TWO WAYS OF VEGETATION CLASSIFICATION FOR THE HIGH MOUNTAINS OF CRETE: A CRITICAL COMPARISON OF METHODS AND RESULTS

E. BERGMEIER

Albert-von-Haller Institute for Plant Sciences, Department Vegetation and Phytodiversity Analysis, University of Göttingen, Untere Karspüle 2, D-37073 Göttingen, Germany. E-mail: erwin.bergmeier@bio.uni-goettingen.de

ABSTRACT - A data set of 229 phytosociological relevés recorded in the high mountains of Crete (Greece), by Zaffran (1990), is revised and re-classified. The present classification deviates much from Zaffran's original one by the number of vegetation units which are distinguished, their characters and delimitations. Synoptic tables are provided here for both classifications in order to compare the results. Differences are chiefly due to methodology: The original classification is biased in adopting presumed character species including a high proportion of endemics; the present one is based on differential species with defined criteria. With respect to the aims of international projects such as European Vegetation Survey, it is suggested to define a set of binding basic criteria for syntaxa concerning parameters such as differentiation, representation and distribution of syntaxa. As a basis for regional monographs, vegetation units should comprise most if not all vegetation stands that can actually be observed in the field; the units should be distinct enough in order to be identifiable, and their floristics well-defined; finally they should be ecologically interpretable and meaningful. Evaluation of literature data for, e.g., EVS requires thorough assessing of possible shortcomings in floristics, taxonomy, sampling and classification procedures.

KEY WORDS - Character species, Differential species, Endemism, Greece, Oro-mediterranean vegetation, TWINSPAN

INTRODUCTION

Vegetation classification attempts to define units of various extent and spatial significance. Vegetation units provide means to assess the range of validity of results taken from studies on individual stands. A set of methodologically consistent units allows comparison between the vegetation of different areas, and is a prerequisite for vegetation surveys on any scale. Different kinds of reference data and methodological background generally result in different classification systems. A fruitful classification may inspire scientific hypotheses and subsequent studies, and it should draw the attention of scientists towards ecological, phytogeographical, taxonomic, physiological, historical, phenological or cenological phenomena. With the phytosociological or Braun-Blanquet method, one of the most developed and widely used classification systems in vegetation has evolved. The Braun-Blanquet method makes use of floristic characters when defining units or vegetation types (syntaxa). Much basic knowledge has accumulated about which vegetation types may be distinguished and about their distribution and ecology. However, there is still much discussion related to the variability and delimitation of vegetation units. Classification depends on the quality of the vegetation records and the way of sampling, but of course also on the classification procedure and evaluation, no matter whether sorting of relevés is done by hand or assisted by classification software. It is crucial for vegetation scientists to critically assess a classification in the light of how it was performed, how the results were obtained and whether they are applicable.

In the present paper a study on mediterranean high-mountain vegetation taken from literature is discussed and compared with the results of another classification of the same data set. Flora and vegetation of the principal mountain ranges of Crete (Greece), Lefka Ori, Psiloritis and Dikti, were studied by Zaffran between 1964 and 1972 but his phytosociological data had not been published before 1990 (in 1982 as "preprint" not freely available). Zaffran (1990) distinguishes 22 communities, all but two at association rank: 6 units of rock vegetation ("groupements rupicoles"), 13 units represent the vegetation of fixed slopes and dolines ("pelouses écorchées et garrides"), and 3 units were distinguished on screes ("groupements d'éboulis"). The high number of associations in Zaffran's classification has repeatedly been interpreted as indicator for high variation in vegetation and for habitat diversity (most recently Hempel, 1995).

Zaffran presents his data in tabular form, each unit being represented by a table. Assessment of the proposed vegetation units is difficult, however, as the relations of the units cannot be viewed directly by means of structured full or synoptic tables. Moreover, no explicit information is given on the classification and delimitation principles adopted.

The present contribution attempts to test Zaffran's results by using exactly the same data set. Three questions are discussed: (1) What are the differences between Zaffran's classification principles and those adopted in the present classification? (2) Will re-classification of Zaffran's original data set reveal different results? (3) Are the vegetation units proposed by Zaffran sufficiently discrete by floristic characters to be distinguishable, also in the field? Another aim of this paper is to make Zaffran's data interpretable and more easily usable for future surveys and theoretical and applied work on the vegetation of Crete and the mediterranean mountains.

Methods

From a total of 295 relevés provided by Zaffran (1990), 229 samples were selected that represent high-mountain vegetation. The altitudinal range is between 1.400 m and the peaks above 2.400 m above sea-level. All three major mountain massifs are represented. Bedrock is crystalline limestones and dolomites throughout. Karstic terrains with dolines and underground drainage are common. Taxonomy and nomenclature of taxa adopted by Zaffran was updated according to the "Mountain Flora of Greece" (Strid, 1986; Strid & Tan, 1991) and the "Exkursionsflora für Kreta" (Jahn &

Schönfelder, 1995). For the name of *Silene flavescens* subsp. *dictaea* see Greuter (1995). Various floristic records were considered erroneous and consequently corrected.

The names of Zaffran's associations are invalid since no type relevés have been indicated, hence they are given in this paper in inverted commas. They are used here in a strictly informal way. No attempt was made to validate them, nor to correct them according to the Code of Syntaxonomic Nomenclature. For syntaxonomy and nomenclature of the Cretan high-mountain Vegetation the reader is referred to Bergmeier (2002).

In order to judge distinctness of the vegetation types a synoptic (constancy) table was created using 22 (of 30) unstructured community tables provided by Zaffran (1990). Species and community order within the synoptic table were rearranged in order to emphasize floristic differences. Subsequently, the same data set consisting of all individual relevés was re-classified using Two-way indicator species analysis (TWINSPAN) (Hill, 1979). The initial order of relevés and species calculated by TWINSPAN was modified by hand in order to maximize discreteness of the clusters. No relevé was omitted. Species of similar differential value were grouped. Data entry and handling were supported by using the TURBOVEG/MEGATAB package (Hennekens, 1999). The final number of columns (vegetation units) was obtained by adopting the following criteria: (a) Each unit has a unique floristic composition and is defined by a group of differential species (*i.e.*, taxa diagnostic for one or few communities within the total data set), with or without character species (*i.e.*, diagnostic for one and only one community); (b) each unit is meaningful with respect to environmental interpretation. A taxon is considered diagnostic for one or few communities within the given data set, if its constancy percentage value is more than 30 and more than twice the value than in other communities (slightly modified from a previous definition proposed in Bergmeier, Härdtle, Mierwald, Nowak & Peppler 1990).

RESULTS

ORIGINAL CLASSIFICATION

The 22 plant communities as proposed by Zaffran (1990) are arranged in synoptic tabular form (table 1). Original names are given below, together with comments on distribution, altitude and habitat (compiled from Zaffran, *op. cit.*), and floristic distinctness.

