. Evstratios		DdB_3b_4' DdB_3a'	11	-	7	-	-	-	4	-	-
6. Halkidiki, Thasos, coasts of Makedonia and Thraki		$C_1dB_2b_4'$ DdB_2b_3' DdB_2b_4' DdB_3b_3' DdB_3b_4'	100	3	36	20	13	3	22	3	-
6a. Athos		DdB_2b_4'	66	6	23	17	5	3	10	2	-
7. Peloponnisos, Sterea, Eptanissa	$B_2s_2B_2b_4'$ $B_1s_2B_2b_4'$ $B_1s_2B_3b_4'$ $C_2s_2B_2b_4'$ $C_2s_2B_3b_4'$ $C_2s_2B_3a'$	$C_1s_2B_3b_4'$ $C_1sB_3b_4'$ C_1sB_3a'	143	33	41	26	11	4	23	5	-
8. Kerkira, Paxi	$B_2s_2B_3b_4'$		60	4	28	7	6	1	11	3	-
9. Ipiros	$B_3sB_2b_4'$ $B_1sB_2b_4'$ $B_3s_2B_2b_4'$ $B_1s_2B_2b_4'$ $B_2sB_2b_4'$ $B_1s_2B_3b_4'$ $B_2s_2B_2b_4'$ $C_2sB_1b_3'$ $B_2s_2B_3b_4'$ $C_2sB_2b_3'$		93	6	21	27	9	3	22	5	-
10. Thessalia		$C_1s_2B_3b_4'$ $C_1dB_3b_3'$ $C_1sB_2b_3'$ DdB_2b_3' $C_1sB_3b_3'$ DdB_3b_3' $C_1dB_2b_3'$ DdB_3b_4'	94	8	21	18	12	5	26	4	-
11. Makedonia	$C_2sB_1b_3'$ $C_2sB_2b_3'$ $C_2s_2B_2b_3'$	$C_1sB_2b_3'$ $C_1sB_3b_3'$ $C_1dB_2b_3'$ $C_1dB_2b_4'$ DdB_2b_3' DdB_3b_3'	132	6	24	38	15	6	37	6	-
12. Thraki		$C_1sB_2b_3'$ $C_1dB_2b_3'$ $C_1dB_2b_4'$	45	1	13	13	7	1	10	-	-
13. Mts Orvilos, Menikio, Falakro, Rhodopi		$C_1sB_2b_3'$ $C_1dB_2b_3'$ $C_1dB_2b_4'$	83	1	12	32	12	3	21	2	-

taken separately. As shown in Fig. 1, different distributional patterns are recorded in each of them. In particular, in the southern and east Aegean regions (no 1, 2, 3, 5) the maximum number of taxa appears at low altitudes (<300 m), while from southwest to north direction this maximum is seen in higher altitudes.

Concerning the representation of the different chorological elements, the following hierarchy is observed: endemics 28.8%, mediterranean 23.8%, balkan 20.6%, eurasiatic 15.9%, submediterranean 5.3%, european 3.4%, boreal 1.9% and tropical with only one taxon, 0.3%.

The majority of greek endemics (c. 70%) belong to the following six genera: *Stachys* (21 taxa), *Teucrium* (12), *Scutellaria* (11), *Nepeta* (7), *Origanum* and *Sideritis* (each with 6 taxa).

Abouth 50% of the mediterranean taxa belong to the genera *Salvia* and *Teucrium* (each with 10 taxa), *Stachys* (6), *Sideritis* and *Satureja* (each with 5 taxa). In parallel, all six monospecific genera, mentioned above, are strictly connected to the Mediterranean region.

Endemics and mediterranean elements, taken together, make 52.5% of the *Lamiaceae* in Greece, which shows the domination of this unified chorological group over all other elements.

The majority of balkan taxa (c. 75%) belong to the following four genera: *Thymus* (22 taxa), *Stachys* (19), *Sideritis* (5), *Salvia* (4).

