Carpological and Palynological Characterization of Germplasm of Oregano (*Origanum syriacum* L.) in Lebanon

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The morphobiometric characters of the pollens and mericarps of 74 accessions of *Origanum syriacum* L. collected in the Damour River area of Mount Lebanon, Lebanon, were studied for the first time. The detailed analysis of the morphobiometric descriptors and the further elaboration of these by means of cluster analysis distinguished two principal groups. These groups seem to correspond to the two varieties of *O. syriacum* described by Ietswaart (1980), *viz.*, *O. syriacum* L. var. *syriacum* and *O. syriacum* L. var. *bevanii* (Holmes) Ietswaart. On the other hand, with regard to their pollen characteristics, the studied accessions could be considered as ecoform variants. The greater uniformity detected in pollen traits could be ascribed to the enthomogamic pollination mechanisms present in *Origanum syriacum* and the related gene flow taking place among the populations under study. It can be hypothesized that such mechanisms might have in fact contributed to the natural selection of these populations, favoring greater uniformity in pollen traits rather than in those related to the mericarps. The diversity detected by this study in mericarps and pollen grains represents a useful diacritic element for the better understanding of *Origanum syriacum*, suggesting at the same time the presence of genetic variation that could be exploited in crop improvement programmes targeting this species.

Key Words: ***Origanum syriacum*, Morphology, Mericarps, Pollen grains, Lebanon**

Introduction

The genus *Origanum* L. (Family Lamiaceae) is characterized by annual, biennial or perennial herbs distributed predominantly in the eastern Mediterranean (75%) and only a few species in the Western Mediterranean region. The genus consists of 42 species and a total of 49 taxa including species, subspecies, and varieties (Ietswaart, 1980; Calström, 1984; Danin, 1990; Danin and Künne, 1996).

Oregano has been always playing an important role in the daily life of many populations around the world. The cultivation of oregano in its natural habitat is particularly significant in Morocco, Turkey, Lebanon, Albania, which are major world exporting countries of this spice. In spite of its high social and economic value, oregano can be considered a neglected crop from the stand point of its genetic resources (Padulosi, 1997). Very little research has been carried out with regard to the better understanding of its genetic diversity, gene pool, conservation and sustainable use. Oregano species are also valuable for their widespread use in gardening and in medicine due to the presence of essential oils with antimicrobic, cytotoxic and antioxidant properties (Lagouri *et al.*, 1993; Sivropoulou *et al.*, 1996). The possibility of inter-specific crosses within the *Origanum* genus (Ietswaart, 1980) is also an opportunity for crop improvement programmes, including those aiming at enhancement of agronomic performance (resistance to biotic and abiotic stresses) and improvement of its values as condiment and medicinal plant.

In order to shed more light on the genetic diversity of *Origanum* and its sustainable use, a study was carried out in Lebanon during 2003-2004. The study focused on the palynological and carpological characterization of wild accessions of *Origanum syriacum* collected in Lebanon.

Materials and Methods

Seventy four wild populations of *O. syriacum* were sampled from a study area of 100 km² in the watershed of the Damour River in Mount Lebanon, a region characterized by a Mediterranean ecosystem (Fig. 1, 2). The collected mericarps were planted in nearby fields. Table 1 provides a complete list of the material investigated. The characterization and the determination of the morphobiometric parameters of the accessions relative to the mericarps were carried out with a stereomicroscope Jena Citoval 2 provided with magnification lens up to 16x.

For the shape and colour of the mericarps, the number codes as suggested by Berggren (1969) were used. Table 2 and Figs. 3 and 4 report biometric and carpological characters considered in the study.

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Fig. 1: Harvesting of *Origanum syriacum* plants

Fig. 2: A view of the flora of the Mount Lebanon

Table 1. Codes of 74 accessions of *Origanum syriacum* present in the villages of Mount Lebanon

Codes	Accessions	Villages	Codes	Accessions	Villages
1	A Da 1	Ain Dara	38	K Nab 18	Kfar Nabrakh
2	A Da 4	Ain Dara	39	K Nab 21	Kfar Nabrakh
3	Agh 3	Aghmid	40	K Nab 25	Kfar Nabrakh
4	Agh 5	Aghmid	41	K Nab 26	Kfar Nabrakh
5	Agh 8	Aghmid	42	K Nab 29	Kfar Nabrakh
6	Agh 13	Aghmid	43	K Nab 31	Kfar Nabrakh
7	Agh 14	Aghmid	44	K Nab 32	Kfar Nabrakh
8	Agh 15	Aghmid	45	K Nab 35	Kfar Nabrakh
9	Agh 17	Aghmid	46	K Nab 36	Kfar Nabrakh
10	A Ha 3a	Ain El Halazoun	47	M Ba 1	Majdel Baana
11	A Ha 4	Ain El Halazoun	48	M Ba 2ab	Majdel Baana
12	Amm 1	Ammiq	49	M Me 3	Majdel Meoush
13	Amm 6	Ammiq	50	M Me 4	Majdel Meoush
14	Amm 11	Ammiq	51	M Me 8	Majdel Meoush
15	Amm 12	Ammiq	52	M Me 9	Majdel Meoush
16	Amm 15	Ammiq	53	M Me 11	Majdel Meoush
17	Amm 17	Ammiq	54	M Me 16	Majdel Meoush
18	A Tr 1	Ain Trez	55	M Me 17	Majdel Meoush
19	A Tr 3	Ain Trez	56	M Me 19	Majdel Meoush
20	Bir 6	Bireh	57	M Me 20	Majdel Meoush
21	Bir 7	Bireh	58	M Me 26	Majdel Meoush
22	Bir 9	Bireh	59	M Me 27	Majdel Meoush
23	Bir 13	Bireh	60	M Me 28	Majdel Meoush
24	Bmh 2	Bmehray	61	M Me 31	Majdel Meoush
25	Bmh 3	Bmehray	62	Ram 2A	Ramlieh
26	Bmh 4	Bmehray	63	Ram 4	Ramlieh
27	Bmh 6	Bmehray	64	Ram 6	Ramlieh
28	Gea 2	Geael	65	Ram 8	Ramlieh
29	Gea 4	Geael	66	R Naa 2a	Rouaisset En Naamane
30	K Nab 4	Kfar Nabrakh	67	R Naa 3	Rouaisset En Naamane
31	K Nab 7	Kfar Nabrakh	68	R Naa 7	Rouaisset En Naamane
32	K Nab 8	Kfar Nabrakh	69	R Naa 8	Rouaisset En Naamane
33	K Nab 10	Kfar Nabrakh	70	R Naa 9	Rouaisset En Naamane
34	K Nab 12	Kfar Nabrakh	71	War 1	Warhanieh
35	K Nab 14	Kfar Nabrakh	72	War 4	Warhanieh
36	K Nab 15	Kfar Nabrakh	73	War 9	Warhanieh
37	K Nab 15a	Kfar Nabrakh	74	War 10	Warhanieh