- Column 1 (Orig. table 5: "*Origano-Staehelinetum fruticosae*")
  Psiloritis and Dikti; (1400-)1700-1900 m; dolomitic rock, south-exposed fissures. Well-defined in the given data set (mountains) but similar species combinations occur at lower levels; the community is distinct enough to occur also in the re-classified table (see community 1).
- Col. 2 (Orig. table 6: "*Asplenio-Alyssetum lassitici*")
  Psiloritis and Dikti; 1400-2100 m; limestone rocks. Although no less than 9 association character species are listed, the community is mainly characterized by the endemic *Silene antri-jovis* (as "*S. fruticulosa*") and *Asplenium lepidum* subsp. *haussknechtii*. The unit is almost identical with the *Silene antri-jovis-Campanula jacquinii* community in the new classification.

TABLE 1 - SYNOPTIC TABLE FOR 22 VEGETATION UNITS AS CLASSIFIED BY ZAFFRAN (1990). CONSTANCY PERCENTAGE VALUES ARE GIVEN EXCEPT IN COLUMNS 5 AND 20 (HERE ABSOLUTE RELEVÉ NUMBERS). TAXA WITH LESS THAN 30 % CONSTANCY IN EACH COLUMN ARE OMITTED, EXCEPT FOR THOSE WHICH ARE SAID TO BE ASSOCIATION CHARACTER SPECIES. SPECIES OF DIAGNOSTIC VALUE FOR ONE COMMUNITY (FOR DEFINITION SEE TEXT) ACCORDING TO THE CLASSIFICATION ARE SET BOLD. E: LOCAL AND REGIONAL ENDEMICS OF THE CRETAN AREA. AN ASTERISK (*) PRECEDES SUBSPECIES OR VARIETY EPITHETON. THE LETTER "A" INDICATES TAXA WHICH HAVE BEEN CONSIDERED ASSOCIATION CHARACTER SPECIES BY ZAFFRAN; THE FIGURES GIVE THE COLUMN NUMBER(S) OF THE RESPECTIVE UNIT(S).

	Column number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Original table number		5	6	1	2	3	4	29	28	27	15	16	19	20	21	18	17	30	22	23	24	26	25
	Number of relevés		5	10	11	6	4	5	16	16	16	14	8	10	8	8	18	21	8	21	6	4	6	8
E	**Origanum dictamnus**	A1	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Satureja juliana	A1,3,11	80	.	27	.	.	.	.	.	.	.	50	.	.	.	.	.	.	5	.	.	.	.
	Scrophularia lucida	A1	80	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Rosularia serrata	A1	60	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Erica manipuliflora		60	.	9	.	.	.	13	.	.	.	.	.	.	13	.	.	.	.	.	.	.	.
	Helictotrichon agropyroides	A1	40	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Crepis fraasii * mungieri	A1,22	40	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25
	Staehelina fruticosa	A1	40	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E	**Silene antri-jovis**	A2	40	90	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	29	.	.	.	.
E	**Arenaria fragillima**	A2	40	80	.	.	.	20	.	.	.	.	.	.	13	.	.	.	.	.	.	.	.	.
	Arenaria muralis		40	30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Asplenium lepidum * haussknechtii	A2	.	50	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Euphorbia deflexa	A2	.	40	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E	Crepis auriculifolia	A2	20	30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Carum multiflorum	A2,12	20	30	.	.	.	.	.	.	.	.	.	30	.	.	.	.	.	.	.	.	.	.
	Galium incanum * creticum	A2	.	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.
	Alyssum lassiticum	A2	.	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Lamium garganicum * striatum	A2	.	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Gypsophila nana	A3	.	.	91	50	1	.	.	6	.	7	.	.	.	.	.	.	.	.	.	.	.	.
	Hieracium schmidtii	A3,4	.	.	36	67	.	20	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Asplenium ×javorkae	A3	.	.	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Ranunculus brevifolius		.	.	9	67	.	.	19	31	6	.	.	.	.	.	6	5	.	.	.	.	.	.
E	Asplenium creticum		.	20	18	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Campanula aizoides		.	.	9	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Melica minuta		.	.	.	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Poa cenisia	A4	.	.	.	33	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Arabis alpina		.	20	46	100	2	40	.	6	6	.	13	.	.	.	.	5	.	.	17	.	.	.
	Arenaria cretica	(incl. var. stygia A4)	.	.	46	100	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Polystichum lonchitis		.	.	.	33	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E	**Bellis longifolia**	A5	.	.	.	.	3	.	.	.	.	7	13	.	13	.	.	.	.	.	.	.	.	.
	Campanula spatulata * filicaulis	A5	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Asplenium lepidum * lepidum	A5	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Asplenium viride	A5	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Cheilanthes persica	A5	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E	Myosotis solange	A5	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Asplenium scolopendrium * antri-jovis	A5	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E	Centaurea lancifolia	A5	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sedum laconicum * insulare	A6	.	.	.	33	.	100	.	6	6	.	13	10	25	13	6	.	.	5	.	.	17	.
E	**Arabis cretica**	A6	.	.	9	.	1	80	.	.	.	.	13	.	.	.	.	5	.	.	.	.	.	.
	Lepidium hirtum * oxyotum		.	.	9	.	.	40	.	.	6	.	13	.	.	.	.	.	.	10	.	.	33	.
	Muscari comosum		.	.	.	.	.	40	.	.	.	7	.	10	.	.	.	.	.	.	.	.	17	.
	Arabis auriculata	A6	.	.	.	.	.	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E	Nepeta sphaciotica	A6	.	.	.	.	.	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E	**Lomelosia sphaciotica**	A7	.	10	9	.	.	.	88	.	.	.	.	.	.	.	.	.	.	5	17	.	.	.
E	**Dianthus sphacioticus**	A7	.	.	.	.	.	.	88	19	.	.	.	.	.	13	.	.	.	.	.	.	.	.
	Fumana paphlagonica * alpina		.	.	.	.	.	.	31	.	13	14	.	.	.	.	.	5	.	10	.	.	.	.
	Helianthemum hymettium		.	.	.	.	.	.	31	.	19	14	.	.	.	.	.	5	.	.	.	.	.	.
	Iberis sempervirens	A7	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E	Centranthus sieberi	A7	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Cicer incisum	A9	.	.	.	17	.	.	25	88	44	.	.	.	.	.	.	.	.	.	.	.	.	.