Typical eurasiatic elements belong to the genera *Salvia* and *Stachys* (each with 5 taxa), *Ajuga, Lamium, Mentha, Nepeta, Scutellaria* (with 4), *Galeopsis* and *Ziziphora* (with 3); while those of submediterranean origin belong to the genera: *Calamintha* (3 taxa), *Ajuga, Ballota, Salvia* and *Stachys* (each with 2 taxa).

The European elements are very weakly represented and belong to seven genera, namely *Stachys* (4 taxa), *Thymus* (2), *Galeopsis, Glechoma, Hyssopus, Prunella* and *Teucrium* (each with 1 taxon).

Finally, the boreal elements are *Clinopodium vulgare* L. subsp. *vulgare, Glechoma hederacea* L., *Lycopus europaeus* L., *Prunella vulgaris* L., *Scutellaria galericulata* L. and *Stachys palustris* L., while one species is of tropical origin, *Phlomis floccosa* D. DON.

The representatives of the seven chorological groups of the *Lamiaceae* family are variously distributed in the different phytogeographical regions of Greece. As it can be seen from Table 1, the endemism, in absolute numbers, is highest in the insular arch of Kithira, Crete, Rhodos, Karpathos (no 1) followed by the phytogeographical region of Peloponnisos, Sterea, Eptanissa (no 7). Concerning the mediterranean taxa, most of them occur in the East Aegean islands; we should note, though, that their presence is remarkably high all over the Aegean sea (both in the islands and the coastline). On the other hand, balkan elements are mainly represented in the northern areas of the country.

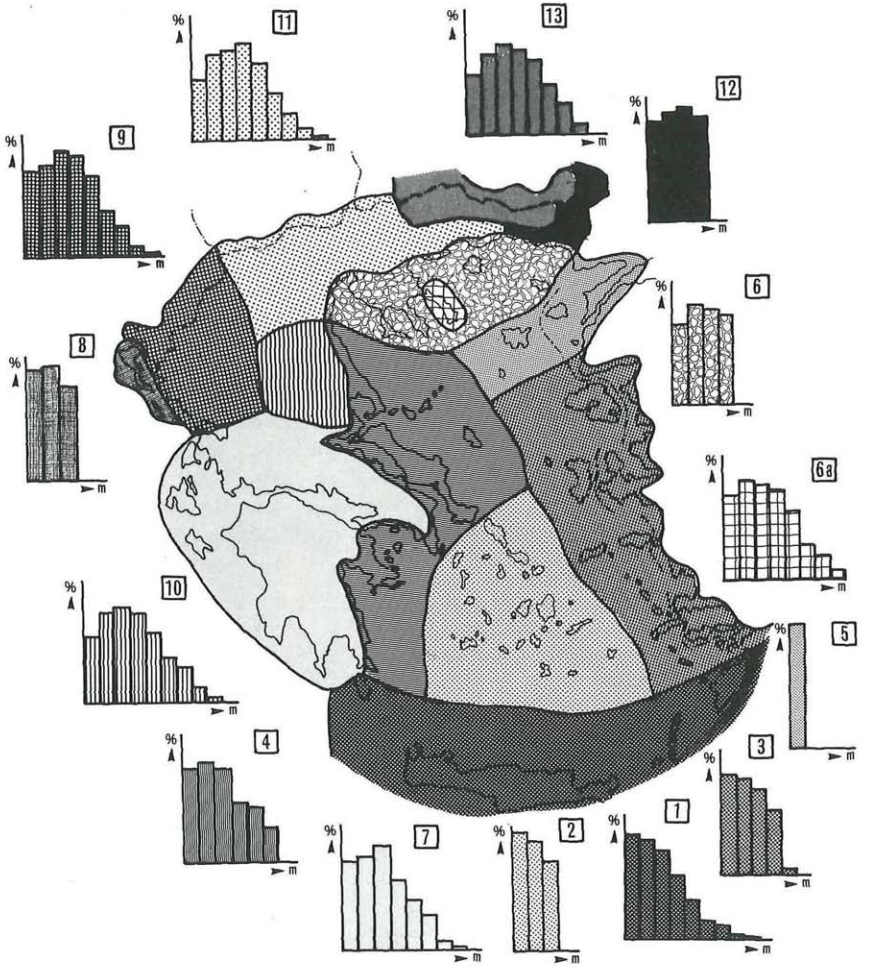

Fig. 1. Altitudinal distribution of the *Lamiaceae* taxa in each of the 14 phytogeographical regions of Greece.

