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The genus *Origanum* (*Labiatae*) in Crete: distribution and essential oils

Abstract

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The distribution of the *Origanum* taxa in Crete is presented and the essential oils of several populations scattered on the island are studied. The essential oil content varies from 0,4% in *O. calcaratum* and *O. microphyllum* up to 7,4% in *O. vulgare* subsp. *hirtum*. The main oil components of *O. calcaratum*, *O. onites* and *O. vulgare* subsp. *hirtum* are γ-terpinene, *p*-cymene, thymol and carvacrol while the oils of *O. microphyllum* are rich in *trans*- and *cis*-sabinene hydrate and terpinene-4-ol. Our results are discussed in relation to their chemotaxonomic value.

Introduction

The genus *Origanum* L. is represented in Crete by five species *viz. O. dictamnus* L., *O. calcaratum* Jussieu [Section *Amaracus* (Gleditsch) Bentham], *O. microphyllum* (Bentham) Vogel [Section *Chilocalyx* (Briquet) Ietswaart], *O. onites* L. [Section *Majorana* (Miller) Bentham] and *O. vulgare* L. subsp. *hirtum* (Link) Ietswaart, member of the monotypic Section *Origanum*. Furthermore the occurrence of two hybrids has been recorded, *viz. O.* x *intercedens* Rech. fil. (= *O. onites* x *vulgare* subsp. *hirtum*) and *O.* x *minoanum* Davis (= *O. microphyllum* x *vulgare* subsp. *hirtum*).

Origanum taxa are widely exploited aromatic herbs and different attempts for the taxonomic value of their essential oils have been published (Kokkini & al 1991; Kokkini 1997; Skoula & al. 1999).

This work is part of a wider study concerning the Greek Labiatae taxa and in particular their distribution and essential oils. Our findings are further discussed in relation to their chemotaxonomic value.

Materials and methods

The study of the *Origanum* taxa distribution is based on our own collections deposited in TAU, specimens examined (ATH and B) and literature sources (Turland & al. 1993).

The map grid follows Turland et al. (1993). The methodology followed in the essential oil analyses is reported elsewhere (Kokkini & al. 1997).

Results and discussion

DISTRIBUTION. *Origanum dictamnus,* a chasmophyte endemic in Crete, occurs all over the island (Fig. 1). It grows on cliffs, crevices, ledges or rubble of gorge bed, mainly in shade, at an altitude (0-) 100-1800 (-2300) m. Its closely related species, the Greek endemic *O. calcaratum*, is extremely rare in Crete, found only in one population in Eastern Crete, near the city of Sitia, on calcareous cliffs, at an altitude of 600m (Fig. 1). The Cretan endemic *O. microphyllum* is restricted on the White Mountains and Mt. Dikti (Fig. 1). It is found in phrygana, garigue, rocky places and openings of *Pinus* forest at an altitude 400-1700 (-1800) m. *Origanum onites* mainly occurs in Eastern and Central Crete, whereas it is almost lacking from Western Crete (Fig. 1). It grows in phrygana and garigue, scrub or calcareous cliffs at an altitude 0-700 (-800) m. On the other hand *O. vulgare* subsp. *hirtum* is widespread in Western and Central Crete and only sporadically found in Eastern Crete, where it is replaced by the former taxon (Fig. 1). It occurs in roadsides, waste places and olive groves at altitudes between 0 and 1050(-1500) m. Finally, the two hybrids, *O.* x *intercedens* and *O.* x *minoanum*, have a rare occurrence and are confined in areas where the two parental taxa co-occur (Fig. 1).

ESSENTIAL OILS. A great variation with respect to the essential oil content has been observed in the examined *Origanum* species (Table 1). The highest values have been encountered in *O. vulgare* subsp. *hirtum* (7,4 ml/100 g of dry weight) followed by those of *O. onites* (4,2%) and the lowest in *O. microphyllum* and *O. calcaratum* (0,4%). Besides the existing variation *O. vulgare* subsp. *hirtum* is distinguished from the other species with oil content generally higher than 3,5%, whereas values lower than 1,5% differentiate *O. cal-*