E	**Alyssum sphacioticum**	A8	.	.	9	17	.	20	19	81	19	.	.	.	.	.	.	.	.	.	.	.	17	.
E	**Silene variegata**	A9	.	.	9	.	.	.	19	75	38	.	.	.	.	.	.	5	.	5	17	.	.	.
	Peucedanum alpinum	A8	.	.	.	.	.	.	.	81	13	.	.	.	.	.	.	.	.	.	.	.	.	.
E	Cynoglossum sphacioticum	A8	.	.	.	.	.	.	.	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Cynoglossum lithospermifolium * cariense	A9	.	.	.	17	.	40	38	69	94	21	.	.	13	.	.	10	.	.	.	.	.	.
E	Alyssum fragillimum	A9	.	.	.	.	.	20	19	56	69	14	.	.	.	.	11	29	25	.	.	.	.	.
E	Crepis sibthorpiana	A10	.	.	18	17	1	20	38	.	31	71	13	10	.	.	.	38	.	.	.	.	17	.
E	**Linum arboreum * minor**	A11	.	.	.	.	.	.	6	.	.	.	50	.	.	.	.	.	.	.	.	.	.	.
E	Zelkova abelicea	A12,20	.	.	.	.	.	.	.	.	.	.	.	100	.	.	.	.	.	.	.	3	.	.
	Acer sempervirens	A12,20	.	.	.	.	.	.	.	.	.	.	.	40	.	.	.	.	.	.	.	4	.	.
	Helichrysum microphyllum	(as „Thymelaea tartonraira“ A12)	.	.	.	.	.	.	.	.	.	.	.	10	.	.	.	.	.	.	.	.	.	.
	Thymus leucotrichus	A13	.	.	.	.	.	.	31	.	.	.	.	.	50	.	.	.	.	.	.	.	.	.
	Asphodeline liburnica	A13	.	.	.	.	.	.	.	.	.	.	.	.	50	.	.	.	.	.	.	.	.	.
	Muscari neglectum	A13	.	.	.	.	.	.	.	.	.	.	.	.	25	.	.	.	.	.	.	.	.	.
E	Galium incurvum	A14	.	.	.	.	.	.	.	.	.	.	13	20	.	50	50	.	.	.	.	.	.	.
	Ornithogalum nivale	A14	.	.	.	.	.	.	.	.	.	.	.	.	.	38	.	.	.	.	.	.	.	.
E	Anchusa cespitosa	A15/16	.	.	.	.	.	.	6	6	25	.	13	.	.	.	100	100	100	.	.	.	.	.
	Anthemis rigida	[A17; as „A.pusilla“ A10]	.	.	.	.	.	.	.	.	.	36	13	.	.	.	11	24	88	33	17	.	33	38
	Herniaria parnassica * cretica	A17,18	.	10	9	17	1	20	6	.	6	21	25	.	.	13	33	14	88	48	17	1	.	.
	Astragalus depressus		.	.	.	.	.	.	.	.	.	14	13	30	13	25	.	19	75	.	.	.	.	.
E	Telephium imperati * pauciflorum	A17,18	.	.	.	.	.	20	.	.	.	14	13	.	.	.	17	19	75	43	17	.	33	.
E	**Hypericum trichocaulon**	A17	.	.	.	.	.	.	.	.	.	7	.	.	.	.	6	.	50	.	.	.	.	.
	Polygonum arenastrum	[as „P.idaeum“ A17]	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	38	.	.	.	.	.
E	**Hypericum kelleri**	A17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	38	.	.	.	.	.
	Carex distans	[„var.rigidifolia“ A17]	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	.	.	.	.	.
	Centaurea raphanina * raphanina		20	.	9	.	.	20	6	.	6	14	.	30	.	25	.	10	13	33	67	.	.	25
E	Astracantha cretica	[„f.glaberrimus“ A18]	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	57	33	4	83	38
E	Cirsium morinaefolium	[as „Picnomon acarna“ A15/16]	.	.	.	.	.	.	.	.	.	7	.	.	.	.	39	29	25	19	33	4	33	.
	Arenaria saponarioides	A18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.
E	**Silene flavescens * dictaea**	A19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	33	.	.	.
E	Vincetoxicum creticum	A20	.	.	.	.	.	.	.	.	.	.	.	.	.	13	.	.	.	.	.	1	.	.
	"Galactites tomentosa"		.	.	.	.	.	.	.	.	.	7	.	.	.	.	.	.	.	33	50	4	.	.
	Bromus scoparius		.	.	.	.	.	.	.	.	.	.	.	20	25	13	6	10	.	.	.	.	67	.
	Cerastium brachypetalum * roeseri		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	67	.
	Galium murale		.	.	.	.	.	.	.	.	.	14	.	10	13	.	.	10	.	5	.	.	67	38
	Juniperus oxycedrus	A21	.	.	.	.	.	.	6	.	.	14	.	10	13	.	.	.	.	.	.	.	50	.
	Arenaria serpyllifolia		.	.	9	.	.	.	.	.	.	.	13	.	25	.	.	.	.	5	.	.	50	13
	Scandix macrorhyncha	A21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	33	.
	Veronica arvensis		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	33	.
	Alyssum minutum		.	.	.	.	.	.	.	.	.	7	.	10	.	.	17	.	.	19	.	.	33	.
	Viola rauliniana	[as „V.heldreichiana“ A21]	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	.
E	Tragopogon lassiticus	A21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	.
E	**Phlomis lanata**	A22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	88
	Sarcopoterium spinosum	A22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	88
	Trifolium uniflorum		.	.	.	.	.	.	.	.	.	.	.	10	.	.	11	10	13	.	.	1	.	50
	Trifolium campestre		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	38
	Trifolium tomentosum		.	.	.	.	.	.	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	38
	Asplenium ceterach		100	30	18	.	2	60	.	.	.	.	25	.	.	.	.	.	.	.	.	.	.	.
	Potentilla speciosa		20	30	55	67	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E	Campanula jacquinii		20	60	27	17	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Asplenium trichomanes		.	40	36	33	3	.	.	.	.	.	13	.	.	.	.	.	.	.	.	.	.	.
	Cystopteris fragilis		.	40	46	83	4	40	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