For the characterization and the determination of the morphobiometric parameters of pollen material, the technique of Erdtman (1960) was deployed and the data are presented in Table 3. For the measurements of the parameters studied, an optical microscope Zeiss with a magnification of x100 was used. For the SEM observations (Jeol 35), pollen grains were placed on stubs and covered by gold dust to a thickness of 100Å (Fig. 5a, 5b). For the palynological terminology, the work of De Leonardis *et al.* (1986) was considered as a reference.

Table 2. Mean values of the carpological parameters of 74 accessions of *Origanum syriacum* (mm)

Codes	Le	Wi	Th	A	B	C	D	E	F	Colour	Shape
1	1.00	0.61	0.38	0.24	0.13	0.14	0.37	0.23	0..22	15,23,28,29,31	3,4,39
2	0.99	0.62	0.31	0.19	0.19	0.13	0.32	0.18	0.18	22,23,29	3,4
3	1.10	0.50	0.32	0.21	0.16	0.17	0.37	0.20	0.22	16,22,23,29,30,31	2,3,4,38,46,47
4	1.00	0.65	0.36	0.22	0.18	0.17	0.38	0.19	0.20	23,28,29,30,31,35	2,3,46,47,48
5	0.96	0.62	0.36	0.20	0.16	0.15	0.36	0.21	0.19	22,23,28,29,30	2,3,4,37,47
6	1.00	0.66	0.33	0.23	0.17	0.18	0.40	0.20	0.20	21,29,30	3,4,39,47
7	1.00	0.66	0.33	0.19	0.19	0.19	0.40	0.18	0.19	22,23,26,27,28,29	3,4,37,38,47,48
8	1.00	0.69	0.38	0.20	0.12	0.18	0.38	0.18	0.20	21,22,23,29,30	2,3,4,47,48
9	1.07	0.66	0.38	0.20	0.19	0.18	0.40	0.20	0.22	21,22,29,30	2,3,37,46,47
10	0.90	0.54	0.36	0.23	0.20	0.18	0.40	0.20	0.22	22,23,29,30,32	2,3,37,38,46,47,48
11	1.00	0.65	0.32	0.19	0.17	0.16	0.30	0.14	0.19	22,23,29,30,31	3,46,47,48
12	1.00	0.65	0.33	0.20	0.16	0.17	0.37	0.17	0.19	22,23,29	3,46,47,48
13	0.99	0.67	0.34	0.22	0.15	0.20	0.45	0.19	0.19	22,23,28,29,30	3,46,47,48
14	0.90	0.67	0.34	0.21	0.14	0.16	0.38	0.19	0.18	22,28,29,30	3,4,46,47,49
15	0.90	0.63	0.33	0.19	0.15	0.16	0.30	0.17	0.17	26,27,28,29,30	3,4,46,47,48
16	1.00	0.67	0.37	0.20	0.15	0.17	0.40	0.20	0.20	21,23,28,29	2,3,37,46,47
17	0.88	0.56	0.31	0.23	0.15	0.12	0.34	0.25	0.23	22,23,28,29,30	3,4,6,47,48
18	0.90	0.55	0.30	0.18	0.15	0.12	0.30	0.18	0.20	22,23,28,29,30	2,3,46,47
19	0.80	0.55	0.33	0.20	0.17	0.14	0.34	0.19	0.20	23,28,29,30,31	3,4,46,47,48
20	0.90	0.66	0.34	0.20	0.13	0.16	0.30	0.19	0.22	23,29,30,31	4,47,48
21	1.10	0.66	0.38	0.23	0.18	0.18	0..38	0.23	0.21	22,23,29,30,40	3,4,46,47,48
22	0.98	0.66	0.36	0.23	0.17	0.16	0.30	0.23	0.19	23,26,29,30	4,46,47,48,49
23	1.20	0.68	0.38	0.26	0.20	0.24	0.45	0.24	0.22	23,29,30	4,37,38,39,48
24	1.10	0.70	0.41	0.22	0.17	0.17	0.39	0.23	0.21	22,23,29,30	3,4,37,39,47,48
25	1.10	0.65	0.39	0.22	0.18	0.16	0.30	0.20	0.22	22,29,30	4,37,38,39,47,48
26	1.10	0.75	0.36	0.21	0.19	0.16	0.40	0.21	0.21	29,30	38,46,47,48
27	1.00	0.65	0.37	0.21	0.15	0.15	0.35	0.23	0.23	23,29,30,31	4,38,39,47,48
28	1.00	0.69	0.35	0.24	0.14	0.18	0.38	0.21	0.22	29,30	38,39,47,48
29	1.00	0.71	0.33	0.22	0.22	0.14	0.33	0.21	0.23	23,29,30	47,48
30	1.00	0.67	0.37	0.22	0.15	0.13	0.28	0.20	0.22	23,29,30,31	38,47,48
31	1.10	0.69	0.33	0.20	0.12	0.16	0.33	0.20	0.23	23,29,30	37,39,47,48
