Studia bot. hung. 29, pp. 69–78, 1998 (1999)

BRYOPHYTES AND LICHENS OF SOME PHRYGANA AND MAQUIS STANDS OF CRETE (GREECE)

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Terricolous and saxicolous bryophytes and lichens of six areas of maquis and phrygana stands were studied in the regions of Chania, Rethimno, Iraklion and Lasithi (Crete) during a field trip in April, 1997. Floristical evaluation and comparison of the different maquis and phrygana stands were carried out using the European distribution of the bryophyte species and bryophyte life strategy categories. In the stands investigated 19 liverworts, 47 mosses and 31 lichen species were collected. Three bryophyte and 4 lichen species are new to Crete. A vulnerable liverwort species were found in Rethymno region in the maquis stands of Mt Psiloritis. Acrocarpous mosses and xerotolerant thalloid liverworts have great importance in the species composition of the stands of Mediterranean vegetation type and they are represented by many species in the stands investigated.

Key words: bryophytes, Crete, lichens, maquis, phrygana

INTRODUCTION

It is still very promising to study the cryptogams in Greece even today. From several areas (*e.g.* Peloponnisos), being very poorly explored, still a great deal of new floristical and taxonomic results might be expected. The most complete checklists on the bryophytes of Greece, summarising all the earlier records, were published by PRESTON (1981, 1984). Recently DÜLL (1995) gave also a very good compilation, including a lot of new records. A detailed introduction to the literature on Greek lichens was published by CHRISTENSEN (1989).

Most of these records originated usually from foreign specialists. Recently in Greece, at least at some institutes, also Greek researchers started to study the cryptogamic flora of Greece. It is very important to know the flora satisfactorily, because more and more areas are influenced, even destroyed by human impact. Several habitats have been disappearing without being known their flora and fauna in detail. It is especially true in case of the East Mediterranean region, where the nature has been used and transformed already for thousands of years.

Our knowledge on the bryophytes and lichens of Crete are more complete in contrast with those of Greece. Some papers on the Cretan bryophytes and lichens were published already at the beginning of this century, *e.g.* ZAHLBRUCKNER

(1906), NICOLSON (1907), SCHIFFNER (1915), STEINER (1916) and MEDELIUS (1927). The bryophyte flora and vegetation of Crete were studied thoroughly by DÜLL (1966) and DÜLL and DÜLL-HERMANNS (1973). Some more bryofloristical records were published by GRADSTEIN (1970), LAFLIN (1973), and BISCHLER and JOVET-AST (1979). The lichens collected by K. H. Rechinger in Crete were identified by SZATALA (1951). KLEINIG (1966) summarised all the earlier records together with his own findings. Several more records were published by RONDON (1969).

The aim of our study was the comparison of the different maquis and phrygana stands on the basis of their cryptogamic vegetation.

MATERIALS AND METHODS

Terricolous and saxicolous bryophytes and lichens of six areas of maquis and phrygana stands (Fig. 1) were studied in the western, central and eastern part of Crete during a field trip in April, 1997.

1. Chania region, 2 km from the village Kartsamatados to Miloi in the valley of Tiflos stream, maquis on a southeast facing slope, alt. 250 m. Dominant vascular plants: *Arbutus unedo*, *Calicotome villosa*, *Cistus salvifolius*, *Erica arborea*, *Genista acanthoclada*.

2. Iraklion region, Mt Jouhtas, at the village Epano Arhanes, a stand in a transitional stage between maquis and phrygana on an east facing slope, alt. 500 m. Dominant vascular plants: *Calicotome villosa*, *Coridothymus capitatus*, *Ebenus cretica*, *Euphorbia characias*, *Phlomis lanata*, *Pistacia lentiscus*, *Quercus coccifera*, *Salvia triloba*, *Sarcopoterium spinosum*.

3. Rethymno region, Mt Psilorotis 2 km from the village Sisses to Aloides, maquis on an east facing slope, alt. 220 m. Dominant vascular plants: *Arbutus unedo*, *Calicotome villosa*, *Pistacia lentiscus*, *Quercus coccifera*.