	Valantia muralis		.	20	27	67	3	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sedum magellense * olympicum		.	40	36	100	3	80	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Asplenium aegaeum		.	10	27	17	2	40	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E	Scilla nana		20	30	27	33	.	40	6	.	6	.	13	.	.	.	.	5	.	.	.	.	.	.
E	Phagnalon pygmaeum		60	20	36	17	2	60	31	.	6	.	.	10	.	.	.	.	13	.	.	.	.	.
	Festuca sipylea		.	40	36	33	1	20	25	19	.	.	.	.	.	.	6	.	.	10	17	.	.	13
E	Draba cretica		80	50	73	50	1	40	69	19	13	.	25	.	.	.	.	10	.	10	67	.	17	.
E	Viola fragrans		60	50	73	50	1	20	63	69	38	.	.	10	.	.	.	19	.	5	17	.	.	.
E	Senecio fruticulosus		.	20	27	17	2	.	.	38	38	7	.	.	.	.	.	14	.	.	.	.	.	.
	Minuartia verna * attica		.	20	55	50	1	40	81	31	38	21	13	.	.	.	.	29	.	5	50	.	.	.
	Euphorbia hemiariifolia	A19	20	40	55	100	1	60	63	69	69	43	50	.	13	13	11	29	13	5	67	.	17	.
E	Acantholimon androsaceum		.	.	27	17	.	20	75	81	94	100	75	50	88	88	83	76	63	.	.	.	50	.
	Valantia aprica		.	.	.	.	.	.	50	50	44	.	.	.	13	.	22	19	.	.	17	.	.	.
	Aubrieta deltoidea		.	10	27	50	1	80	.	44	31	36	75	30	.	75	50	43	.	.	.	.	.	.
	Melica ciliata		.	.	.	.	.	.	.	.	.	43	50	10	63	.	.	24	.	.	.	.	.	.
	Paronychia macrosepala	A19	40	10	9	.	.	.	50	.	25	36	25	30	50	38	6	24	13	10	50	.	.	.
E	Sideritis syriaca * syriaca		20	.	18	.	2	.	6	.	6	71	75	80	100	50	78	48	88	.	.	.	.	.
E	Verbascum spinosum		.	.	.	.	.	.	6	.	6	43	.	90	88	63	56	38	75	.	.	.	.	.
	Bufonia stricta		.	10	36	.	.	20	6	25	44	50	50	80	50	88	56	67	25	24	.	.	.	.
	Astragalus angustifolius		.	.	9	.	.	20	6	31	38	86	50	80	75	75	94	86	88	62	100	.	.	.
	Coridothymus capitatus	A19	.	.	.	.	.	40	50	19	75	57	25	.	.	.	.	67	.	5	100	.	.	38
E	Lactuca alpestris		.	.	.	.	.	.	25	13	44	14	.	.	.	38	22	48	13	10	33	1	17	.
E	Centaurea idaea		.	.	.	.	.	.	.	13	63	50	25	80	13	63	78	52	50	52	.	3	.	50
	Carlina corymbosa * curetum		.	.	.	.	.	.	25	.	19	50	.	50	.	25	28	48	50	5	.	.	.	50
	Euphorbia acanthothamnos		.	10	9	.	.	.	.	.	25	57	75	90	50	88	28	24	50	43	50	4	67	.
E	Muscari spreitzenhoferi	A11	.	.	.	.	.	.	.	.	.	36	50	.	13	13	.	24	.	5	17	.	.	13
	Dactylis glomerata * rigida		.	.	.	.	.	20	.	.	.	21	.	40	13	38	33	29	50	29	33	1	50	25
	Erodium cicutarium		.	.	.	.	.	.	.	.	.	7	.	30	.	.	6	.	.	.	.	.	.	25
	Arum creticum		.	.	.	.	.	.	.	.	.	7	.	20	.	.	6	5	25	5	.	2	33	.
	Poa bulbosa		.	.	9	.	.	.	.	.	.	.	13	20	.	.	33	5	13	.	.	.	17	.
	Cynosurus effusus	A12	.	.	.	.	.	.	.	.	.	.	.	50	25	25	17	5	.	5	17	.	.	.
E	Teucrium alpestre * alpestre		.	.	.	.	.	.	.	.	6	.	.	10	13	.	.	.	.	10	33	.	.	38
E	Pimpinella tragium * depressa		.	10	18	33	1	20	56	13	50	79	.	50	63	75	61	71	50	10	17	.	.	.
	Melica rectiflora	A14	60	50	46	50	3	60	31	6	50	14	13	.	63	50	.	19	.	.	17	.	.	.
	Bromus tomentellus		60	10	36	33	.	.	.	.	.	.	.	20	.	38	22	5	.	.	33	.	.	.
	Lysimachia serpyllifolia	A11	.	10	.	.	3	.	6	.	6	.	50	.	25	13	6	.	.	5	.	.	.	.
	Aethionema saxatile * creticum		20	30	9	17	2	40	.	6	25	21	13	20	13	13	11	5	.	14	17	.	.	.
	Daphne oleoides		.	20	9	.	.	.	31	.	25	57	50	10	25	.	17	62	38	38	83	.	.	.
E	Asperula idaea		.	80	55	33	.	40	81	50	38	43	38	30	63	38	83	62	63	62	83	.	17	25
	Satureja alpina * meridionalis		.	10	55	17	.	40	25	.	31	50	50	30	75	63	78	67	88	67	33	.	17	25
	Satureja spinosa		.	.	27	.	.	.	19	.	6	7	.	40	.	63	44	10	13	14	17	.	17	.
	Rhamnus saxatilis * prunifolia		.	30	18	.	1	.	38	13	69	93	75	70	88	75	56	76	38	52	67	3	100	63
	Prunus prostrata		.	20	9	17	1	60	31	44	94	86	38	80	13	63	89	100	75	67	100	4	33	13
E	Scutellaria hirta		.	20	36	67	1	80	38	25	56	14	38	20	.	25	11	29	.	.	33	.	33	13
	Berberis cretica		.	30	27	.	2	40	19	38	75	79	63	100	63	100	100	95	88	86	83	4	100	50
	Sedum album		80	70	36	33	1	20	6	.	31	64	63	20	63	63	28	67	63	62	67	.	67	38
	Medicago lupulina		40	10	.	.	.	20	.	.	.	14	25	10	38	13	6	24	50	10	.	.	17	.
	Sedum tristriatum	A6	80	50	9	33	.	60	.	.	6	21	25	10	13	25	17	14	13	5	.	.	.	13
E	Hypericum empetrifolium * tortuosum	A11	60	30	27	.	.	.	.	.	.	.	50	10	25	.	.	.	.	14	.	.	.	25
	Thlaspi perfoliatum		.	10	.	33	1	.	6	.	.	7	25	.	.	13	6	.	38	5	17	.	.	.
	Festuca circummediterranea		20	10	18	33	.	20	.	6	.	14	13	20	.	13	33	5	.	5	.	.	.	.
	Veronica thymifolia		.	.	27	.	1	20	31	13	19	14	.	.	.	25	.	5	.	.	.	.	17	.
E	Hypochaeris tenuiflora		.	.	.	17	.	20	31	.	19	.	.	.	13	.	17	10	13	14	.	.	.	.