32	1.00	0.68	0.36	0.23	0.14	0.16	0.33	0.23	0.20	23,29,30,31	37,38,47,48
33	0.90	0.66	0.33	0.23	0.13	0.14	0.30	0.20	0.23	29,30,31	47,48
34	0.90	0.69	0.37	0.22	0.16	0.14	0.33	0.19	0.20	23,29,30	38,39,47,48
35	1.00	0.68	0.37	0.21	0.12	0.16	0.30	0.19	0.19	23,27,29,30,31	38,47,48
36	0.90	0.61	0.30	0.20	0.14	0.16	0.30	0.20	0.20	29,30,32	2,3,4,5,47
37	0.90	0.65	0.30	0.20	0.14	0.16	0.30	0.20	0.20	29,30,32	2,3,4,5,47
38	0.90	0.69	0.38	0.19	0.14	0.13	0.30	0.16	0.20	29,30,31	47,48,49
39	1.05	0.67	0.38	0.21	0.14	0.13	0.30	0.16	0.23	22,23,28,29,30,31	38,47,48,49
40	1.00	0.69	0.35	0.20	0.15	0.12	0.30	0.16	0.18	29,30,31	38,47,48,49
41	1.09	0.66	0.35	0.24	0.14	0.15	0.30	0.17	0.17	23,27,29,30,31	47,48
42	1.05	0.64	0.37	0.22	0.15	0.14	0.30	0.17	0.17	28,29,30,31	38,39,47,48,49
43	0.90	0.71	0.35	0.22	0.13	0.14	0.30	0.17	0.16	23,27,29,30	38,47,48,49
44	1.02	0.68	0.40	0.22	0.16	0.17	0.40	0.19	0.22	23,29,30	39,47,48
45	0.99	0.69	0.36	0.20	0.15	0.16	0.36	0.17	0.18	29,30	38,39,47,48
46	1.00	0.65	0.37	0.21	0.14	0.12	0.32	0.17	0.18	23,29,30	38,39,47,48
47	1.00	0.64	0.37	0.20	0.13	0.16	0.30	0.18	0.19	23,29,30	46,47,48
48	1.04	0.66	0.38	0.20	0.16	0.12	0.30	0.17	0.19	23,29,30	38,47,48
49	0.98	0.62	0.37	0.20	0.13	0.14	0.30	0.18	0.18	23,29,30	28,46,47
50	1.01	0.52	0.37	0.20	0.14	0.17	0.36	0.17	0.19	23,29,30	38,47,48
51	0.90	0.62	0.36	0.19	0.14	0.14	0.30	0.15	0.16	23,29,30	46,47
52	0.90	0.63	0.37	0.20	0.16	0.16	0.30	0.17	0.19	23,27,29,30	38,47,48
53	1.07	0.75	0.39	0.23	0.16	0.16	0.38	0.18	0.18	23,29,30	38,39,47,48
54	1.10	0.69	0.36	0.20	0.17	0.16	0.37	0.18	0.18	23,28,29,30	47,48
55	1.03	0.63	0.39	0.20	0.19	0.16	0.41	0.19	0.19	23,29,30	38,39,47,48
56	1.03	0.67	0.35	0.20	0.18	0.17	0.40	0.18	0.19	23,29,30	47,48
57	1.02	0.62	0.40	0.20	0.16	0.14	0.40	0.18	0.17	23,29,30	38,47,48
58	1.07	0.68	0.37	0.21	0.14	0.16	0.37	0.18	0.17	23,28,29,30,31	38,47,48
59	1.04	0.77	0.37	0.21	0.15	0.12	0.35	0.18	0.19	23,29,30,31	38,47,48,49
60	1.04	0.66	0.37	0.21	0.15	0.16	0.38	0.19	0.19	28,29,30	47,48
61	1.08	0.69	0.34	0.25	0.16	0.14	0.35	0.18	0.19	23,29,30	47,48
62	0.96	0.65	0.32	0.23	0.17	0.12	0.35	0.17	0.17	23,29,30	38,47,48
63	1.00	0.65	0.33	0.21	0.15	0.14	0.34	0.17	0.18	22,23	37,38,39,48
64	1.00	0.66	0.32	0.19	0.15	0.13	0.30	0.15	0.17	22,23,29,30	38,46,47,48
65	0.99	0.62	0.33	0.19	0.11	0.16	0.30	0.16	0.17	23,29,30	38,47,48
66	1.00	0.65	0.33	0.20	0.14	0.14	0.33	0.17	0.18	23,28,29,30	38,39,47,48
67	1.03	0.67	0.32	0.21	0.18	0.14	0.36	0.16	0.17	22,23,29,30	38,47,48,49
68	1.01	0.69	0.39	0.19	0.13	0.14	0.30	0.16	0.17	23,28,29,30	38,46,47,48
69	0.90	0.66	0.33	0.20	0.15	0.13	0.30	0.16	0.17	23,28,29,30	38,46,47,48,49
70	0.90	0.66	0.35	0.23	0.13	0.14	0.3	0.16	0.17	22,23,28,29,30	38,39,47,48
71	1.01	0.67	0.37	0.19	0.15	0.14	0.3	0.15	0.16	23,29,30,40	38,39,47,48
72	1.16	0.70	0.32	0.23	0.15	0.17	0.37	0.19	0.19	29,30	38,47,48,49
73	1.03	0.67	0.38	0.21	0.14	0.13	0.3	0.15	0.19	23,29,30	38,47,48
74	1.18	0.77	0.37	0.20	0.18	0.15	0.38	0.18	0.18	23,29,30	38,47,48