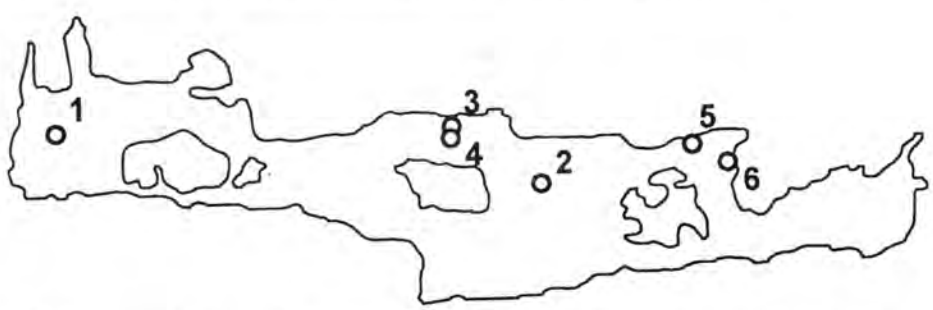

Fig. 1. Location of the stands in Crete. (1 = Valley of Tiflos stream (Chania region), 2 = Mt Jouhtas (Iraklion region), 3 = Mt Psilorotis at Sisses (Rethymno region), 4 = Mt Psilorotis at Damasta (Rethymno region), 5 = cave Milatos (Lasithi region), 6 = near Elunda (Lasithi region)).

4. Rethymno region, Mt Psilorotis 3 km from the village Damasta to Marathos, maquis on a northeast facing slope, alt. 330 m. Dominant vascular plants: *Calicotome villosa*, *Phlomis lanata*, *Pistacia lentiscus*, *Quercus coccifera*, *Sarcopoterium spinosum*.

5. Lasithi region, around the cave Milatos at the village Milatos, phrygana on a west facing slope, alt. 150 m. Dominant vascular plants: *Euphorbia acanthothamnos*, *E. dendroides*, *Phlomis lanata*, *Quercus coccifera*, *Salvia triloba*.

6. Lasithi region, at the village Plaka near Elunda, phrygana on a south facing slope, alt. 50 m. Dominant vascular plants: *Asphodelus aestivus*, *Calicotome villosa*, *Phlomis lanata*, *Pistacia lentiscus*.

The specimens collected during the study trip are deposited in the Hungarian Natural History Museum and the Natural History Museum of Crete. The floristical evaluation and comparison of the different maquis and phrygana stands were carried out using the European distribution of the bryophyte species according to DÜLL (1983, 1984, 1985) and bryophyte life strategy categories (DURING 1979, ORBÁN 1984).

RESULTS

In the stands investigated 19 liverworts, 47 mosses and 31 lichens were collected (Table 1). Three bryophyte species, new to Crete (as *Weissia longifolia*, *W. rutilans*, *Funaria pulchella*) and *Petalophyllum ralfsii*, a vulnerable species according the list of Red Data Book of European Bryophytes (SCHUMACKER, R. and MARTINY, PH. (1995), were collected in Rethymno region in the maquis stands of Mt Psiloritis. Four lichen species (*Caloplaca carphinea*, *Cladonia cervicornis* subsp. *verticillata*, *Psora testacea* and *Xanthoparmelia tinctina*) seem to be new to Crete.

Acrocarpous mosses and xerotolerant thalloid liverworts have great importance in the species composition of the stands of Mediterranean vegetation type and they are represented by many species in the stands investigated. For example 21 taxa of Pottiaceae acrocarpous moss family and 5 taxa of Ricciaceae a drought tolerant thalloid liverwort family were found. The members of these groups avoid desiccation by the virtue of their morphological and anatomical features that promote water uptake or storage, or restrict water loss. On drying, the leaves or thallus become crisped, contorted to impede the water loss. In the Pottiaceae the leaves have recurved margins, papillose surfaces. The papillae and recurved leaf margin accelerate the spread of the water over leaf surfaces.

Table 1. List of the species in the stands (I: Miloi, II: Jouhtas, III: Milatos, IV: Elunda, V: Sisses, VI: Damasta).