- Col. 3 (Orig. table 1: "*Hieracio-Gypsophiletum nanae*")
  Central, southern and western mountains of Lefka Ori; 1700-2400 m; limestone and dolomitic rock. Four association character species are given by Zaffran but the community is in fact rather ill-defined by *Gypsophila nana* only (see Tab. 1).
- Col. 4 (Orig. table 2: "*Hieracio-Arenarietum creticae*")
  Northern part of Lefka Ori; 1950-2200 m; limestone rocks, chiefly north-exposed. The community is poorly differentiated from the preceding one. *Arenaria cretica* var. *stygia* is said to be character species but co-occurs with the type variety and is of little taxonomic value (Phitos, 1997).
- Col. 5 (Orig. table 3: "*Asplenio-Centaureetum lancifoliae*")
  On three summits of northern Lefka Ori; (1400-)1500-1800 m, altitudinal vicariant of the preceding association; limestone rocks. Poorly documented community with eight (!) association character species listed by Zaffran, none of which in all four relevés, and five in just one sample. Due to the limited material the syntaxonomic value of the community cannot finally be assessed.
- Col. 6 (Orig. table 4: "*Nepeto-Arabidetum creticae*")
  Southern parts of Lefka Ori; 1900-2200 m; dolomitic limestone rocks. Said to be characterized by five association character species but according to the original data only *Sedum laconicum* subsp. *insulare* (as "*S. idaeum*") and *Arabis cretica* seem to be diagnostic with sufficient constancy.
- Col. 7 (Orig. table 29: "*Lomelosio-Kentranthetum sieberi*")
  Lefka Ori, Psiloritis, Dikti; 1700-2400 m, chiefly north-exposed limestone screes. Two of four association character species given occur in only one relevé. However, with *Lomelosia sphaciotica* and *Dianthus sphacioticus* this unit is readily distinguished from others.
- Col. 8 (Orig. table 28: "*Peucedano-Cynoglossetum sphaciotici*", assigned by Zaffran in his text but not in the table as subassociation of the following)
  Lefka Ori; 2060-2400 m; limestone screes, at higher levels than the following and mainly at northexposed slopes. The unit is well-characterized by *Cicer incisum*, *Silene variegata*, *Alyssum sphacioticum* and *Peucedanum alpinum*, while only the latter two are considered diagnostic by Zaffran.
- Col. 9 (Orig. table 27: "*Alysso-Silenetum variegatae*")
  Lefka Ori; 1850-2250(-2400) m; southexposed limestone screes. Mostly negatively differentiated from the previous community.
- Col. 10 (Orig. table 15: "*Anthemido-Crepidetum sibthorpianae*")
  Lefka Ori, particularly in the east; 1800-2200 m; xerophytic slopes. Somewhat poorly characterized by *Crepis sibthorpiana*.
- Col. 11 (Orig. table 16: "*Muscareto-Linetum caespitosi*")
  Northern mountains of Lefka Ori, 1500-2000 m; limestone slopes, said to be less xerophilous than the previous community. Although six association character species are given the community is ill-defined. Only *Linum arboreum* var. *minor* (as "*Linum caespitosum*"), with doubtful taxonomic rank, may be diagnostic but occurs in half of the relevés only.
- Col. 12 (Orig. table 19: "*Zelcovo-Aceretum sempervirentis*")
  Western part of Lefka Ori; 1600-1800(-2100) m; limestone slopes with relatively well developed soil and organic matter in humid environment. Five species are considered diagnostic by Zaffran but only *Zelkova abelicea* and *Acer*

sempervirens may be accepted in the light of the synoptic table, if column 20 from Dikti is disregarded.

- Col. 13 (Orig. table 20: "*Thymo-Asphodelinetum liburnicae*")
  Northern mountains of Lefka Ori; 1600-2150 m; karstic limestone slopes. The community as circumscribed by Zaffran is poorly characterized, since *Thymus leucotrichus* and *Asphodeline liburnica* are each present in only four out of eight relevés.
- Col. 14 (Orig. table 21: "*Galio-Melicetum rectiflorae*")
  Central Lefka Ori; (1600-)1700-2020(-2100) m; westexposed calcareous slopes. Three association character species are given, each with rather low constancy, but none is diagnostic if viewed synoptically (table 1).
- Columns 15 and 16 (Orig. table 18: "*Anchuso-Picnomonetum acarnae* sous-ass. à *Galium incurvum* et *Taraxacum megalorhizon*"; orig. table 17: "*Anchuso-Picnomonetum acarnae*")
  Most widespread community in the Lefka Ori, the type subassociation chiefly in the eastern, the subunit with Galium incurvum mainly in the western part; 1700-2200 m; limestone slopes with little soil. *Anchusa cespitosa* is said to be character species but is also frequent in the following community. *Cirsium morinaefolium* (misidentified as "*Picnomon acarna*") is not diagnostic in the light of the synoptic table. The "sous-ass. à *Galium incurvum* et *Taraxacum megalorhizon*" is somewhat poorly differentiated from the "type subassociation" by *Galium incurvum* and *Crepis sibthorpiana*.
- Col. 17 (Orig. table 30: "*Hyperico-Herniarietum parnassicae*")
  Samples not documented and table not discussed by Zaffran in his text but obviously assignable to doline habitats in the Lefka Ori. Several species such as *Telephium imperati* subsp. *pauciflorum*, *Hypericum trichocaulon*, *Anthemis rigida*, *Astragalus depressus* and *Herniaria parnassica* subsp. *cretica* are diagnostic for this community.
- Col. 18 (Orig. table 22: "*Herniario-Arenarietum saponarioidis*")
  Predominant community throughout Dikti; 1500-2100 m; calcareous slopes. Four association character species are given, none of which can be maintained if compared with the following units.
- Col. 19 (Orig. table 23: "*Euphorbio-Silenetum dictaeae*")
  Summit of Afendi Christo (Dikti), said to replace the preceding at high levels; 1850-2100 m. None of the four association character species given clearly distinguishes this community from the previous, though species of rocks and screes are more prominent.
- Col. 20 (Orig. table 24: "*Vincetoxico-Zelcovetum abeliceae*")
  Afendi Christo (Dikti); (1550-)1600-1700(-1800) m; southexposed calcareous slopes. Eastern vicariant of the "*Zelcovo-Aceretum*" (column 12). Both are locally characterized by *Zelkova* and *Acer*. *Vincetoxicum creticum* (as "*V. canescens*") is said to be another association character species but is rare.
- Col. 21 (Orig. table 26: "*Tragopogo-Violetum heldreichianae*")
  Psiloritis; 1700-2500 m; calcareous slopes. From the four association character species given only *Juniperus oxycedrus* is restricted more or less

TABLE 2 - SYNOPTIC TABLE FOR THE SAME DATA SET AS IN TABLE 1, BUT RE-CLASSIFIED. CONSTANCY PERCENTAGE VALUES ARE GIVEN THROUGHOUT. TAXA WITH LESS THAN 30 % CONSTANCY IN EACH COLUMN ARE OMITTED. SPECIES OF DIAGNOSTIC VALUE FOR ONE COMMUNITY (EVTL. FOR BOTH SUBUNITS WITHIN A COMMUNITY) ARE SET BOLD. E: LOCAL AND REGIONAL ENDEMICS OF THE CRETAN AREA. AN ASTERISK (*) PRECEDES SUBSPECIES OR VARIETY EPITHETON.

