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**Contribution to the knowledge of flora and vegetation of Khrisi islet
(Crete, SE Mediterranean sea)**

Abstract

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The results of a floristic and vegetational investigation on the Aegean islet of Khrisi are presented. Its vascular flora numbers 172 taxa (species, subspecies and hybrids), 92 of which are new records. A species new to science, *Limonium chrisianum*, is described and illustrated and two new combinations, *Limonium roridum* and *Teucrium dumulosum*, are proposed. Furthermore, an iconography of the fruited *Bupleurum gaudianum*, a rare endemic known up to now only from the islet of Gávdos is provided. The phytosociological analysis identifies 8 associations, that have been put in evidence by belonging to relevés of maquis, phrygana, salt marshes, psammophilous and rupicolous vegetation. The observed association, six of which are here described for the first time, are outlined from the floristic, ecological and chorological point of view. Besides, a new alliance, *Cichorio-Limonium roridi*, is proposed.

Introduction

Within a floristic and phytosociological investigation of the Aegean region, a daily excursion on the small islet of Khrisi has been carried out, whose results are here presented. Khrisi (or Hrisi, Krissi, Gaidourónisi, Khrisi) is located at 34° 52' N latitude and 25° 43' E longitude, only 15 km southwards from the south-eastern coast of Crete (Fig. 1). The sea between Crete and Khrisi is more than 500 m deep, therefore it appears unlikely that connections between the two islands could have occurred during Pleistocene glaciations. Human impact on the islet is nowadays quite low and mostly seasonally concentrated along the sandy shores, as Khrisi is not inhabited during most part of the year. Very few buildings and manufactures, mainly devoted to the summer daily tourist services, are concentrated on the western tip of the islet, in the southern part around the landing place, and behind the beach along the northern coast. Nevertheless, traces of the past agricultural and pastoral activities are still evident, mainly in the west part. The most relevant natural patrimony of the islet is a thick *Juniperus turbinata* and *J. macrocarpa* vegetation, consisting of hundreds of very old individuals in the eastern part. The botanical data regarding Khrisi are up to now very few and this is the first paper especially devoted to it.

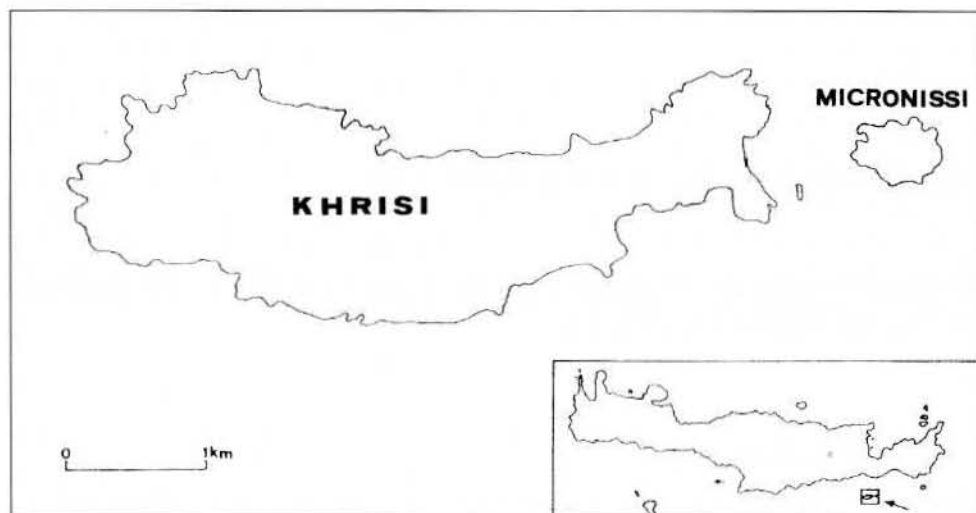


Fig.1 — Khrisi and Mikronissi islets.

The first botanical collection was probably carried out on April, 5th 1914 by Cousturier; the collected material is conserved in Lyon (LY). Subsequently, on the May, 18th 1942 the islet was visited by Rechinger. Other botanical records from Khrisi are reported in Gandoger (1916), Rechinger (1943b), Greuter (1967), Turland & al. (1993), Jahn & Schönfelder (1995) and Press (1997). With the present study, the taxa (species, subspecies and hybrids) of vascular plants recorded from Khrisi raises up to 172, representing 43 families. Within this number, 92 are new records.