		Species/locality			I	II	III	IV	V	VI
		HEPATICAE								
1		*Cephalozia bicuspidata* (L.) Dum.	temp	C					+	
2		*Cephaloziella baumgartneri* Schiffn.	oc-med	C		+			+	+
3		*Corsinia coriandrina* (Spreng.) Lindb.	suboc-med	C	+				+	+
4		*Fossombronia angulosa* (Dicks.) Raddi	oc-med	AS	+					
5		*Fossombronia caespitiformis* De Not. ex Rabenh.	oc-med	AS	+	+	+		+	+
6		*Gongylanthus ericetorum* (Raddi) Nees	oc-med	C	+					
7		*Lunularia cruciata* (L.) Dum. ex Lindb.	oc-med	C					+	+
8	×	*Mannia androgyna* (Lindb.) Evans	med	SL			+	+		
9		*Petalophyllum ralfsii* (Wils.) Nees et Gott.	oc-med	C					+	
10		*Phaeoceros laevis* (L.) Prosk.	suboc-submed	AS	+				+	
11	×	*Plagiochasma rupestre* (Forst.) Steph.	med	SL			+	+		
12	×	*Riccia bicarinata* Lindb.	med-suboc	AS						+
13	×	*Riccia canescens* Steph.	submed	AS	+					
14	×	*Riccia macrocarpa* Levier in Goiran	suboc-med	AS	+					
15	×	*Riccia michelii* Raddi	med-suboc	AS					+	
16	×	*Riccia trabutiana* Steph.	oc-med	AS				+		
17		*Southbya nigrella* (De Not.) Henriques	oc-med	C		+	+		+	+
18		*Southbya tophacea* (Spruce) Spruce	oc-med	C					+	
19	×	*Targionia lorbeeriana* K. Muell.	med-suboc	SL			+	+	+	+
		MUSCI								
20	*	*Aloina aloides* (Schultz) Kindb.	submed	C		+	+	+		
21	*	*Barbula unguiculata* Hedw.	temp	C		+				
22		*Bryum caespiticium* Hedw.	temp	C	+	+			+	+
23		*Bryum torquescens* B. et S.	submed-suboc	C	+	+	+			+
24		*Bryum* sp. 1			+					
25		*Bryum* sp. 2						+		
26		*Cheilothela chloropus* (Brid.) Lindb.	oc-med	C					+	
27		*Dicranella varia* (Hedw.) Schimp.	temp	C		+			+	+
28	*	*Didymodon luridus* Hornsch.	submed	C		+			+	+
29	*	*Didymodon vinealis* (Brid.) Zander	submed	C		+				

Table 1 (continued)

		Species/locality			I	II	III	IV	V	VI
30		*Encalypta vulgaris* Hedw.	submed	SL					+	+
31		*Entosthodon attenuatus* (Dicks.) Bryhn	submed-oc	SL	+					
32		*Entosthodon curvisetus* (Schwaegr.) C. Muell.	med	SL			+			
33		*Fissidens bryoides* Hedw.	temp	C					+	
34		*Fissidens incurvus* Starke ex Roehl.	submed	C						+
35		*Fissidens limbatus* Sull. var. *bambergeri* (Schimp. ex Milde) Düll	suboc-med	C		+				
36		*Fissidens pusillus* (Wils.) Milde	temp(-mont)	C					+	
37		*Fissidens taxifolius* Hedw. subsp. *pallidicaulis* (Mitt.) Moenk.	oc-med	C	+				+	
38		*Funaria hygrometrica* Hedw.	temp	F					+	
39		*Funaria muehlenbergii* Turn.	submed-suboc-mont	C			+			
40	°	*Funaria pulchella* Philib.	submed-suboc-mont	C					+	+
41		*Grimmia laevigata* (Brid.) Brid.	submed-suboc-mont	C	+					
42		*Grimmia pulvinata* (Hedw.) Sm.	temp	C		+				
43		*Grimmia trichophylla* Grev.	temp(-mont)	C	+				+	+
44	*	*Gymnostomum calcareum* Nees et Hornsch.	submed-mont	C					+	
45	*	*Gyroweisia reflexa* (Brid.) Schimp.	oc-med(-mont)	C		+			+	
46	*	*Gyroweisia tenuis* (Hedw.) Schimp.	submed-suboc-mont	C			+		+	
47	~	*Homalothecium sericeum* (Hedw.) B., S. et G. var. *meridionale* Schimp.	suboc-med-mont	P						+
48	~	*Hypnum cupressiforme* Hedw.	temp	P	+					
49	*	*Pottia davalliana* (Sm.) C. Jens.	submed	AS		+				
50	~	*Rhynchostegiella tenella* (Dicks.) Limpr. var. *litorea* (De Not.) Rich. et Wallace	oc-med	P	+				+	
51	~	*Rhynchostegium megapolitanum* (Web. et Mohr) B., S. et G.	submed	P					+	+
52	~	*Scleropodium touretii* (Brid.) L. Koch	oc-submed	P					+	+
53	~	*Scorpiurium circinatum* (Brid.) Fleisch. et Loeske	oc-med	P					+	
54	*	*Timmiella barbuloides* (Brid.) Moenk.	med	C					+	