Le: length of mericarps; Wi: width of mericarps; Th: thickness of mericarps; A: length of areola; B: width of left areola cavity; C: width of right areola cavity; D: width of areola; E: length of areola seen laterally; F: width of areola seen laterally

Table 3. Mean values of palynological parameters of 74 accessions of *Origanum syriacum* (µm)

Codes	P.	E.	P.ex	E.ex	Mes	E.lum	P.lum
1	40	38	3.3	2.4	14	1.4	1.2
2	42	37	3.5	2.4	12	1.4	1.2
3	37	37	3.4	2.4	12	1.5	1.2
4	40	37	3.5	2.4	13	1.5	1.2
5	40	37	3.5	2.4	12	1.5	1.3
6	41	39	3.5	2.4	12	1.9	1.5
7	39	31	2.8	2.1	9	0.6	0.6
8	38	34	2.7	2.0	11	0.6	0.6
9	41	37	3.2	2.4	13	1.3	0.6
10	38	36	2.9	2.4	12	1.3	0.6
11	38	34	2.9	2.4	12	1.2	0.6
12	39	35	3.2	2.5	12	1.2	1.2
13	42	37	3.3	2.6	13	1.3	1.2
14	39	37	2.5	2.4	12	0.6	0.6
15	41	39	3.2	2.7	13	1.5	1.2
16	31	33	2.6	2.0	11	1.1	1.0
17	33	30	2.7	2.0	12	1.2	1.1
18	41	33	3.3	2.6	13	1.2	1.2
19	29	31	2.5	2.0	12	1.0	1.0
20	34	28	2.7	2.0	10	1.2	1.0
21	33	30	2.8	2.0	11	1.2	1.0
22	31	30	2.8	2.0	12	1.5	1.0
23	31	33	2.9	2.0	11	1.1	1.0
24	32	30	3.0	2.0	11	1.2	1.0
25	32	29	2.9	2.0	11	1.5	1.0
26	32	32	2.9	2.0	11	1.2	1.0
27	30	31	3.0	2.0	12	1.5	1.0
28	37	36	3.2	2.0	14	1.3	1.2
29	32	29	3.0	2.0	11	1.1	1.1
30	29	31	2.6	1.8	12	1.2	1.0
31	30	33	2.8	1.9	12	1.2	1.0
32	28	31	2.7	1.9	11	1.3	1.0
33	29	32	2.9	2.2	12	1.3	1.0
34	31	32	2.5	1.7	12	1.5	1.0
35	29	30	3.0	2.1	11	1.2	1.0
36	32	34	3.0	2.0	13	1.5	1.0
37	28	32	2.7	2.0	12	1.3	1.0
38	32	29	2.6	2.0	11	1.4	1.0
39	32	30	2.6	2.0	12	1.3	1.0
40	41	37	2.6	2.4	13	1.4	1.2
41	30	32	2.7	2.0	12	1.1	1.0
42	31	30	2.8	2.0	12	1.1	1.0
43	29	32	2.8	2.0	12	1.5	1.0
44	30	30	2.7	2.0	11	1.1	1.0
45	33	30	2.8	2.0	11	1.2	1.0
46	29	31	2.7	2.0	11	1.5	1.0
47	30	30	2.7	2.0	11	1.6	1.0
48	26	28	2.8	2.4	13	1.2	1.2
49	30	29	2.6	2.0	10	1.3	1.0
50	29	27	2.6	2.0	11	1.2	1.0
51	30	31	2.7	2.0	10	1.5	1.1
52	37	37	2.7	2.1	11	1.3	1.0
53	30	29	2.7	2.0	11	1.2	1.1
54	29	32	3.0	2.0	11	1.3	1.0
55	28	31	2.8	2.0	11	1.2	1.0
56	31	28	3.0	2.0	10	1.5	1.2
57	30	31	2.8	2.0	12	1.5	1.0
58	32	30	2.5	2.5	12	1.1	1.0
59	34	32	3.0	2.0	12	1.6	1.3
60	31	32	3.0	2.0	12	1.7	1.3
61	31	30	2.7	2.1	10	1.4	1.1
62	37	39	2.8	2.2	14	1.2	1.2
63	37	35	2.9	2.4	13	1.2	1.2
64	39	37	3.0	2.4	14	1.3	1.2
65	32	29	2.4	2.1	10	1.2	1.2
66	29	27	2.5	2.0	10	1.1	1.0
67	25	27	2.5	2.0	10	1.1	1.0
68	30	29	2.5	2.0	12	1.3	1.0
69	30	29	2.8	2.0	11	1.2	1.1
70	29	29	2.7	2.0	12	1.2	1.0
71	32	29	2.5	2.0	11	1.2	1.0
72	29	31	2.5	2.0	12	1.1	1.0
73	31	29	2.5	2.0	10	1.1	1.0
74	29	30	2.3	1.8	11	1.2	1.0

P.: polar axis; E.: equatorial axis; P.ex: exine thickness in polar view; E.ex: exine thickness in equatorial view; Mes: mesocolpium; E.lum: length of the lumina in equatorial view; P.lum: length of the lumina in polar view.