Geomorphology and Climate

Khrisi has a maximum length and width of 5 km² 1.6 km i.e. approximately 9.5 km² surface. The highest point is only 30 m a.s.l., 700 m far from the Eastern tip of Khrisi, there is Mikronissi islet, much smaller than Khrisi and completely uninhabited. The sandy seaside is found along the northern part of the islet, on a length of 2.5 km. Elsewhere the shore is constituted by limestone and flysch outcrops, which form the plateau at the base of the islet (Creutzburg & Seidel, 1975). Due to the small dimensions and its geological nature Khrisi has not any source of fresh water, whereas the formation of retrodunal salt marshes and of temporary hyper-

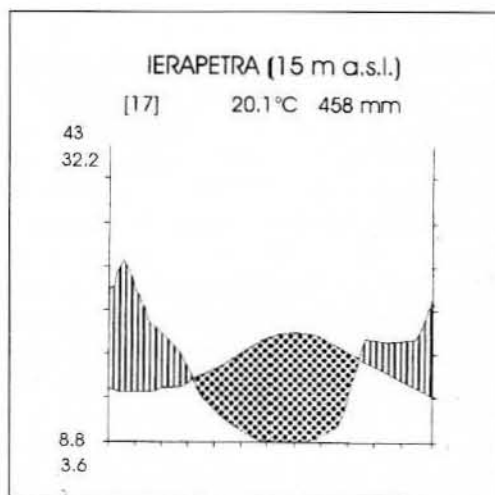


Fig.2 — Climatic diagram of Ierapetra (35° 00' N; 25° 45' E).

saline puddles along the rocky shore is favoured by the flatness of the coasts. There are no meteorological stations; therefore climatic conditions can be referred to that of Ierapetra, a town 15 km northwards, on the Cretan coast (Fig. 2). The mean annual temperature is about 20.1° C, January is the coldest month (average: min. T 8.8° C, max. T: 16.3° C) and July-August the hottest ones (average: min. T Jul.: 22.8° C, Aug.: 23° C, max. T Jul.: 32.2° C, Aug.: 32.1° C). The mean daily temperature range is about 7.6° C during winter and 9.4° C in summer. The mean annual temperature range is 15.3° C. The total rainfall is 458 mm per year on average. According to the bioclimatic classification of Rivas-Martínez (1997), the bioclimate of the islet is Mediterranean desertic-oceanic, with a lower dry ombrotype, and an upper inframediterranean thermotype.

Flora

Thanks to its relatively low anthropogenic impact, Khrisi has many rare and interesting species that justify the protection of the islet as a wildlife reserve. Some of these species are Cretan endemics, such as *Bupleurum gaudianum*, known up to now only from the islet of Gávdhos (Snogerup 1984), *Colchicum cousturieri* previously known only from Khrisi and Koufonisi islets (Greuter 1967) and *Silene ammophila* subsp. *ammophila*, occurring along the SE coast of Crete and on Khrisi (Turland & al. 1993). As regards *Bupleurum gaudianum*, since it was described by Snogerup (1984) on material collected in May, the description of its ripe fruit was hypothetical and no drawings were supplied by the author. We provide an iconography of the fruited plant and of the mericarps in detail (Fig. 3). These are ovoid, ventrally compressed, 1- 1.1 mm long with 10 marked longitudinal ribs covered with papillae. Many other species of Khrisi are particularly interesting from the phytogeographical point of view, such as the Aegean endemics *Crepis cretica*, *Scorzonera cretica*, *Teucrium dumulosum*, *Elytrigia rechingeri*, *Phleum crypsoides* subsp. *crypsoides* as well as several S.-Mediterranean species which are rare or absent on Crete, as *Hedypnois coronopifolia*, *Hyoseris lucida*, *Silene succulenta*, *Helianthemum stipulatum*, *Astragalus sinaicus*, *Cistanche phelipaea*, *Aeluropus lagopoides*, *Lycium schweinfurthii*, *Zygophyllum album*. Most of the recorded species are shared by the flora of Gávdhos islet, the southernmost European outpost, which probably underwent the same paleogeographical events of Khrisi (Bergmeier & al. 1997).

Among the critical taxa of the Aegean flora, a relevant role is played by the genus *Limonium*, that on Khrisi is represented by four species and one nothospecies. Two of these species show taxonomical problems:

Limonium roridum (Sibth. & Sm.) Brullo & Guarino **comb. nov.**

Bas.: *Statice rorida* Sibth & Sm, Fl. Graeca, 3: 91, 1821.

Syn.: *Statice prolifera* D'Urv. Enum., 35, 1822

Statice (Limonium) graeca Auct. non Poiret 1817

Iconotype: Sibth & Sm, Fl. Graeca, 3, Tav. 298, 1821.

The name *Limonium graecum* (Poiret) Rech. f., quoted in many papers dealing with the Aegean area, should be in many cases substituted by the name *Limonium roridum*, which designates one of the most common Aegean *Limonium*. Confusion is due to misidentification