The percentage contribution of the chorological elements in each phytogeographical region is shown in Fig. 2. Two of the chorological elements are present everywere; they are the mediterranean and Eurasiatic elements with a participation range of 15–60% and 10–35%, respectively. The submediterranean, European and boreal elements can be grouped together, all three with a low participation, ranging from 0 to 15%. Balkan and endemic elements, on the other hand, have a wider range of participation (0–35%).

Concerning the altitudinal distribution of the different chorological elements, in Greece, it can be seen from Fig. 3 that the mediterranean and submediterranean elements are concentrated at low altitudes (<900 m). Balkan taxa on the other hand are normally distributed along the altitudi-

Table 3. Values of Sørensen similarity index for all pairs of the phytogeographical regions on the basis of *Lamiaceae* taxa present.

1	2	3	4	5	6	6a	7	8	9	10	11	12	13	
1	0.46	0.53	0.30	0.11	0.23	0.21	0.24	0.26	0.12	0.14	0.12	0.13	0.06	1
	1	0.41	0.26	0.12	0.19	0.19	0.17	0.27	0.09	0.10	0.10	0.17	0.05	2
		1	0.33	0.13	0.30	0.26	0.29	0.28	0.16	0.19	0.16	0.17	0.10	3
			1	0.10	0.39	0.32	0.40	0.32	0.28	0.31	0.26	0.19	0.21	4
				1	0.14	0.07	0.07	0.14	0.06	0.07	0.05	0.09	0.03	5
					1	0.41	0.35	0.28	0.09	0.44	0.48	0.31	0.35	6
						1	0.32	0.27	0.27	0.32	0.28	0.21	0.22	6a
							1	0.33	0.40	0.37	0.34	0.17	0.19	7
								1	0.23	0.27	0.18	0.14	0.18	8
									1	0.54	0.41	0.23	0.24	9
										1	0.42	0.27	0.34	10
											1	0.26	0.47	11
												1	0.37	12
													1	13

nal gradient with maximun occurrence between 900 and 1200 m. Fairly similar to that is the distribution of Eurasiatic elements. Endemics are more or less equally distributed from sea level up to 1200 m, with their number decreasing gradually further on. A quite interesting point is the similarity observed in the altitudinal paterns of distribution between endemics and the whole family of *Lamiaceae*.

Comparison of the phytogeographical regions, according to the Sørensen similarity index, shows that the greatest affinities exist between the islands of southern, central and eastern Aegean (no 1, 2, 3) as well as between the regions of north-central Greece (no 6, 10, 11). Accordingly, the areas of southern and northern Greece show the lowest affinities (e.g. no 1, 2, 3, compared to no 13). The floristic peculiarity of the islands of Limnos and Ag. Evstratios (no 5) makes their affinity to any of the other phytogeographical regions always very low.