Table 1 (continued)

		Species/locality			I	II	III	IV	V	VI
55	*	*Tortella flavovirens* (Bruch) Broth.	suboc-submed	C	+					
56	*	*Tortella nitida* (Lindb.) Broth.	oc-med	C		+	+		+	+
57	*	*Tortula atrovirens* (Sm.) Lindb.	submed	C		+				
58	*	*Tortula intermedia* (Brid.) De Not.	submed-mont	C		+				+
59	*	*Tortula muralis* Hedw.	temp	C		+				+
60	*	*Trichostomum brachydontium* Bruch	oc-med	C		+				
61	*	*Weissia brachycarpa* (Nees et Hornsch.) Jur.	temp	C			+		+	+
62	*	*Weissia condensa* (Voit.) Lindb.	submed-mont	C	+	+		+		
63	*	*Weissia controversa* Hedw. var. *controversa*	temp	C	+					
64	*	*Weissia controversa* Hedw. var. *crispata* (Nees et Hornsch.) Nyh.	submed-mont	C					+	
65	*°	*Weissia longifolia* Mitt.	temp	C						+
66	*°	*Weissia rutilans* (Hedw.) Lindb.	suboc	SL					+	+
		LICHENS								
1		*Aspicilia calcarea* (L.) Mudd		rup		+			+	
2		*Aspicilia radiosa* (Hoffm.) Poelt et Leuckert		rup					+	
3		*Aspicilia* sp. 1		rup	+					
4		*Aspicilia* sp. 2		rup			+		+	+
5	°	*Caloplaca carphinea* (Fr.) Jatta		rup	+					
6		*Caloplaca crenularia* (With.) Laundon		rup	+					
7		*Caloplaca* sp.		rup		+			+	+
8		*Candelariella vitellina* (Hoffm.) Müll. Arg.		rup	+					
9		*Cladonia pyxidata* subsp. *pocillum* (Ach.) Dahl		ter					+	
10	°	*Cladonia cervicornis* subsp. *verticillata* (Hoffm.) Ahti		ter	+					
11		*Cladonia convoluta* (Lam.) Anders		ter	+					
12		*Collema cristatum* (L.) Weber ex Wigg.		ter					+	
13		*Collema* sp.		ter		+				
14		*Diploschistes muscorum* (Scop.) R. Sant.		ter	+					+
15		*Fulgensia subbracteata* (Nyl.) Poelt		ter	+	+			+	
16		*Lecanora muralis* (Schreber) Rabenh.		rup			+			
17		*Neofuscelia pulla* (Ach.) Essl.		rup	+					
18		*Physcia wainioi* Räsänen		rup	+					

Table 1 (continued)