	Column (= community) number	1	2	3	4	5	6	7	8	9	10	11
	Number of relevés	5	8	24	15	7	18	52	47	20	26	7
E	**Origanum dictamnus**	100	.	.	.	.	.	.	.	.	.	.
	Asplenium ceterach	100	25	25	.	.	.	8	.	.	.	.
	Scrophularia lucida	80	.	8	.	.	.	.	.	.	.	.
	Satureja juliana	80	.	13	.	.	.	8	2	.	.	.
	Sedum tristriatum	80	38	21	.	.	.	17	17	15	8	.
	Rosularia serrata	60	.	.	.	.	.	.	.	.	.	.
	Erica manipuliflora	60	.	4	13	.	.	.	2	.	.	.
	Bromus tomentellus	60	13	25	.	.	.	4	17	10	.	.
	Hypericum empetrifolium * tortuosum	60	13	13	.	.	.	12	11	.	8	14
	Staehelina fruticosa	40	.	.	.	.	.	.	.	.	.	.
	Helictotrichon agropyroides	40	.	.	.	.	.	.	.	.	.	.
	Arenaria muralis	40	38	.	.	.	.	.	.	.	.	.
E	**Silene antri-jovis**	40	100	.	.	.	.	6	.	.	15	.
E	Arenaria fragillima	40	75	4	.	.	.	2	4	.	.	.
E	**Campanula jacquinii**	20	75	25	.	.	.	.	.	.	.	.
E	Crepis auriculifolia	20	38	.	.	.	.	.	.	.	.	.
	Carum multiflorum	20	38	.	.	.	.	.	6	.	.	.
	Asplenium lepidum * haussknechtii	.	63	.	.	.	.	.	.	.	.	.
	Euphorbia deflexa	.	50	.	.	.	.	.	.	.	.	.
	Asplenium trichomanes	.	50	38	.	.	.	2	.	.	.	.
	Potentilla speciosa	20	38	54	.	.	.	.	.	.	.	.
	Valantia muralis	.	25	58	.	.	.	2	.	.	.	.
	Sedum magellense * olympicum	.	50	67	.	.	.	2	.	.	.	.
	Cystopteris fragilis	.	50	63	.	.	.	.	2	.	.	.
	Arabis alpina	.	25	63	.	14	6	4	2	.	.	.
	Arenaria cretica	.	.	63	.	.	.	.	.	.	.	.
	Gypsophila nana	.	.	54	.	.	6	2	2	.	.	.
	Hieracium schmidtii	.	.	38	.	.	6	.	.	.	.	.
	Asplenium aegaeum	.	13	33	.	.	.	.	.	.	.	.
E	**Lomelosia sphaciotica**	.	.	4	87	.	.	6	.	.	4	.
E	**Dianthus sphacioticus**	.	.	.	87	29	11	.	2	.	.	.
	Minuartia verna * attica	.	25	42	87	43	33	29	2	.	8	.
	Fumana paphlagonica * alpina	.	.	.	40	.	.	8	.	.	8	.
	Helianthemum hymettium	.	.	.	40	.	.	10	.	.	.	.
	Thymus leucotrichus	.	.	.	33	.	.	2	6	.	.	.
E	**Hypochaeris tenuiflora**	.	.	8	33	.	11	10	4	5	12	.
	Ranunculus brevifolius	.	.	21	13	43	17	6	.	.	.	.
	Valantia aprica	.	.	.	47	57	61	17	2	5	.	.
E	**Silene variegata**	.	.	4	27	86	61	6	.	.	.	.
	Cicer incisum	.	.	4	20	86	89	.	.	.	.	.
	Cynoglossum lithospermifolium * cariense	.	.	8	33	71	78	27	2	.	.	.
E	**Alyssum sphacioticum**	.	.	13	20	86	50	2	.	.	4	.
	Peucedanum alpinum	.	.	.	.	71	56	.	.	.	.	.
E	**Cynoglossum sphacioticum**	.	.	.	.	43	.	.	.	.	.	.
E	**Alyssum fragillimum**	.	.	4	13	29	67	27	2	20	.	.
	Astragalus angustifolius	.	.	.	.	.	39	71	85	95	31	.
E	Sideritis syriaca * syriaca	20	.	13	7	.	.	27	81	85	.	.
E	Verbascum spinosum	.	.	.	7	.	.	4	75	75	.	.
	Euphorbia acanthothamnos	.	.	.	.	.	.	35	66	50	58	.
E	**Anchusa cespitosa**	.	.	.	.	.	22	35	32	85	.	.
	Herniaria parnassica * cretica	.	13	13	7	.	6	12	11	75	35	.
	Anthemis rigida	.	.	.	.	.	.	12	4	75	27	43
E	**Telephium imperati * pauciflorum**	.	.	4	.	.	.	8	6	70	27	.
	Astragalus depressus	.	.	.	.	.	.	.	15	60	.	.
E	**Astracantha cretica**	.	.	.	.	.	.	.	.	.	92	29
	Galactites tomentosa (?)	.	.	.	.	.	.	2	2	.	50	.
E	**Phlomis lanata**	.	.	.	.	.	.	.	.	.	.	100
	Sarcopoterium spinosum	.	.	.	.	.	.	.	.	.	8	86
	Trifolium uniflorum	.	.	.	.	.	.	2	9	5	4	57
	Galium murale	.	.	.	.	.	.	4	6	10	15	43
	Trifolium tomentosum	.	.	.	.	.	.	2	.	.	.	43
	Trifolium campestre	.	.	.	.	.	.	.	.	.	.	43
E	Scilla nana	20	38	29	7	.	6	2	.	5	.	.
E	Phagnalon pygmaeum	60	25	38	40	.	.	2	2	5	.	.
E	Draba cretica	80	50	58	67	14	28	15	2	.	12	.

E	Viola fragrans	60	63	54	67	57	61	14	2	5	.	.
	Melica rectiflora	60	63	54	33	.	22	19	23	10	.	.
	Sedum album	80	63	29	7	.	.	56	55	60	50	29
	Euphorbia herniariifolia	20	38	63	53	29	89	62	2	5	4	.
	Festuca sipylea	.	50	33	27	29	6	6	.	.	4	14
E	Asperula idaea	.	88	38	73	.	72	65	47	65	31	29
E	Acantholimon androsaceum	.	.	13	73	57	100	69	77	65	8	.
	Coridothymus capitatus	.	.	4	47	.	56	58	2	25	8	43
	Berberis cretica	.	13	21	13	.	61	89	89	90	92	43
	Prunus prostrata	.	13	17	20	.	89	77	72	90	69	.
	Rhamnus saxatilis * prunifolia	.	13	8	33	.	50	73	72	60	65	57
	Bufonia stricta	.	13	13	.	.	33	54	64	35	15	.
	Satureja alpina * meridionalis	.	.	29	27	.	6	62	55	80	39	29
E	Centaurea idaea	.	.	.	.	.	33	42	62	50	42	57
	Carlina corymbosa * curetum	.	.	.	27	.	.	25	28	50	8	43
	Dactylis glomerata * rigida	.	.	4	.	.	.	4	30	60	42	29
E	Cirsium morinaefolium	.	.	.	.	.	.	23	6	20	35	.
	Paronychia macrosepala	40	13	4	53	.	6	29	26	15	8	.
E	Pimpinella tragium * depressa	.	13	25	60	14	17	54	49	60	12	.
E	Scutellaria hirta	.	13	50	40	29	39	37	13	.	12	.
	Daphne oleoides	.	25	4	33	.	.	48	19	45	31	.
	Aubrieta deltoidea	.	13	42	.	14	50	33	40	25	.	.
	Veronica thymifolia	.	.	21	40	14	11	8	4	.	4	.
	Medicago lupulina	40	13	4	.	.	.	12	17	30	8	.
E	Senecio fruticulosus	.	25	25	.	43	44	8	.	5	.	.
E	Crepis sibthorpiana	.	.	17	40	.	17	33	11	10	.	.
	Crepis fraasii * mungieri	40	.	.	.	.	.	.	.	.	.	29
	Aethionema saxatile * creticum	20	38	21	.	.	6	21	15	5	4	.

to this community within the present data set (but not beyond!). However, some likewise widespread annuals such as *Bromus scoparius*, *Cerastium brachypetalum* (most probably the correct species instead of "*C. diffusum*") and *Galium murale* are also diagnostic in this community.