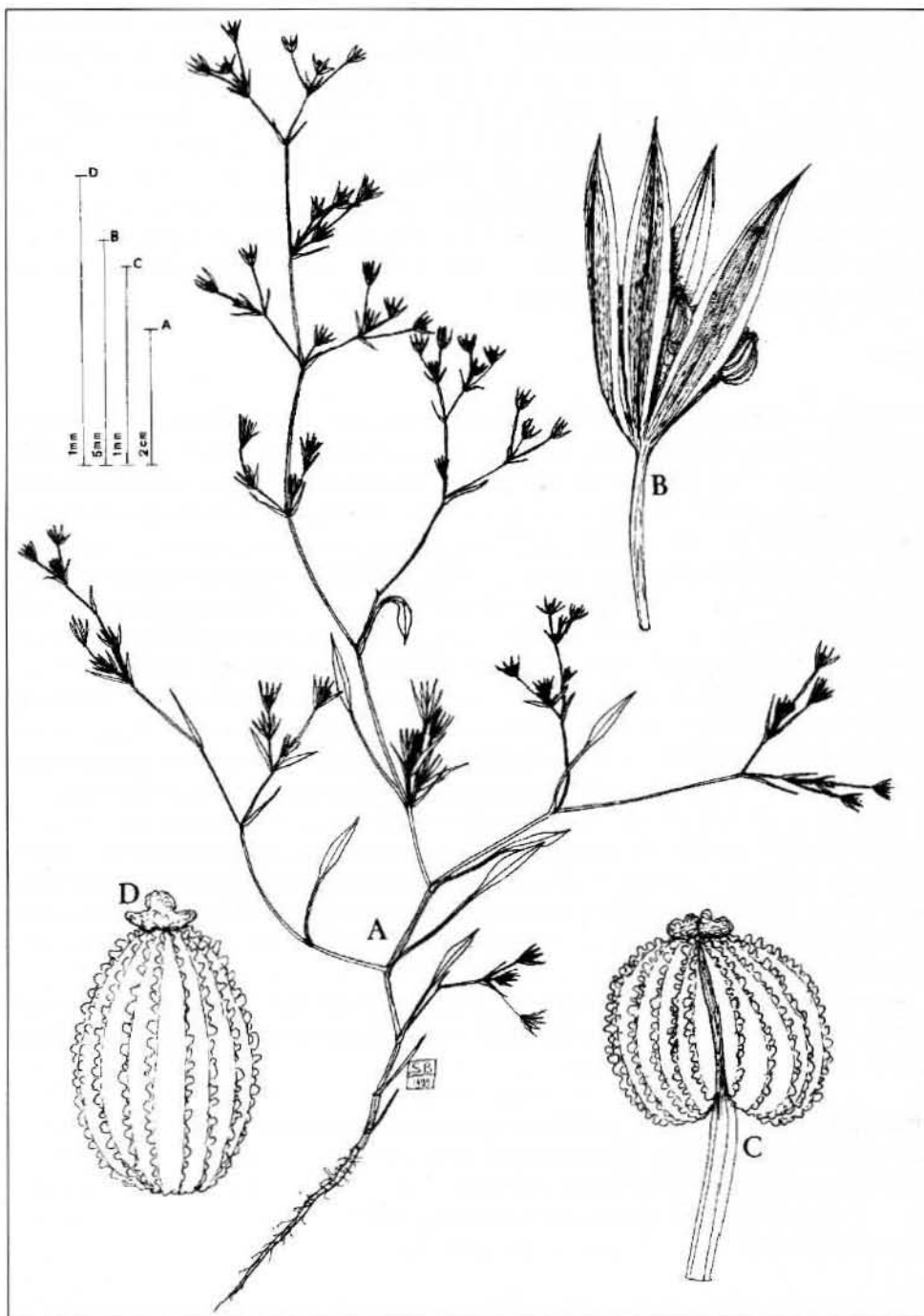


Fig.3—*Bupleurum gaudianum* Snogerup: A, habit of the fruited plant; B, fruited umbel; C, fruit; D, mericarplobes.

of *L. graecum*, species described by Poirét (1817) as *Statice graeca*, on a specimen collected by Tournefort "ex insula Stenosa", but in the protologue generically indicated as coming from Greece, under the following annotation: "*Limonium graecum, bellidis folio, minori & lanceolato*. Tournef. Coroll. 24". As a matter of fact, many original folders of the Tournefort's collection are stored in several herbaria (P, M, BM, C). Among these, a specimen inclusive of leaves and inflorescence has been designated here as the lectotype *Statice graeca*. It comes from the Poirét's herbarium and it is labelled as "*Statice graeca* (x), *Limonium graecum bellidis folio minori et lanceolato*, Tourn. Coroll., *stipes lignosus, repens, nososus, crassus — herb. Poirét*" (P!). The *locus classicus* of *Statice graeca* Poirét is the above-mentioned Stenosa island, which, according to Rechinger (1943a), corresponds to the present Donoussa islet, as can be inferred from the description of Tournefort (1727): "Stenosa est à l'est-nord-est, à 18. milles de Naxie, si l'on compte de cap en cap". In order to verify the correct identification of the island, a field investigation on Donoussa has been carried out, which drove us to the finding of several populations relating to the Tournefort's specimens. On the other hand, *Limonium roridum* was described sub *Statice rorida* by Sibthorp & Smith (1821), who recorded it from Crete, Cyprus, Milos and Smirne and published a detailed drawn in Tav. 298. In the Sibthorp's Greek herbarium (OXF) there are no folders concerning *Statice rorida*, so it was probably described and illustrated on cultivated plants, as it happened for several species quoted in the Sibthorp & Smith's *Flora Graeca*. On the basis of herbarium and field surveys, *Limonium roridum* appears to be widely distributed in the whole Aegean area. This species was treated as a synonym of *L. graecum* by Halácsy (1904), Hayek (1928), Rechinger (1943a), Pignatti (1972), Greuter & al. (1989) and many others, while Boissier (1879) and Gandoger (1916) are among the few who considered *Statice rorida* as a distinct species.