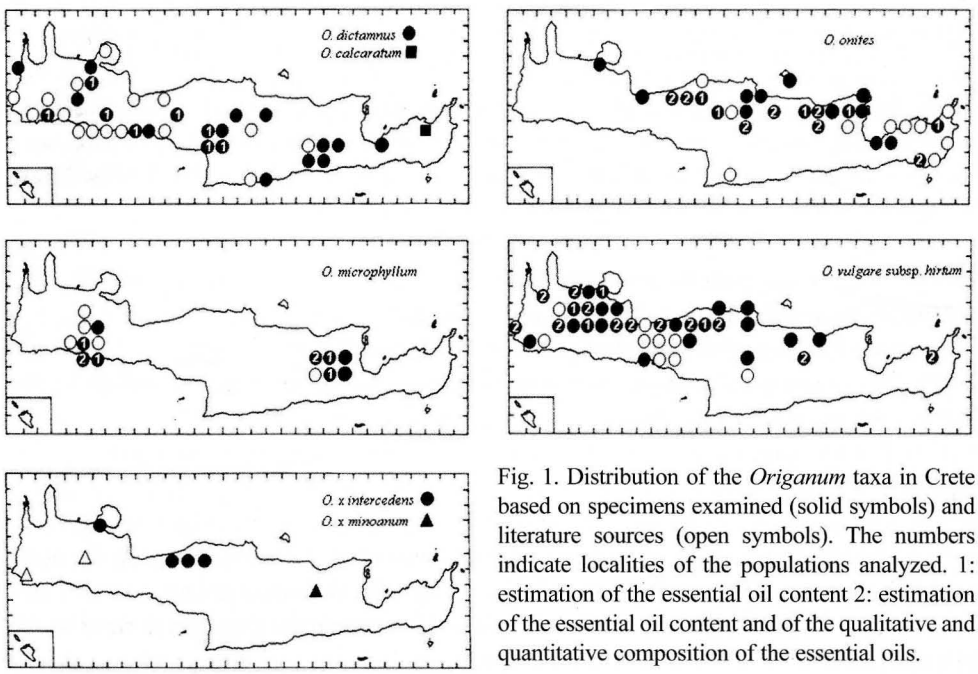

Fig. 1. Distribution of the *Origanum* taxa in Crete based on specimens examined (solid symbols) and literature sources (open symbols). The numbers indicate localities of the populations analyzed. 1: estimation of the essential oil content 2: estimation of the essential oil content and of the qualitative and quantitative composition of the essential oils.

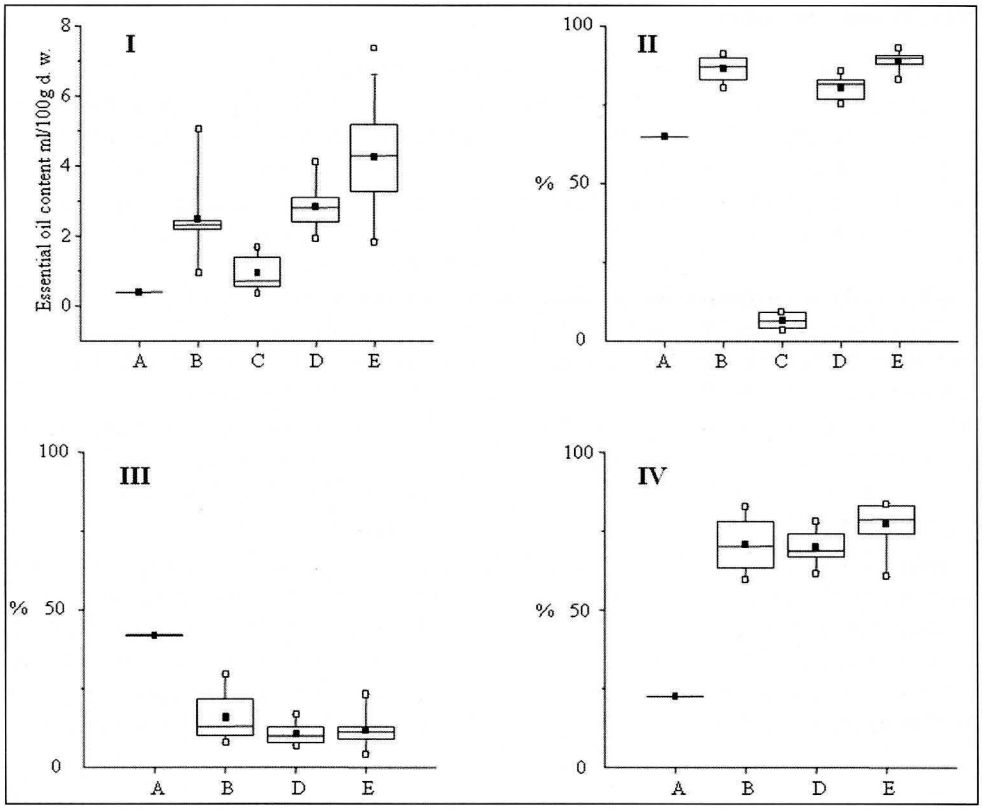

Fig. 2. I. Essential oil content of the *Origanum* species in Crete. II. Participation in the total oil (%) of the sum of the phenolic compounds (γ-terpinene + *p*-cymene + thymol + carvacrol) III. Participation in the total oil of γ-terpinene + p-cymene IV. Participation in the total oil of thymol + carvacrol. Horizontal lines of the boxes show the 25, 50 and 75th percentile. Solid squares indicate average values, while open squares indicate min and max values. A. *O. calcaratum* B. *O. dictamnus* C. *O. microphyllym* D. *O. onites* E. *O. vulgare* subsp. *hirtum*.

caratum and *O. microphyllum* (Fig. 2.I). Similar values of oil content have been reported for other Greek populations of the above species (Katsiotis & Oikonomou 1986; Harvala & al. 1987; Kokkini 1997 and references therein, Gotsiou 2000).