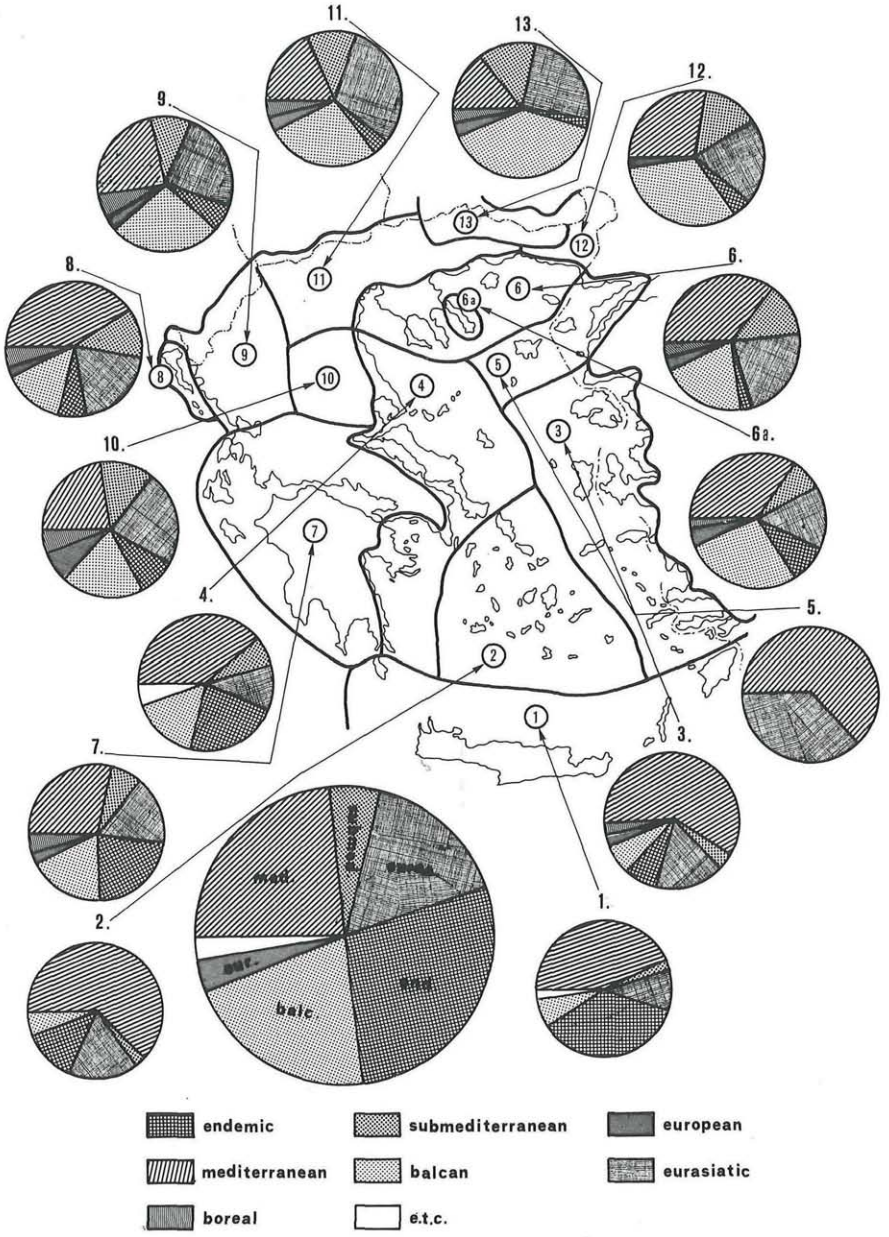

Fig. 2. Percent contribution of the different chorologial elements in the *Lamiaceae* flora of Greece and in its phytogeographical regions.

Table 2. Distribution of infra-generic taxa of the family *Lamiaceae* in the 14 phytogeographical regions of Greece (numbered according to Table 1).