***Limonium chrisianum* Brullo & Guarino sp. nova — Fig. 4.**

Typus: Khrii (Ierapetra, Crete), 25-VIII-1996 Brullo & Guarino s.n. (CAT, holo).

Limonium hierapetrae affine, a quo habito minori (10-30 cm), foliis brevioribus (0,8-4 cm longis), spicis densioribus 0,6-4 cm longis, spiculis 3-5 per 1 cm, bractea externa ovato-lanceolata, bractea media latiore (1,5-1,8 mm), bractea interna obovato-elliptica, rotundata, lobis calycis semiorbiculatis 0,3 mm longis, nervis attingentibus basem loborum, differt.

Limonium chrisianum is a perennial, caespitose, glabrous, grey-greenish; stems 10-30 cm long, erect, rigid, feebly rugose; leaves in basal rosettes, entire or slightly undulate at margin, rigid, coriaceous, one-nerved, 8-40 mm long, 3.5-8 mm wide, rounded at apex, sometimes shortly mucronate; inflorescence angled-ovate, flexuous, without sterile branches; spike lax, 0.6-4 cm long, with 3-5 spikelets per cm; spikelet with 3-7 flowers; outer bract ovate-lanceolate, keeled, 2.2-2.6 × 1.8-2 mm, acute, with brown back and membranous margin, keel extended in a thin tip never reaching the apex; middle bract ovate, 2.2-2.5 × 1.5-1.8 mm, rounded or slightly retuse at the apex, membranous, brown in the middle, two-nerved; inner bract oblong, keeled, 4.8-5.2 × 3-3.2 mm, rounded at the apex, smooth, one-nerved on each side, green-brown in the middle, with a hyaline margin 0.5-0.7 mm wide and keel extended in a thin tip 0.7-0.9 mm long, never reaching the apex; calyx 4.8-5 mm long, membranous in the distal half and coriaceous in the proximal half, with lobes rounded 0.4 mm long and ribs hairy in the lower part, not reaching the lobes, corolla lilac.

This species is closely related to *Limonium hierapetrae* Rech. f., endemic of a short stretch