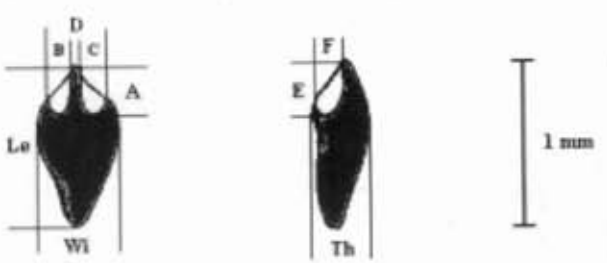

Fig. 3: Frontal and lateral views of *Origanum syriacum* mericarp

Fig. 4: a, b, c Different shapes in *Origanum syriacum* mericarp

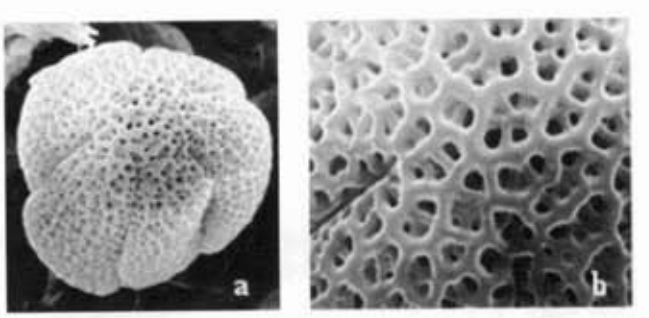

Fig. 5: SEM micrographs of *Origanum syriacum* pollen: a) pollen with six colpi (x3.000), b) reticulate ornamentation with lumina of the exinic wall (x10.000)

The measurements were recorded on 30 mericarps and 30 pollen grains for each accession.

Based on cluster analyses relative to the mericarps and pollen grains using the Euclidean distance of the morphobiometric characters (length, width, polar axis,

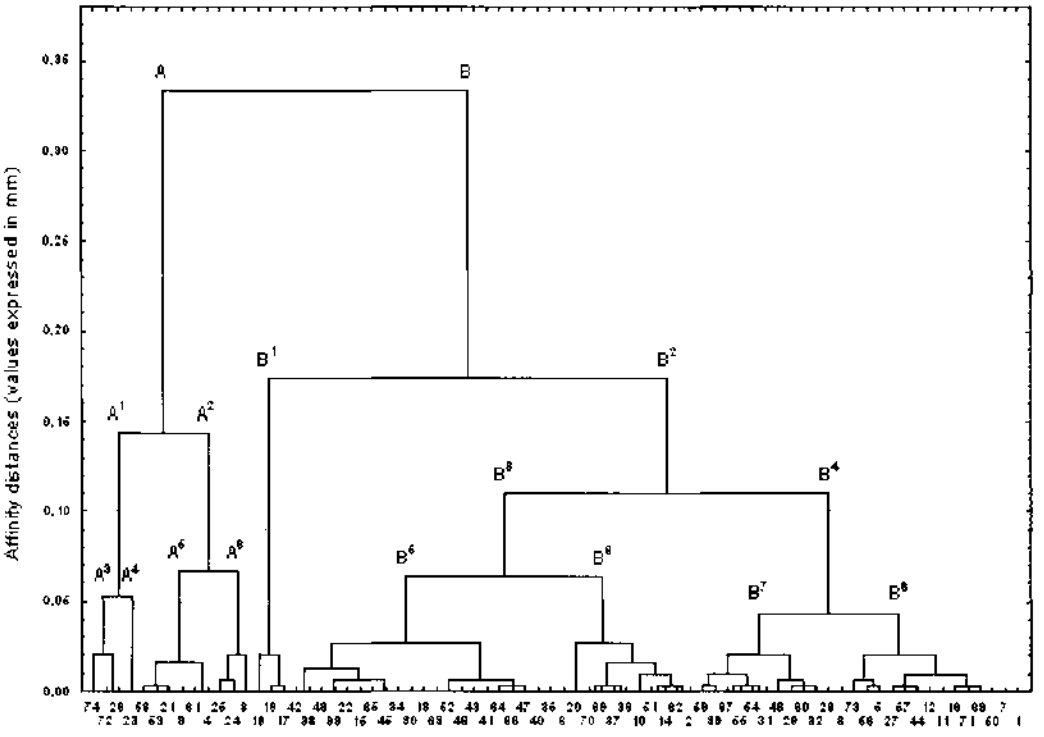

Fig. 6: Average linkage cluster analysis of 74 *Origanum syriacum* accessions based on length (Le) of the mericarps