- Col. 22 (Orig. table 25: "*Crepido-Phlometum lanatae*")
  Northern low summits of Dikti; 1400-1600; calcareous slopes, said to replace "*Vincetoxico-Zelcovetum*" at lower levels.
  Within the present data set well characterized by phryganic species of low and medium altitudes such as *Phlomis lanata*, *Sarcopoterium spinosum* and *Trifolium uniflorum*. The species are close to their altitudinal distribution limits, and so is the community which is clearly "phryganic" and should as such be compared with similar species combinations of lower levels.

NEW CLASSIFICATION

The results of re-classification of the original data set are shown in table 2. Eleven plant communities were found to be reasonably distinct with respect to species composition, set of differential species and ecology. Here follows a survey of the units with comments on distribution, ecology, floristics, and relations to units proposed by Zaffran (1990).

1. *Origanum dictamnus-Asplenium ceterach* community
   Distribution and ecology as for "*Origano-Staehelinetum*" of the original classification (see above).

2. *Silene antri-jovis-Campanula jacquinii* comm.
   Distribution and ecology about the same as for "*Asplenio-Alyssetum lassitici*" (see above).
3. *Arenaria cretica-Gypsophila nana* comm.
   Lefka Ori; 1500-2400 m; limestone rocks. This community includes most relevés of four associations distinguished by Zaffran, viz. "*Hieracio-Gypsophiletum*", "*Hieracio-Arenarietum*", "*Asplenio-Centaureetum*" and "*Nepeto-Arabidetum*". It is well differentiated by, e.g., *Arenaria cretica*, *Gypsophila nana* and *Arabis alpina*.
4. *Lomelosia sphaciotica-Dianthus sphacioticus* comm.
   Distribution and ecology as for "*Lomelosio-Kentranthetum sieberi*" of the original classification although the relevé set included here is slightly different. Thc community is clearly separated and readily identified by the presence of *Dianthus sphacioticus* and *Lomelosia sphaciotica*. Less constant but also characteristic are *Minuartia attica*, *Fumana alpina* subsp. *paphlagonica* and *Helianthemum hymettium*.
5. *Cicer incisum-Silene variegata* comm., typical subunit
   Lefka Ori, calcareous screes between 2100 and 2400 m. This subunit occurs at high altitudes generally without dwarf shrubs. It comprises 50% of the relcvés of Zaffran's "*Peucedano-Cynoglossetum sphaciotici*". This and the following subunit form a well-defined vegetation type characterized by *Silene variegata*, *Alyssum sphacioticum*, *Peucedanum alpinum* and *Cicer incisum*.
6. *Cicer incisum-Silene variegata* comm., subunit with *Prunus prostrata*
   Lefka Ori, calcareous screes; 1850-2350 m, generally at lower levels than the previous one. This subunit is differentiated against the typical subunit by the presence of procumbent or prostrate, often thorny shrubs such as *Berberis cretica*, *Prunus prostrata*, *Rhamnus saxatilis* subsp. *prunifolius*. It comprises major parts of both "*Alysso-Silenetum variegatae*" and "*Peucedano-Cynoglossetum sphaciotici*".
7. *Astragalus angustifolius-Euphorbia acanthothamnos* comm., subunit with *Euphorbia herniariifolia*
   Lefka Ori, Psiloritis, Dikti; calcareous, more or less fixed rocky slopes. Typical Cretan "thorncushion" vegetation with compact, often thorny procumbent shrubs or dwarf shrubs. The present subtype is separated against the following by *Coridothymus capitatus*, *Euphorbia herniariifolia*, *Alyssum fragillimum* and *Cynoglossum lithospermifolium* subsp. *cariense*, indicating somewhat poorly consolidated stony ground with little fine-grained soil.
8. *Astragalus angustifolius-Euphorbia acanthothamnos* comm., subunit with *Verbascum spinosum*
   Lefka Ori, fixed calcareous slopes. In contrast to the previous subtype, *Verbascum spinosum* and *Sideritis syriaca* are well present, indicating stony but stabilized ground throughout and somewhat better soil conditions. "Thorncushion" vegetation with open *Zelkova* and *Acer* canopy also belongs here. The subtype with *Verbascum* and *Sideritis* is restricted to the Lefka Ori while similar habitats in the central and eastern mountains are the domain of the *Astracantha cretica* community (see below). The *Astragalus angustifolius-Euphorbia acanthothamnos* comm. comprises much of the following units in the original classification: "*Anthemido-Crepidetum sibthorpianae*", "*Muscareto-Linetum*

caespitosi", "*Anchuso-Picnomonetum*", "*Zelkovo-Aceretum sempervirentis*", "*Thymo-Asphodelinetum*", "*Galio-Melicetum*", as well as parts of "*Euphorbio-Silenetum dictaeae*" and single relevés of other units.

9. *Anchusa cespitosa* comm.
   Lefka Ori (a single relevé is included here from Dikti, the latter naturally without *Anchusa*); dolines and slopes with calcareous soils with long snow-cover and relatively good water supply. The community as cirumscribed here includes the "*Hyperico-Herniarietum parnassicae*", as well as some relevés of the "*Anthemido-Crepidetum*" and the "*Anchuso-Picnomonetum*". It is well characterized by the woody mat-forming *Anchusa cespitosa* which is endemic to the Lefka Ori, and by the more widespread *Herniaria parnassica* subsp. *cretica*, *Anthemis rigida*, *Telephium imperati* subsp. *pauciflorum*, and *Astragalus depressus*.
10. *Astracantha cretica* comm.
   Dikti, Psiloritis; calcareous slopes between 1500 and 2100(-2500) m. "Thorncushion" community which replaces comm. 8 in most of Psiloritis and Dikti. Phytogeographical differential species are *Verbascum spinosum* and *Sideritis syriaca* in the latter, *Astracantha cretica* and "*Galactites tomentosa*" in the present community. The latter species is probably misidentified but the correct name of the species seen by Zaffran remains doubtful.
11. *Phlomis lanata-Sarcopoterium spinosum* comm.
   Distribution and ecology as for "*Crepido-Phlometum lanatae*" (column 22) in the original classification.

Discussion

The two classifications deviate substantially in floristic characters, delimitation, and number of vegetation units. Phytosociologists may find this result appalling but in fact it is hardly surprising. Whatever agreements exist for phytosociological classification criteria, they are obviously not sufficiently binding on international scale, hence not adopted throughout. This is not a controversy between traditional and numerical approaches in vegetation classification because the crucial points, definition and interpretation of units, are in both cases a matter of subjective decision by the scientist. Nor is it a matter of argument whether floristic or ecological criteria should rule vegetation classification. Both results presented here are based on floristic criteria. However, the question remains: which floristic criteria?