Genera	Total No of taxa	No of taxa in the phytogeographical regions													
		1	2	3	4	5	6	6a	7	8	9	10	11	12	13
Acinos	5	2	1	2	4	-	5	3	5	1	4	3	5	3	3
Ajuga	9	4	1	4	4	-	7	2	5	3	3	4	5	1	3
Ballota	7	3	2	2	2	1	4	1	1	1	2	2	4	1	1
Calamintha	8	3	2	2	4	-	4	2	5	1	2	5	4	1	3
Clinopodium	2	1	1	1	1	-	1	1	1	1	2	1	2	1	2
Coridothymus	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-
Galeopsis	4	-	-	-	-	-	-	1	-	-	-	-	2	-	3
Galebdolon	2	-	-	-	-	-	1	-	-	-	1	1	2	-	-
Glechoma	2	-	-	-	-	-	-	-	1	1	-	1	1	-	-
Hyssopus	2	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Lamium	10	4	2	4	5	-	6	6	6	4	2	4	5	2	4
Lavandula	2	1	1	2	1	-	1	1	1	1	-	-	-	-	-
Leonurus	2	-	-	-	1	-	2	1	1	-	1	2	2	1	1
Lycopus	2	-	-	1	1	-	1	-	1	2	1	2	2	1	1
Marrubium	6	1	1	1	2	1	2	1	4	1	2	4	4	1	2
Melittis	1	-	-	-	1	-	1	1	1	1	1	1	1	-	1
Melissa	1	1	1	1	1	-	1	1	1	1	1	1	1	1	1
Mentha	8	5	5	5	3	2	5	3	7	3	5	6	6	4	2
Micromeria	11	6	4	4	5	1	5	3	6	2	1	3	4	2	4
Moluccela	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Nepeta	13	3	1	1	2	-	3	2	7	2	5	3	4	1	2
Origanum	12	6	4	5	3	1	2	2	2	2	2	2	2	1	1
Phlomis	10	5	1	4	2	-	1	1	4	1	2	2	3	-	-
Prasium	1	1	1	1	1	-	1	1	1	1	-	-	-	-	-
Prunella	4	3	-	2	1	-	3	1	2	2	2	2	2	1	2
Rosmarinus	1	1	1	1	1	-	-	1	1	1	-	-	-	-	-
Salvia	24	6	6	10	9	2	9	5	13	11	11	10	11	3	7
Satureja	11	2	1	3	3	-	1	2	3	1	2	1	3	1	1
Scutellaria	20	4	2	2	5	-	3	2	7	1	5	5	5	2	2
Sideritis	16	4	2	5	3	-	3	3	5	2	2	4	4	1	3
Stachys	58	9	2	5	13	1	10	6	26	6	16	12	21	6	14
Teucrium	25	13	6	7	9	1	7	4	11	5	4	5	6	4	3
Thymbra	2	1	-	1	-	-	-	-	1	1	-	-	-	-	-
Thymus	34	1	-	5	9	-	10	7	10	-	11	7	20	5	16
Ziziphora	3	-	-	3	1	-	-	1	1	-	1	1	1	1	-
TOTAL	320	91	49	85	98	11	100	66	143	60	93	94	132	45	83

Discussion

It is well known that plant distribution is controlled by climatic and edaphic factors. Especially for the Balkan Peninsula, it is claimed (TURRILL 1929) that climatic conditions have a much wider importance than soil ones. Greece, though relatively small in surface (c. 132,000 km^2), is characterized by a variety of climates, ranging from hot and very dry to cold and very humid (Table 1). Its diversified landscape contributes a lot to this climatic variability; proximity to the sea, presence of local mountain ranges, plains and valleys, as well as prevailing winds determine largely the climatic type of each area.

The transition of climatic types, from the mediterranean to the continental one, in a south to north direction in general, is well reflected in the floristic composition of each phytogeographical area, when the different chorological elements of the *Lamiaceae* family are taken into account (Fig. 2). The presence of the mediterranean and eurasiatic elements all over the Greek territory corresponds to the main centre of distribution of the Lamiaceae family (GREUTER & al. 1986). Apart from these two chorological elements, participating with a high number of taxa, endemics and balkans are very numerous as well. In this case, however, there are two opposing trends, concerning their distribution in Greece. Balkan elements decrease from north to south direction, while endemics increase (Table 1, Fig. 2). We could argue therefore, that a substitution of balkans by endemics takes place, where the first are not able to occupy the space available.

It should be mentioned that most of these endemics are geographically or altitudinally vicarious taxa (GREUTER 1972, IATROU 1986, PAPANICOLAOU & KOKKINI 1982).

By considering the number of taxa in each phytogeographical region, it comes out that the richest regions are those of Peloponnisos, Sterea, Eptanissa (no 7) and Makedonia (no 11). This richness is obviously related to the large surface that they occupy and to the variety of climatic types existing inside their boundaries (Table 1). The poorest region, on the other hand, is that of the islands of Limnos and Ag. Evstrations (no 5) with only 11 taxa, covering a very small surface and with only two arid climatic types. It should be noted however, that both Kerkira (no 8) and Athos (no 6a) with only one climatic type and with relatively equal surface far exceed Limnos, Ag. Evstrations in number of taxa (60 and 66, respectively). The remarkable poverty of this phytogeographical region is not restricted to the family of *Lamiaceae* but characteristically extends to all of its flora (TURRILL 1929, RAUH 1949).