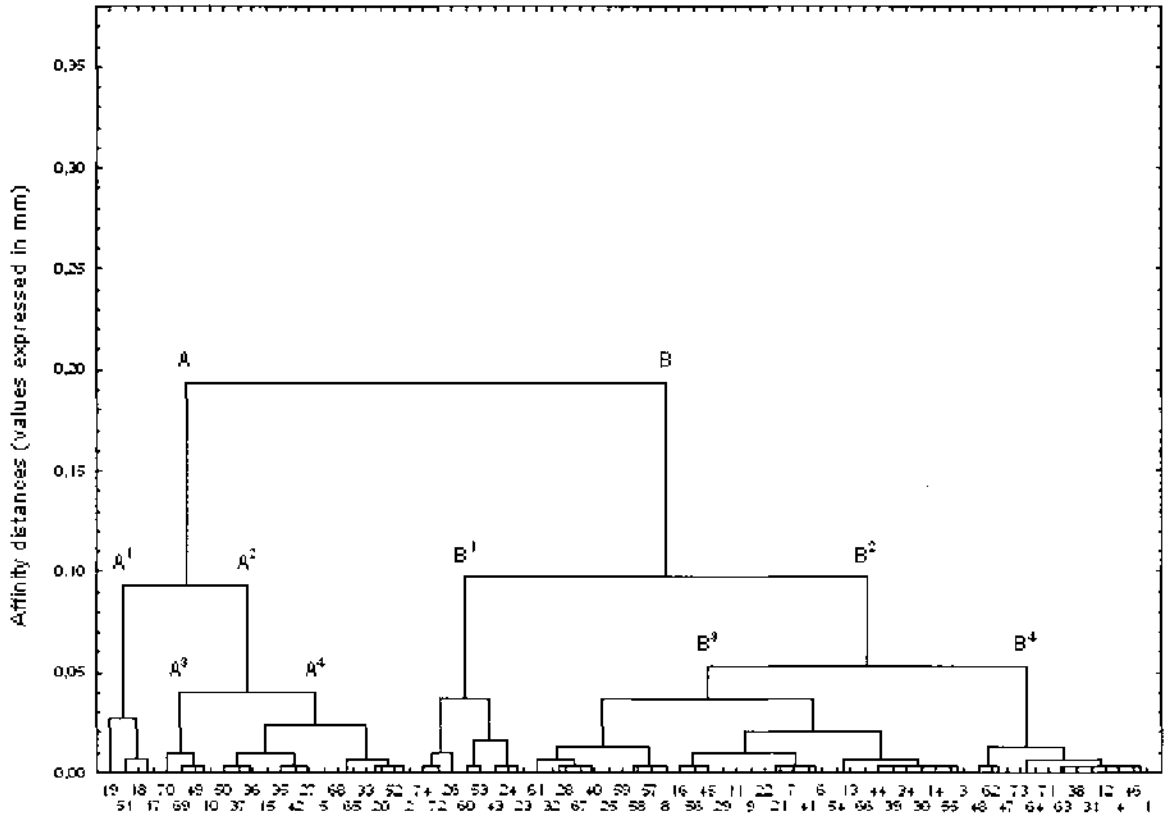

Fig. 7: Average linkage cluster analysis of 74 *Origanum syriacum* accessions based on width (Wi) of the mericarps

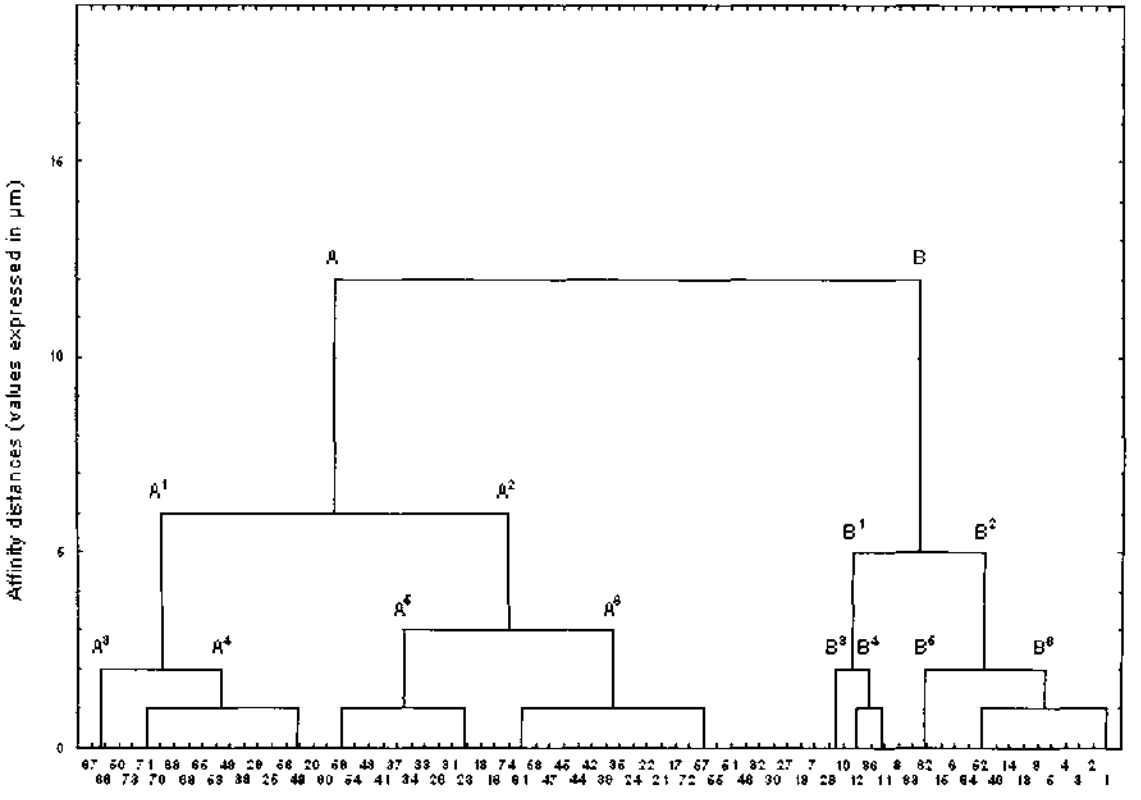

Fig. 8: Average linkage cluster analysis of 74 *Origanum syriacum* accessions based on equatorial axis (E.) of the pollen grains