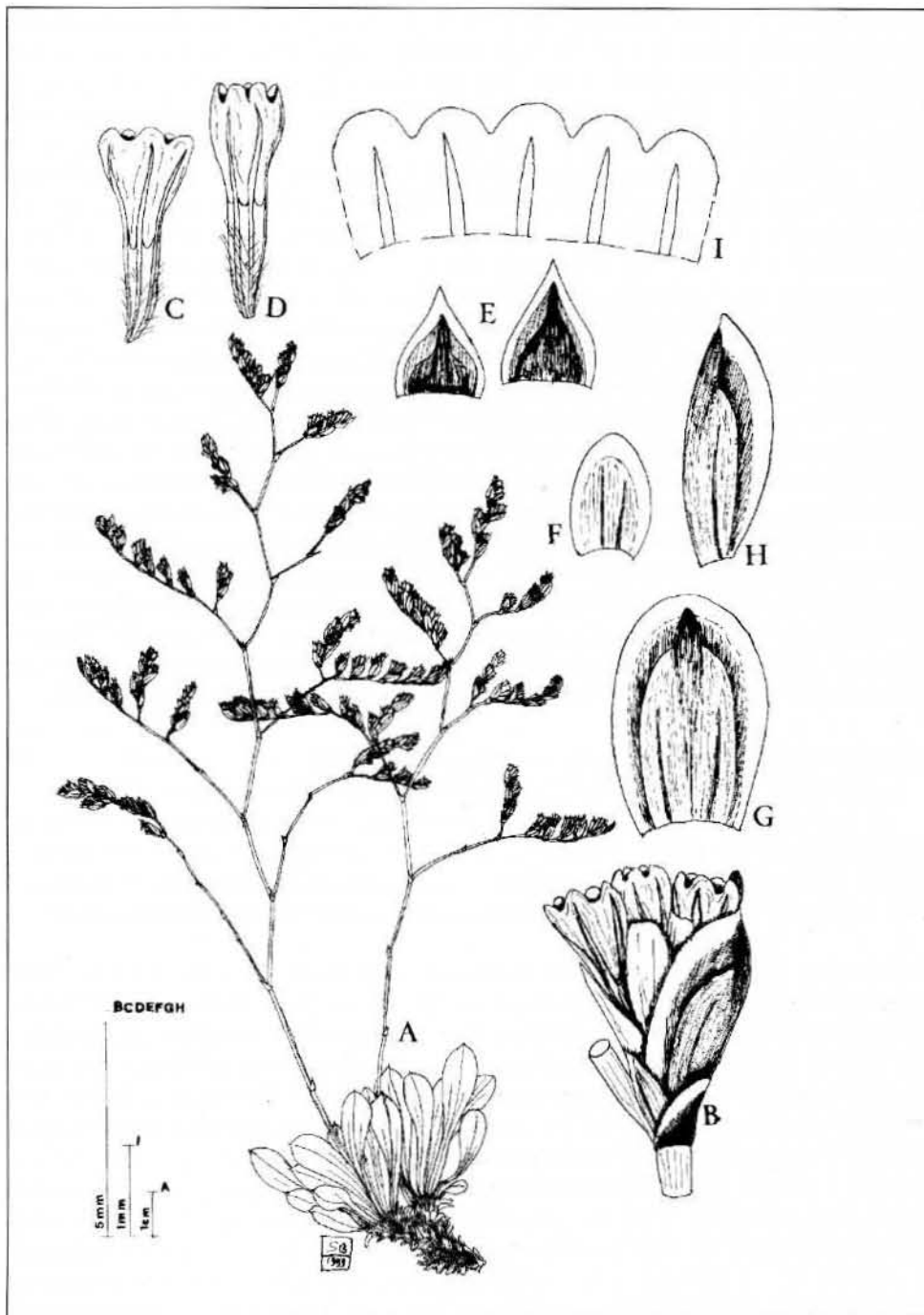


Fig.4— *Limonium chrisianum* Brullo & Guarino: A, habit; B, spikelet; C, D, calyces; E, outer bracts; F, middle bract; G, inner bract (front view); H, inner bract (lateral view); I, calyx lobes.

of coast near the town of Ierapetra (SE Crete). On the basis of herbarium material examined by us and according to literature data (Rechinger 1943b, Artelari 1989), *L. hierapetrae* is characterized by a larger size (up to 80 cm tall), leaves 1.5-8 cm long with a markedly lengthened peduncle, lax spikes, up to 12 cm long, with (1-) 2-3 (-4) spikelets per cm, outer bract ovate-triangular, middle bract 1.4-1.5 mm wide, inner bract elliptic, obtuse, calyx lobes ovate, obtuse, 0.4-0.5 mm long with nerves prolonged beyond the base of the lobes. Conversely, *L. chrisianum* is smaller (10-30 cm tall), with leaves 0.8-4 cm long, having a relatively short peduncle; dense spikes, 0.6-4 cm long, with 4-5 spikelets per cm, outer bract ovate-lanceolate, middle bract 1.5-1.8 mm wide, inner bract obovate-elliptic, rounded, calyx lobes semicircular, 0.3 mm long with nerves only reaching the base of the lobes.

For habit, leaf shape, and lack or rarity of sterile branches, *L. chrisianum* shows some affinity with other Cretan *Limonium* taxa, such as *L. sieberi* (Boiss.) Kuntze, *L. sitiaceum* Rech. f. and *L. rigidum* A. Mayer. In particular, *L. sieberi* differs in having stems 20-40 cm long, with one or few sterile branches, leaves rounded to somewhat obtuse at the apex, inflorescence with 1-3 spikelets per cm, spikelets 2-3 flowered, keel-tip of the outer bract reaching the apex, middle bract 2.6-3 mm long, inner bract 6-7.5 × 3.6-4 mm, 3-4-nerved on each side, calyx 6-7 mm long, with lobes obtuse 0.8-1 mm long; whereas *L. sitiaceum* differs for its more suffrutescent habit with a well-developed root-stock totally covered by fleshy leaves generally canaliculate, stems markedly rugose-papillose, inflorescence with 1-3 spikelets per cm, spikelets 1-2 flowered, outer bract 3.3-3.6 × 2-2.3 mm, middle bract 3.4-3.6 × 2-2.2 mm, inner bract 8-8.5 × 3.8-4.5 mm 3-nerved on each side, calyx 6.5-8 mm long, with lobes acute 0.7-0.8 mm long; finally *L. rigidum* differs in having stems scabrous-tuberculate, leaves somewhat obtuse to acute, normally mucronate, inflorescence with 2-3 spikelets per cm 1-3 (4) flowered, outer bract ovate 2.8-3 × 2.2-2.4 mm, middle bract obovate 3-3.4 × 2-2.2 mm, inner bract obovate 6-7 × 4.2-4.5 mm, calyx 5-5.5 mm long, with acute ribs, 0.8-0.9 mm long, reaching the middle of the lobe.