	Species/locality		I	II	III	IV	V	VI
19	*Porpidia crustulata* (Ach.) Hertel et Knoph	rup	+					
20	*Psora decipiens* (Hedwig) Hoffm.	ter		+				
21	*Psora lurida* (Ach.) DC.	ter	+					
22	° *Psora testacea* Hoffm.	ter						+
23	*Squamarina cartilaginea* (With.) P. James	ter	+	+	+		+	
24	*Squamarina concrescens* (Müll. Arg.) Poelt	ter		+				
25	*Squamarina gypsacea* (Sm.) Poelt	ter			+			
26	*Squamarina lentigera* (Weber) Poelt	ter		+				
27	*Toninia candida* (Weber) Th. Fr.	rup		+				
28	*Toninia sedifolia* (Scop.) Timdal	ter		+				
29	*Toninia* sp.	ter					+	
30	*Verrucaria* sp.	rup			+		+	+
31	° *Xanthoparmelia tinctina* (Maheu et Gillet) Hale	rup	+					

° = new species to Crete, * = members of fam. Pottiaceae, ~ = pleurocarpous species, × = xerotolerant thalloid liverworts, rup = saxicolous lichens, ter = terricolous lichens

Maquis

In the maquis stands the bryophyte flora was very rich in species. Pleurocarpous mosses (*e.g. Sclepodium tourettii*, *Rhynchostegiella tenella* var. *litorea*, *Rhynchostegium megapolitanum*) were frequent in shady and more humid places such as under shrubs. On the other hand thalloid liverworts such as *Riccia* species and *Corsinia coriandrina*, *Lunularia cruciata* were characteristic on the open soil. A few drought tolerant leafy liverworts (*Gongylanthus ericetorum*, *Southbya* spp., *Cephaloziella baumgartneri*) and many acrocarpous mosses occur.

The maquis appeared to be richer in terricolous lichen species than phrygana. *Fulgensia subbracteata* and *Squamarina cartilaginea* occur in both type of vegetation. *Cladonia* spp. (*C. cervicornis* subsp. *verticillata*, *C. convoluta*, *C. pocillum*) and *Diploschistes muscorum* were found mainly in the maquis, while other *Squamarina* spp. (*S. concrescens*, *S. gypsacea*, *S. lentigera*) mainly in the phrygana.

The maquis of Miloi at Chania region is different from the other maquis stands, because of the more acidic soil and rock chemistry, which is indicated by the higher plant vegetation (*Erica arborea* maquis) and the occurrence of acido-

phylous bryophytes (*Gongylanthus ericetorum*, *Fossombronia angulosa*, *Grimmia laevigata*) and lichens (*Aspicilia* spp., *Caloplaca carphinea*, *Melanelia pulla*, *Porpidia* spp., *Xanthoparmelia tinctina*).

Phrygana

In the phrygana stands (Milatos and Elunda at Lasithi region) a large number of drought tolerant acrocarpous mosses (*e.g. Weissia*, *Didymodon*, *Tortella*, *Tortula* spp.) can be found. The pleurocarpous mosses are lacking. In the stands of Lassithi the species number is low. Some xerotolerant thalloid liverworts (*e.g. Plagiochasma rupestre, Mannia androgyna, Targionia lorbeeriana*) play great role.

DISCUSSION

The European distribution patterns of the bryophyte species show, that in the phrygana stands (Milatos, Elunda) the proportion of the Mediterranean (med, med-suboc, med-oc) species is higher than in maquis (Fig. 2). The other difference, that the species of European temperate zone (temp) are also important elements in maquis.