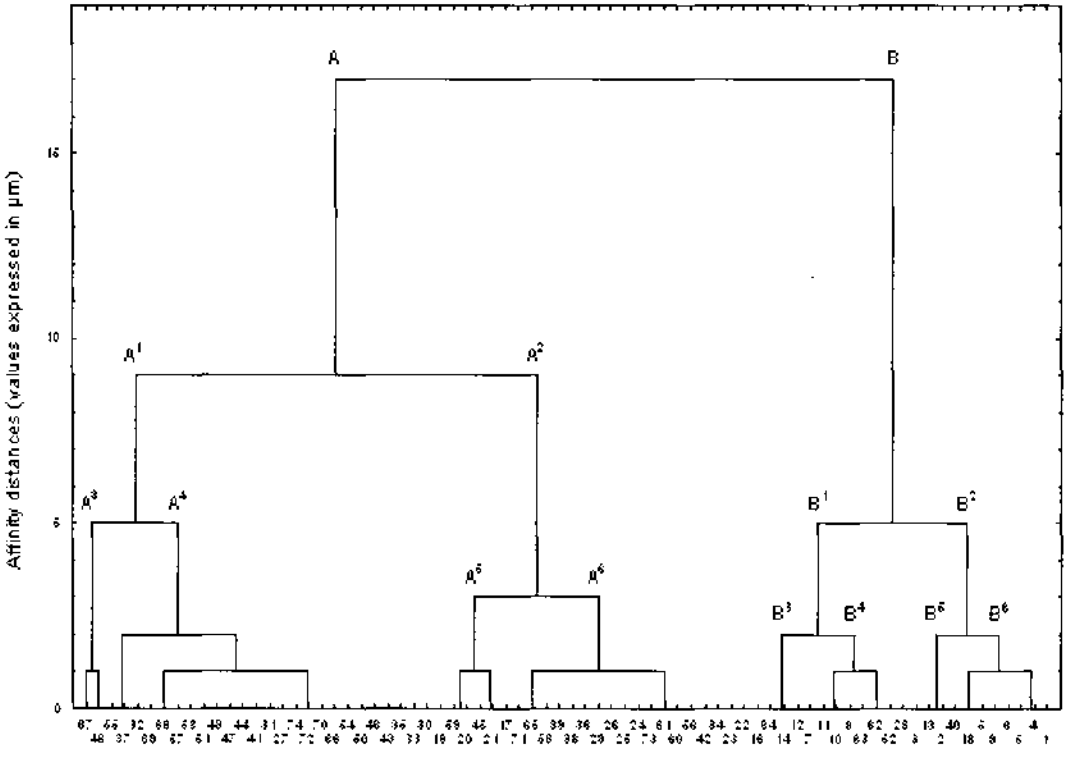

Fig. 9: Average linkage cluster analysis of 74 *Origanum syriacum* accessions based on polar axis (P.) of the pollen grains

equatorial axis), the 74 accessions of *O. syriacum* used in the study were grouped in four clusters (Fig. 6, 7, 8, 9).

Results and Discussion

The study revealed that the mericarps had a colour that varied from egg-yellow to brown-purple, but the most frequent colours were orange-brown, red-brown and nut-brown (Table 2). The shape varied from restricted-elliptical to wide-ovoidal, but the most frequent were ovoidal and tight-ovoidal (Fig. 4a, 4b, 4c). The mean values of different carpological parameters (Table 2) indicated that the mericarp length (Le) varied from 0.70 mm in the accessions Amm 12, A Tr 3, R Naa 8 to 1.40 mm in M Me 31; the width (Wi) from 0.4 mm in Agh 3, A Tr 1, A Tr 3 to 0.9 mm in Agh 17, War 10; the thickness (Th) from 0.2 mm in A Tr 1, K Nab 15, K Nab 15a to 0.5 mm in Agh 5,13,15, Amm 15, Bmh 3, K Nab 18, 21,32, War 4; length of areola (A) from 0.18 mm in A Tr 1 to 0.26 mm in Bir 13; width of left areola cavity (B) from 0.12 mm in Agh 15, Knab 7, K Nab 14 to 0.22 mm in Gea 4; width of right areola cavity (C) from 0.12 mm in Amm 17, A Tr 1, K Nab 25, K Nab 36, M Ba 2ab, M Me 27, Ram 2a to 0.24 mm in Bir 13; width of areola (D) from 0.28 mm in K Nab 4 to 0.45 mm in Amm 6, Bir 13; length of areola seen laterally (E) from 0.14 mm in A Ha 4 to 0.25 mm in Amm 17; and the width of areola seen laterally (F) from 0.16 mm in K Nab 31, M Me 8 to 0.23 mm in Amm 17, Bmh 6, Gea 4, K Nab 7, K Nab 10, K Nab 21.

The pollen grains are characterized by monads, isopolar and radiosymmetrical shapes. The openings are formed by 6 longitudinal colpi running in parallel or slightly nearer in the central part. The tectum has a primary reticulum with wide lumina and a secondary reticulum with a smaller lumina (Fig. 5a, 5b). The mean values of different palynological parameters (Table 3) indicated that the polar axes (P.) varied from 24 μm in R Naa 3 to 46 μm in Agh 17; equatorial axes (E.) from 25 μm in Bir 6, Ram 8, R Naa 2a,3,7,8 to 44 μm in A Da 1, Agh 13; the thickness of the exine in polar view (P.ex) from 2.0 μm in War 10 to 3.5 μm in A Da 1,4, Agh 3,5,8,13,14,15,17, Amm 1,6,12, A Tr 1, Gea 2; thickness of the exine in equatorial view (E.ex) from 1.5 μm in K Nab 4,7,8,12, War 10 to 2.9 μm in Amm 1,6,12, A Tr 1; distance between the two colpi in equatorial view (Mes) from 7 μm in Agh 14, Bir 6 to 24 μm in Agh 5; length of the lumina in equatorial view (E.lum) from 0.6 μm in Agh 14,15, Amm 11 to 2.4 μm in A Da 1,4 Agh 8,13; length of the lumina in polar view (P.lum) from 0.6 μm in Agh 14,15,17, A Ha 3a,4 to 2.4 μm in Agh 13.