The main essential oil components of the examined species are presented in Table 1. As can be seen the oils of *O. calcaratum*, *O. onites* and *O. vulgare* subsp. *hirtum* are characterized by high amounts of compounds involved in the phenolic biosynthetic pathway *viz.* the phenols thymol and carvacrol and their precursors γ-terpinene and *p*-cymene. The sum of the four compounds constitutes the bulk of the essential oils ranging from 64,5% in *O. calcaratum*, up to 92,7% in *O. vulgare* subsp. *hirtum* (Fig. 2.II). Rich in phenolic compounds is also the oil of *O. dictamnus* (Table 1, Fig. 2.II) (Katsiotis & Oikonomou 1986; Harvala & al. 1987). On the other hand the oils of *O. microphyllum* are charaterized by the preponderance of *trans*- and *cis*-sabinene hydrate and terpinene-4-ol, whereas the sum of

Table 1. Essential oil content (ml 100g-1 d.w.) and main components (%) of the total oil of the Origanum species occurring in Crete. Range values, average and standard deviation are given.

	O. calcaratum	*O. dictamnus*	*O. microphyllum*	*O. onites*	*O. vulgare* subsp. *hirtum*
Essential oil content	0,4	0,9 – 5,0 2,5 ± 1,1	0,4 – 1,7 0,9 ± 0,5	1,8 – 4,2 2,8 ± 0,6	1,6 – 7,4 4,2 ± 1,4
γ-terpinene	7,7	1,4 – 7,9 5,2 ± 3,4 *		2,8 – 10,7 6,1 ± 2,8	0,8 – 11,4 3,7 ± 2,8
p-cymene	34,3	6,3 – 7,8 7,3 ± 0,8 *		3,6 – 6,0 4,4 ± 0,8	3,1 – 12,8 8,0 ± 2,8
thymol	18,4	0,3 – 0,5 0,4 ± 0,1 *		0,6 – 0,9 0,7 ± 0,1	0,1 – 2,9 (–49,7) 4,5 ± 13,6
carvacrol	4,1	58,8 – 82,3 69,2 ± 11,9 *		61,4 – 76,9 69,3 ± 5,2	(8,6–) 70,6 – 83,5 72,8 ± 19,8
trans-sabinene hydrate			18,5 – 26,0		
cis-sabinene hydrate			21,6 – 33,7		
terpinen-4-ol			11,0 – 16,8		

* Data from Katsiotis & Oikonomou 1986; Harvala & al. 1987.

the phenolic compounds is very low (less than 8,6%) (Table 1, Fig. 2.II). A similar composition has been also found in other *O. microphyllum* populations (Gotsiou 2000).

Besides the qualitative similarities, the oils of *O. calcaratum*, *O. onites* and *O. vulgare* subsp. *hirtum* are quite variable with respect to their quantitative composition (Table 1). In particular the oils of *O. onites* are characterized by the preponderance of carvacrol (61,4-76,9%), while the rest three compounds have been traced in much lower amounts (less than 11%). Carvacrol is also the major component of *O. vulgare* subsp. *hirtum* oils (70,6–83,5%), though in one population the oils have been found rich in thymol (49,7%). A literature survey suggests that the oils of *O. onites* are always rich in carvacrol, while the oils of *O. vulgare* subsp. *hirtum* are rich either in carvacrol or in thymol (Lawrence 1979-1995 and references therein; Kokkini 1997 and references therein). Besides the quantitative fluctuations of the two phenols, their sum is always high in both species (more than 58%), while the sum of the phenolic precursors γ-terpinene and *p*-cymene is much lower (less than 23%). Similar results have been reported for the oils of *O. dictamnus* (Table 1, Fig 2.III, IV).

On the other hand the main component of *O. calcaratum* oil is *p*-cymene (34,3%), while thymol has been traced in noticeable amount (18,4%). However the sum of the two phenols is much lower (22,5%) than in the above mentioned species, whereas the sum of the phenolic precursors much higher (42,0%) (Table 1, Fig. 2. III, IV).

The above results suggest that the essential oil content and composition of the *Origanum* species can be used as additional taxonomic characters.

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