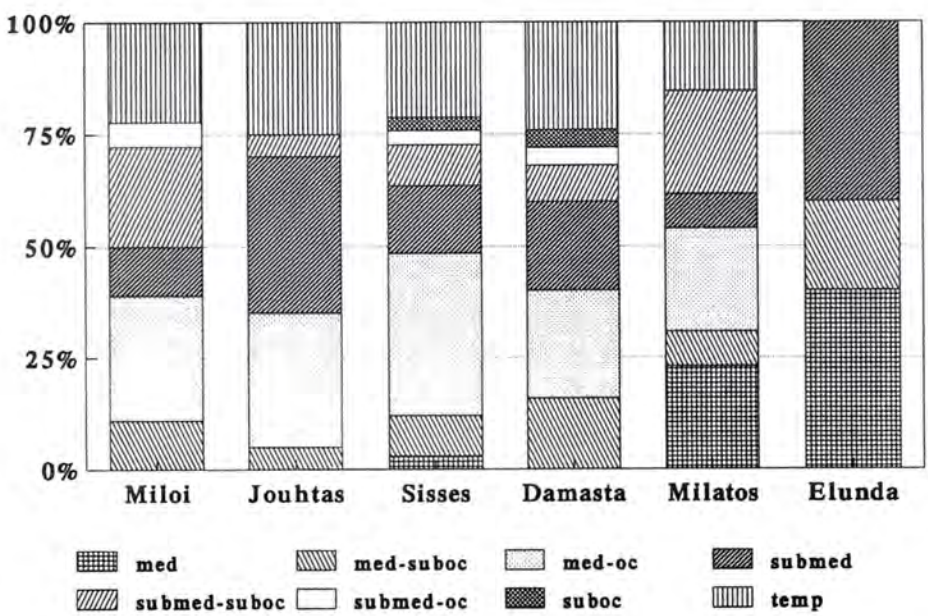

Fig. 2. European distribution character pattern of the stands. (med = Mediterranean, oc = oceanic, submed = sub-Mediterranean, suboc = suboceanic, temp = temperate).

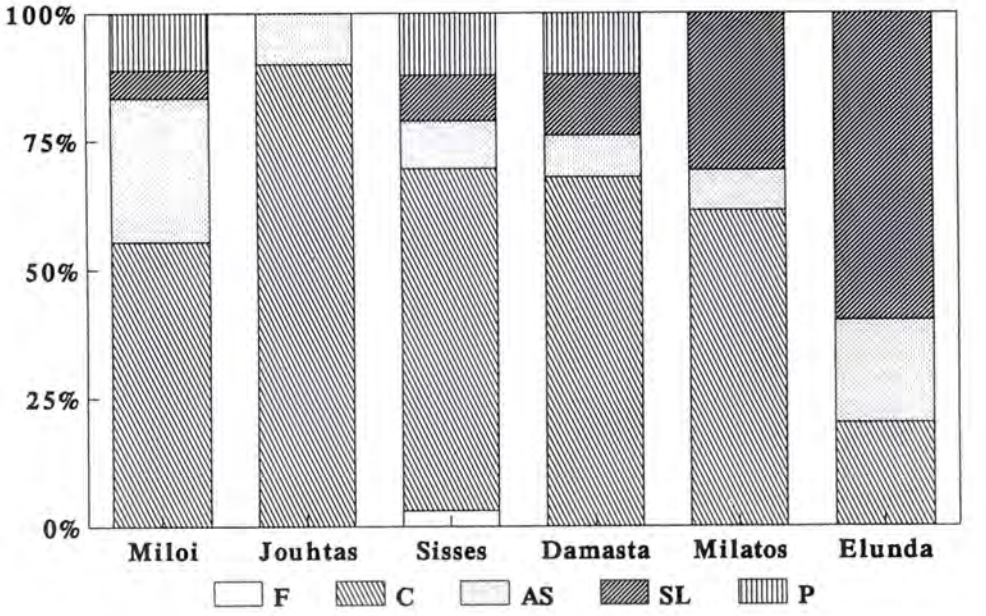

Fig. 3. Life strategy pattern of the stands. (F – fugitive, C – colonist, AS – annual shuttle species, SL – short lived shuttle species, P – perennials).

On the basis of life strategy spectra (Fig. 3) it can be assumed that the perennial (P) species – requiring continuous, constant living conditions – are lacking from phryganas and their proportion is low even in the maquis. Usually a high percentage of colonist (C) species – capable of quickly occupying newly formed habitats – can be detected in each stand. They can tolerate the extreme conditions. In phrygana stands the role of short leaved shuttle (SL) species is also remarkable. These species are adapted to such habitat which remains suitable for 2–3 years. The annual shuttle (AS) species, which also occur in each stand, can be characterized by strong avoidance of seasons with severe stress.

* * *

Acknowledgements. Many thanks for the financial support to the Cretan Natural History Museum (Iraklion) and the Hungarian Scientific Research Fund (OTKA No. T013275). We are grateful to Jorgos Tsourlis and Zoi Tsekoura for the help in the field trip to Chania region, and to Mr O. W. Purvis for sending us a copy of the Rondon's paper.

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(Received 10 June, 1999)