The characteristics of the fruits, the presence of endosperm and the shape of the corolla are some of the useful characters in the phylogeny of the Lamiaceae and have been used as important elements in recent classifications (Cantino and Sanders, 1986; Cantino, 1992; Cantino *et al.*, 1992). There also exists an extensive literature on the study of the pericarp, which indicates the usefulness of this character for the classification of this family (Hedge, 1970; Marin *et al.*, 1994; Rejdali, 1990; Ryding, 1992, 1994, 1995; Campion-Bourget, 1993). The variation in chemical constituents in *O. syriacum* had earlier been reported (Fleisher and Fleisher, 1991; Dudai *et al.*, 1992). Interesting results on the taxonomy, evolution, conservation and utilization of the genus *Origanum* are also available in literature (Padulosi 1997). However, little or no research at all had ever been carried out on the morphobiometry of mericarps of *Origanum* species. More generally, in *O. vulgare* L. and *O. majorana* L., Fabre and Nicoli (1965) observed mericarps with a dimension of 0.5-1.0 mm, ovoid in shape, smooth walls, not hairy and areola with basal position and conical shape. *O. onites* L. (present in the sect. Majorana (Miller) Bentham together with *O. syriacum*) has a colour from orange-brown to brown and a shape from elliptic to widely obovate. From the comparison of the mericarps of these two species, it is apparent that there is a greater thickness of mericarp in *O. onites* both in frontal and lateral view, while the length of the areola and its concavity are smaller.

From the palynological point of view, the family Lamiaceae has been well studied especially with regard to its important melisso-palynological contribution (Maurizio and Louveaux, 1962; Ubera, 1981; De Leonardis *et al.*, 1982, 1984, 1992; Negrin Sosa and La-Serna Ramos, 1985; Zizza *et al.*, 1985; León-Arencibia and La-Serna Ramos, 1992). Pla Dalmau (1961) examined the pollen grains of *O. vulgare* L. defining the surface of the exine as being a rough claveate type. Moore and Webb (1978) included the pollen of the genus *Origanum* in the type *Mentha* (with *Mentha*, *Lycopus*, *Thymus* and *Salvia*), characterized by a perforated eureticolate tectum and distinct from the *Prunella* type (with *Prunella*, *Nepeta* and *Glechoma*) that has a suprareticulate tectum. Luque and Candau (1987) ascribed *O. compactum* Bentham and *O. virens* Hoffmanns. & Link to the type *Salvia verbenaca* characterized by pollen with a exinic wall and double

reticulum. It is possible to palynologically include the genus *Origanum* in one of the melissotypes described by Persano Oddo and Ricciardelli D'Albore (1989). Furthermore, morphobiometric characters in both palynological and carpological studies, always played an important role to distinguish wild and/or cultivated varieties (Vaughan and Whitehouse, 1971; Roselli, 1979; Recupero-Reforgiato *et al.*, 1988; De Leonardis *et al.*, 1993, 1996a, 1996b, 1998, 2002, 2004; De Leonardis and Fichera, 1995).

In the present study, interestingly the results obtained from the measurements carried out on mericarps and pollen grains of the populations of *O. syriacum* revealed that the length and the width of the mericarps, the size of the polar and equatorial axes of the pollens did not have comparable values within the populations observed. As a matter of fact, it can be concluded from the results (Table 2, 3) that parameters such as length, width, polar axis and equatorial axis did not lead to similar groupings in the dendrograms. Consequently, there was no correspondence among the populations presented in the dendrograms.

Such a condition does not prejudice, however the validity of the dendrograms if they are taken into consideration only in relation to single parameters (Fig. 6, 7, 8, 9). In the dendrograms related to the length and the width of the mericarps (Fig. 6, 7) it was in fact possible to discriminate two groups (A and B) in their turn subdivided in further subgroups, as it can be inferred in the dendrograms elaborated on the basis of the values polar axes and equatorial axes of the pollen (Fig. 8, 9). In the mericarps, however, the presence of numerous subgroups highlighted a greater diversity manifested also through a significant diversification of shapes within the same populations. In the pollen grains, on the contrary, the observed fewer number of subgroups indicated a greater affinity among populations. Many gametophytic characteristics were reported to be related to sporophytic traits (Ottaviano and Mulcahy, 1986). These correlations can be explained in physiological terms considering that the growth parameters in both sporophyte and gametophyte depend on the same metabolic activities (Ottaviano *et al.*, 1980). In this study, the palynological uniformity (observed in reticulate exine, exacolpic, radiosymmetry etc.) did not reflect the evolutionary tendencies observed by Punt (1967, 1971 and 1976) and Walker and Doyle (1975) in many other genera. But at the same time, the discrepancy between the pollen uniformity and mericaps diversity observed here could be explained with the enthomogamous mechanism of pollination of the Lamiaceae characterized by intense gene flow among populations which impact mainly pollen grains making them more uniform than mericarps.

In conclusion, the two groups (A and B) identified in the study, could either correspond to the two varieties of *O. syriacum* described by Ietswaart (1980) (*O. syriacum* L. var. *syriacum* and *O. syriacum* var. *bevanii* (Holmes) Ietswaart), or simply be considered as ecoforms related to the specific climatic, edaphic and altitudinal conditions in which the sampled specimens had been growing. The results from this work also indicated the occurrence of diverse populations within *O. syriacum* in Lebanon, an area particularly promising as source of resistant genes to abiotic stresses (e.g. resistant to drought) in view of very dry conditions where the populations were sampled, making these genetic resources an interesting material for breeding aiming at improving agronomic and other economically useful traits in the species.

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