Concerning the altitudinal distribution of *Lamiaceae* taxa in the 14 phytogeographical regions (Fig. 1), it is obvious that in the southern ones most of the taxa occur at low altitudes, whereas in the northern regions their maxima are transposed to higher altitudes. These results could be

explained by taking into account the floristic composition of each phytogeographical region (Fig. 2) and the altitudinal distribution of each chorological group (Fig. 3). The mediterranean elements dominate in the south; these elements have maximum appearance below 600 m. On the other hand balkan, European and Eurasiatic elements dominate in the northern

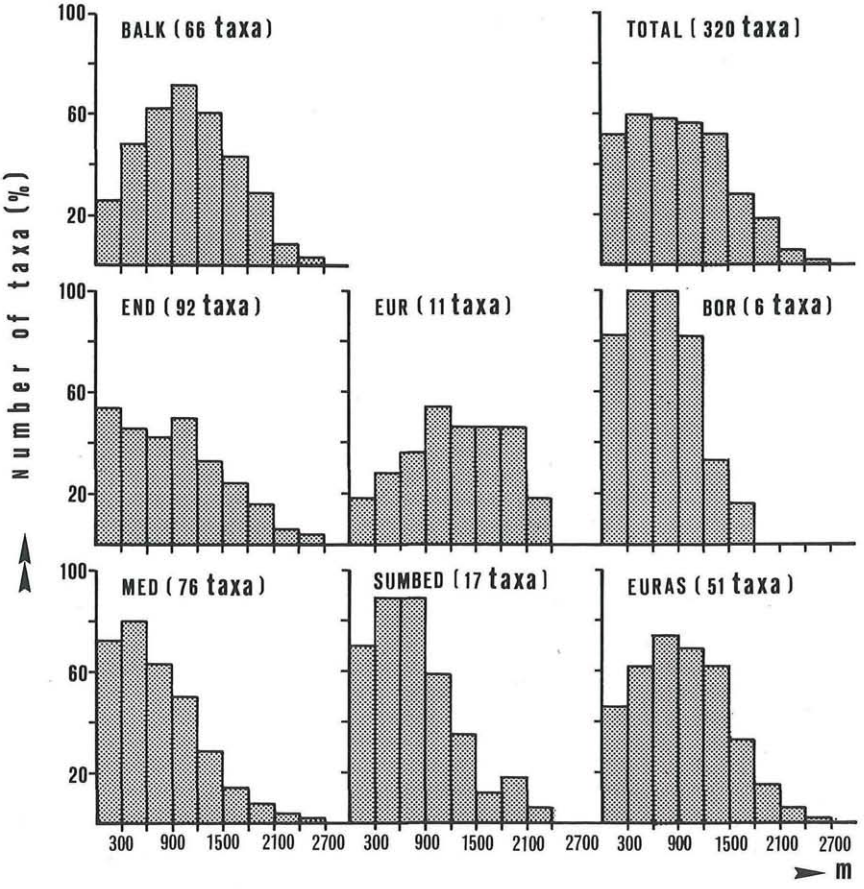

Fig. 3. Altitudinal distribution of all *Lamiaceae* taxa (total) and of the different chorological elements of the family in Greece.

regions; their maximum occurrence is over 600 m. Therefore, the dominant element, in each case, has a special weight, determining the altitude of highest occurrence of all taxa present.

A special note should be made on the high percentage of endemism (c. 30%) of *Lamiaceae* in Greece (2nd family of the Greek flora in respect to endemic taxa, RECHINGER 1965), occuring mostly in three regions (no 1, 4, 7)

of high anthropogenic pressure through centuries. Both endemics and the whole family occur mostly in relatively low altitudes (<1500 m) where man has an easy access (Fig. 3). This fact makes us agree with TURRILL's argument (1929), who states referring to this family that „. . . man's destructive and modifying influences have resulted in an increase in the distribution of the genera and species and in the possibilities of survival of new species".

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