List of the vascular plants

Khrisi and Mikronissi are not always treated separately in literature, so that the 80 records taken from published data refer mostly to both islets. Within the 172 taxa of the total list, 161 have been found during the present research on Khrisi. At the present state of knowledge, among the 11 species unrecorded by us, three (*Cistanche phelypaea*, *Hyparrhenia hirta* and *Cressa cretica*) are known only from Mikronissi (Rechinger, 1943b) and one (*Bupleurum semicompositum*) is probably a misidentification of *Bupleurum gaudianum*. All our specimens have been collected on August 25th, 1996 and are deposited in the herbarium of the Botanical Department of Catania University (CAT). For each record of the list, a numerical code has been given as follows:

0. not found during the present research.
1. quoted from Khrisi by Rechinger (1943b).
2. quoted from Mikronissi by Rechinger (1943b).
3. quoted from Khrisi and/or Mikronissi by Turland & al. (1993).
4. quoted from Khrisi and/or Mikronissi by Press (1988).
5. quoted from Khrisi by Greuter (1967).
6. new record.

GYMNOSPERMAE***Pinaceae***

Pinus brutia Ten. – 3.

Cupressaceae

Juniperus macrocarpa Sm. – 1, 3.

Juniperus turbinata Guss. – 1, 3.

ANGIOSPERMAE**DICOTYLEDONES*****Polygonaceae***

Polygonum maritimum L. – 1, 3.

Rumex bucephalophorus L. subsp. *aegaeus* Rech. f. – 1, 3, 4.

Chenopodiaceae

Arthrocnemum macrostachyum (Moric.) Moris – 1, 3.

Atriplex halimus L. – 3.

Salsola kali L. subsp. *kali* – 3.

Sarcocornia fruticosa (L.) A. J. Scott – 1.

Cactaceae

Opuntia ficus-barbarica A. Berger – 6.

Aizoaceae

Mesembrianthemum nodiflorum L. – 1, 3.

Caryophyllaceae

Arenaria leptoclados (Rechb.) Guss. – 1, 3.

Paronychia macrosepala Boiss. – 6.

Sagina maritima Don. – 6.

Silene ammophila Boiss. & Heldr. subsp. *ammophila* – 1, 3.

Silene apetala Willd. – 6.

Silene nocturna L. – 6.

Silene sedoides Poir. – 1, 3.

Silene succulenta Forssk. – 1, 3.

Spergularia bocconeii (Scheele) Graebner – 1, 3.

Spergularia diandra (Guss.) Boiss. – 0, 1, 3.

Spergularia salina J. & C. Presl. – 6.

Ranunculaceae

Ranunculus paludosus Poir. – 6.

Papaveraceae

Glaucium flavum Krantz – 6.

Brassicaceae

Brassica tournefortii Gouan – 6.

Cakile maritima Scop. – 1, 3.

Carricthera annua (L.) DC. – 6.

Erophila praecox (Steven) DC. – 6.

Malcolmia flexuosa (Sm.) Sm. – 0, 1, 3.

Rosaceae

Sarcopoterium spinosum (L.) Spach – 6.

Fabaceae

Anthyllis hermanniae L. – 1, 3.

Astragalus sinaicus Boiss. – 0, 1, 3.

Ceratonia siliqua L. – 3.

Coronilla scorpioides (L.) Koch – 6.

Hippocrepis ciliata Willd. – 6.

Lotus edulis L. – 6.

Lotus halophilus Boiss. & Spruner – 1, 3.

Lotus peregrinus L. – 6.

Medicago arabica (L.) Huds. – 6.

Medicago coronata (L.) Bartal. – 6.

Medicago litoralis Rohde ex Loisel – 6.

Medicago marina L. – 6.

Onobrychis aequidentata (Sm.) D'Urv. – 6.

Ononis hispanica L. f. – 1, 3.

Ononis ornithopodioides L. – 6.

Ononis reclinata L. – 1, 3.

Trifolium campestre Schreber – 3.

Trifolium infamia-ponertii Greuter – 1, 3.

Trifolium scabrum L. – 6.

Trifolium suffocatum L. – 6.

Trifolium tomentosum L. – 6.

Trifolium uniflorum L. – 6.

Geraniaceae

Erodium cicutarium (L.) L'Hér. – 1, 3.

Erodium laciniatum (Cav.) Willd. subsp. *laciniatum* – 3.

Zygophyllaceae

Fagonia cretica L. – 0, 3.

Zygophyllum album L. f. – 1, 3.

Linaceae

Linum strictum L. – 6.

Euphorbiaceae

Euphorbia paralias L. – 3.

Euphorbia peplis L. – 1, 3.

Anacardiaceae

Pistacia lentiscus L. – 1, 3.

Malvaceae

Malva cretica Cav. subsp. *cretica* – 6.

Malva parviflora L.

Cistaceae

Fumana thymifolia (L.) Spach ex Webb – 1, 3.

Helianthemum salicifolium (L.) Miller – 1, 3.

Helianthemum stipulatum (Forssk.) C. Chr. – 3.

Tuberaria lipopetala (Murb.) Greuter & Burdet. – 6

Frankeniaceae

Frankenia hirsuta L. – 2, 3.

Frankenia pulverulenta L. subsp. *pulverulenta* – 1, 3.