Zaffran's classification of associations is based on taxa which he considers association character species: 92 taxa altogether! However, many such character species show very little constancy in the respective communities (table 1). Others occur with considerable constancy in other units as well. Several have been used as "association character species" for more than one unit by Zaffran himself – disregarding any definition of the term! Such taxa are therefore of little diagnostic value for the respective communities, particularly if the classification serves as a basis for applied field studies and mapping. The synoptic table reveals that the real number of taxa of diagnostic value for one and only one unit within the given data set is only 49, if a threshold of 30% constancy is adopted, and species omitted which are not diagnostic in the sense of the definition given above (table 3). The new classification is based on differential species but 50 taxa are largely restricted to, and therefore diagnostic for, one unit. The ratio between the numbers of such diagnostic taxa and communities is 2.2 in Zaffran's classification but 4.5 in the present one.

The percentage of endemics among the taxa said to be characteristic for certain communities in the original classification is much higher than in the remaining species: 76% of the taxa in the data set indicated as endemics (a total of 58 taxa) are among the presumed association character species (of which the proportion of endemics is 48%) (table 3). Hence, Zaffran considers most endemic taxa diagnostic for a certain association. According to the original classification, the endemics are highly overrepresented among the presumed association character species. In the present classification, 16 endemics would qualify for being association character species, i.e., they are diagnostic (at least within the given data set) for one community. (Subunits are regarded as being sufficiently defined by differential, but not necessarily by own character species.) Both the ratios between this figure and the total number of endemics in the data set (28%), and the total number of diagnostic taxa (32%), respectively, are rather similar and much lower than in the original classification. However, the true figures in that classification are similar (24% and 29%, respectively), if the criteria for diagnostic taxa given above are adopted. This surprising difference between the classification systems concerning the role of endemics in vegetation is most probably due to *a priori* selection of character species by Zaffran without subsequent testing, which is hardly acceptable from a methodological point of view and, moreover, misleading when assessing the role of endemics in vegetation (see Bergmeier, 2002).

TABLE 3 - SELECTED PARAMETERS OF THE ORIGINAL AND THE PRESENT CLASSIFICATION.

	original classification (Zaffran 1990)	present classification
total number of relevés	229	229
number of communities	22	11
A: number of endemic taxa in the data set	58	58
B: number of taxa diagnostic for 1 community	92 ass.char.sp. given but in fact 49* would qualify	50*
ratio diagnostic taxa*/number of communities	2.2	4.5
C: number of endemics which are diagnostic for 1 community	44 given but in fact 14*	16*
C/A	76 %/24 %*	28 %*
C/B	48 %/29 %*	32 %*

* based on diagnostic taxa with constancy threshold of 30 % and constancy percentage value double or more than the next highest constancy value.

Conclusion

As results achieved by phytosociologists from one and the same data set can be so fundamentally different as shown above, it is clear that the process of classification should be standardized, and the results subjected to testing, at least in the framework of a European-wide project such as European Vegetation Survey. Standardization may be obtained by employing classification programs, or by following routines when elaborating a classification. However, standardization of the process alone does little to ensure scientific substance and applicability of the results. More important are binding criteria as a means of testing the results. Such criteria should include: Testing the validity of presumed character species by synoptic tables; and to make maximum use of the differential potential of species within the data set. The basis for any classification should be total species composition rather than character species alone. Consequently, associations should not be defined by character species alone, and certainly not if they are low-constancy taxa, but should be clearly distinguishable by a set of differential species (among which at least one own character species should be a prominent element). On local to regional scale, such a set may he much more diagnostic and more meaningful if it comes to vegetation mapping and ecological interpretation.

The example shown in this contribution suggests the following conclusions:

- When evaluating literature data based on vegetation classification it is indispensable to thoroughly revise the original data. Special attention should be paid to floristic errors (a task which requires own field knowledge!) and to taxonomy. It should always be considered how sampling was performed. Mere classification results should never be used without consulting the original data.
- Re-classification of vegetation data taken from literature is urgently recommended as a basis for vegetation surveys and as a tool for testing presumably biased classification schemes.
- Community classification based on endemics or other *a priori* selected species may be misleading. Results would reflect artificial grouping and tend to be poorly interpretable. Rare species combinations may be overrepresented, widespread ones underrepresented or, if "character species" are missing, neglected at all.
- Classification of vegetation should never neglect units which may be frequent and widespread but lack character species. Otherwise there is hardly sufficient basis for, e.g., vegetation mapping.
- Specialization and diagnostic value of high-mountain endemics should not be overestimated. In Crete, they are in general apparently not more significant than other high-mountain species.
- Community classification based on differential species groups is usually fully interpretable and applicable and makes better use of data variance.

Acknowledgements

I am grateful to an anonymous reviewer whose comments helped to improve the paper.

References

Bergmeier, E. 2002 - *The vegetation of the high mountains of Crete - a revision and multivariate analysis.* Phytocoenologia **32**: 205-249.

Bergmeier, E., Härdtle, W., Mierwald, U., Nowak, B and Peppler, C., 1990 - *Vorschläge zur syntaxonomischen Arbeitsweise in der Pflanzensoziologie.* Kieler Not. Pflanzenk. Schleswig-Holstein Hamburg, **20**: 92-103.

Greuter W., 1995 - *Studies in Greek Caryophylloideae: Agrostemma, Silene, and Vaccaria.* Willdenowia, **25**: 105-142.

Hempel L., 1995 - *Die Hochgebirge Kretas als Wirtschaftsraum: physiogeographische Voraussetzungen, Formen und Veränderungen der Wanderviehhaltung.* Petermanns Geogr. Mitt., **139**: 215-238.

Hennekens S.M., 1999 - *Turboveg for Windows. A comprehensive database management tool for vegetation data.* www.ibn.dlo.nl\research\turboveg.

Hill M.O., 1979 - TWINSPAN. A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Ecology and Systematics, Cornell University, Ithaca, NY.

Jahn R. and Schönfelder P., 1995 - Exkursionsflora für Kreta. Ulmer, Stuttgart.

Phitos D., 1997 - *Arenaria* L. In: Strid, A. & Tan, K., Flora Hellenica, 1: 158-168. Koeltz, Koenigstein.

Strid A. (ed.), 1986 - Mountain flora of Greece, 1. Cambridge University Press, Cambridge.

Strid A., 1993 - *Phytogeographical aspects of the Greek mountain flora.* Fragm. Flor. Geobot. Suppl. **2(2)**: 411-433.

Strid A. and Tan, K. (eds.), 1991 - Mountain flora of Greece, 2. Edinburgh University Press, Edinburgh.

Zaffran J., 1990 - Contributions à la flore et à la vegetation de la Crète. Publications de l'Université de Provence. 615 pp. + tables (enclosed in envelope). Aix en Provence.