Apiaceae

Bupleurum gaudianum Snogerup – 6.

Bupleurum semicompositum L. – 0, 1, 3.

Crithmum maritimum L. – 6.

Daucus guttatus Sm. – 6.

Pseudorhiza pumila (L.) Grande – 1, 3.

Scandix pecten-veneris L. – 6.

Ericaceae

Erica manipuliflora Salisb. – 1, 3.

Primulaceae

Anagallis arvensis L. – 6.

Plumbaginaceae

Limoniastrum monopetalum (L.) Boiss. – 1, 3.

Limonium echioides (L.) Miller – 1, 3.

Limonium chrisianum Brullo & Guarino – 6.

Limonium roridum (Sibth. & Sm.) Brullo & Guarino – 1, 3.

Limonium virgatum (Willd.) Fourr. – 6.

Limonium roridum x *virgatum* – 6.

Oleaceae

Olea europaea L. subsp. *oleaster* (Hoffmanns. & Link) Negodi – 6.

Gentianaceae

Blackstonia acuminata (Koch & Ziz) Domin subsp. *acuminata* – 6.

Centaurium tenuiflorum (Hoffmanns. & Link) Fritsch subsp. *tenuiflorum* – 6.

Asclepiadaceae

Periploca angustifolia Labill. – 1, 3.

Rubiaceae

Galium murale (L.) All. – 6.

Galium setaceum Lam. – 0, 3.

Valantia hispida L. – 6.

Valantia muralis L. – 6.

Convolvulaceae

Cressa cretica L. – 0, 2, 3.

Boraginaceae

Echium angustifolium Miller subsp. *angustifolium* – 2, 3.

Echium arenarium Guss. – 1, 3.

Heliotropium hirsutissimum Grauer – 6.

Myosotis ramosissima Rochel – 6.

Neotostema apulum (L.) Johnston – 6.

Lamiaceae

Coridothymus capitatus (L.) Reichenb. f. – 1, 3.

Prasium majus L. – 6.

Teucrium brevifolium Schreber – 1, 3.

Teucrium dumulosum (Rech. f.) Brullo & Guarino stat. nov. (Bas. *Teucrium polium* L. f. *dumulosum* Rech. f. Beich. Bot. Centralbl. 54, Abt. 2(3): 657, 1936) – 1.

Solanaceae

Lycium schweinfurthii Dammer – 3.

Mandragora autumnalis Bertol. – 6.

Scrophulariaceae

Misopates orontium (L.) Rafin. – 6.

Parentucellia latifolia (L.) Caruel – 6.

Orobanchaceae

Cistanche phelypaea (L.) Cout. – 0, 2 (sub: *C. tinctoria*), 3.

Plantaginaceae

Plantago afra L. – 6.

Plantago albicans L. – 1, 3.

Plantago cretica L. – 6.

Plantago weldenii Rechb. subsp. *weldenii* – 2.

Campanulaceae

Campanula erinus L. – 6.

Asteraceae

Aetheorhiza bulbosa (L.) Cass. subsp. *microcephala* Rech. f. – 6.

Anthemis rigida (Sm.) Boiss. ex Heldr. subsp. *rigida* – 1, 3.

Asteriscus aquaticus (L.) Less. – 6.

Atractylis cancellata L. – 3.

Carduus pycnocephalus L. – 6.

Carlina lanata L. – 6.

Carthamus boissieri Halácsy – 6.

Cichorium pumilum Jacq. – 6.

Cichorium spinosum L. – 6.

Crepis cretica Boiss. – 1, 3.

Cynara cornigera Lindley – 2, 3.

Dittrichia viscosa (L.) Greuter – 0, 3.

Filago aegaea Wagenitz subsp. *aegaea* – 3.

Hedypnois rhagadioloides (L.) F. W. Schmidt – 1.

Hedypnois coronopifolia Ten. – 6.

Hedypnois cretica (L.) Dum. Cours. – 6.

Hyoseris lucida L. – 6.

Hyoseris scabra L. – 6.

Hypochoeris achyrophorus L. – 6.

Leontodon tuberosus L. – 6.

Phagnalon graecum Boiss. & Heldr. – 1, 3.

Reichardia orientalis (L.) Hochreutiner – 1, 3.

Reichardia picroides (L.) Roth var. *maritima* Fiori – 3 (sub. *R. picroides*).

Scolymus hispanicus L. – 6.

Scorzonera cretica Willd. – 1, 3.

Senecio leucanthemifolius Poir. – 6.

Sonchus oleraceus L. – 6.

ANGIOSPERMAE**MONOTYLEDONES****Liliaceae**

Allium rubrovittatum Boiss. & Heldr. – 3.

Asparagus aphyllus L. subsp. *orientalis* (Backer) P. H. Davis – 3.

Asparagus stipularis Forssk. – 3.

Colchicum cousturieri Greuter — 1 (sub: *C. cupanii*), 3, 5.

Leopoldia comosa (L.) Miller — 6.

Scilla autumnalis L. — 6.

Urginea maritima (L.) Baker — 6.

Agavaceae

Agave americana L. — 6.

Amaryllidaceae

Pancratium maritimum L. — 3.

Iridaceae

Gynandris monophylla Boiss. & Heldr. ex Klatt. — 6.

Juncaceae

Juncus bufonius L. — 6.

Juncus heldreichianus Marsson ex Parl. subsp. *heldreichianus* — 3.

Poaceae

Aeluropus lagopoides (L.) Trin ex Thwaites — 3.

Arundo donax L. — 0, 3.

Avellinia michelii (Savi) Parl. — 6.

Avena ludoviciana Durieu — 1 (sub: *A. sterilis*), 3.

Briza maxima L. — 6.

Bromus fasciculatus C. Presl — 6.

Bromus rubens L. — 6.

Bromus scoparius L. — 6.

Catapodium maritimum (L.) Hubbard — 6.

Cynodon dactylon (L.) Pers. — 6.

Elytrigia rechingeri (Runemark) J. Holub — 6.

Hordeum leporinum Link — 6.

Hyparrhenia hirta (L.) Stapf. — 0, 2, 3.

Parapholis incurva (L.) Hubbard — 6.

Parapholis marginata Runemark — 6.

Phleum crypsoides (D'Urv.) Hackel ex Franchet subsp. *crypsoides* — 6.

Piptatherum miliaceum (L.) Cos. — 6.

Polypogon subspataceus Req. — 6.

Psilurus incurvus (Gouan) Sch. et Th. — 6.

Rostraria cristata (L.) Tzvelev — 2, 3

Rostraria hispida (Savi) M. Dogan — 6.

Stipa capensis Thunb. — 6.

Trachynia distachya (L.) Link — 1, 3.

Triplachne nitens (Guss.) Link — 1, 3.

Vulpia ciliata Dumort. subsp. *ciliata* — 6.

Most relevant vegetation types

As far as vegetation of Khrisi is concerned, this is the first contribution to its knowledge. All the relevés have been made on August 25th 1996, so the ephemeral vegetation is not treated here.

Maquis (*Quercetea ilicis*)

As aforesaid, the most impressive vegetation of Khrisi is a maquis dominated by *Juniperus turbinata*, numbering many secular individuals with trunks over 30 cm in diameter. This thick maquis (Tab. 1), shaped by the marine winds, reaches an average height of 3 m and even if quite poor in species. For the presence of *Periploca angustifolia*, it can be ascribed to the S-Mediterranean association *Periploco angustifoliae-Juniperetum turbinatae*, described by Bartolo & al. (1988) for Lampedusa, the southernmost Italian island. Regarding the higher syntaxa, the association clearly belongs to the *Periplocion angustifoliae*, the most thermo-xerophilous alliance of the order *Pistacio-Rhamnietalia alaterni*. The *Periploco angustifoliae-Juniperetum turbinatae* covers a rather large area in the southern part of Khrisi; probably in the past this association was more widespread inland, but it has been nearly completely destroyed by the old settlers of the islet.

The high dunes behind the sandy shores are stabilised by a wooden vegetation dominated by *Juniperus macrocarpa*, a *psammophilous phanerophyte* widespread along the Mediterranean coasts, where it gives the physiognomical characterization to several phytosociological associations (Rivas-Martínez, 1975; Bartolo & al., 1982; Gèhu & al. 1990). On Khrisi this plant community is floristically quite poor, if compared to that of other Mediterranean areas (Tab. 2). Nevertheless, due to the presence of *Pistacia lentiscus* it can be considered as an impoverished aspect of the *Pistacio-Juniperetum macrocarpae*, association up to now quoted for the central Mediterranean area (Caneva & al. 1981, Bartolo & al. 1992).

Phrygana (*Cisto-Micromerietea*)

The inland rocky outcrops, where the soil cannot support a maquis vegetation, are covered by a chamaephytic vegetation dominated by *Corydanthus capitatus*, *Fumana thymifolia* and *Helianthemum stipulatum*. Whose mean height, influenced by the strong marine winds, never exceeds 30 cm. From the floristic and structural point of view, this phytocoenosis belongs to the class *Cisto-Micromerietea* here represented by the Aegean alliance *Hyperico-Micromerion graecae* of the order *Sarcopoterietalia spinosi* (Barbero & Quezel, 1989; Brullo & al. 1997). The abundance of *Helianthemum stipulatum*, a S-Mediterranean element, allows us to distinguish this community from the others known of the aforementioned alliance. Therefore a new association *Coridothymo-Helianthemetum stipulati* is proposed (holotype: rel. 1, Tab. 3), which occurs very likely also in other S-Aegean islands.

Shrubby halo-nitrophilous vegetation (*Pegano-Salsolietea*)

Some traits of the sandy coasts, where the decomposition of the organic material accu-

mulated on the beach causes the nitrataion of the substratum, are colonized by a dense perennial halo-nitrophilous vegetation dominated by *Limoniastrum monopetalum*, *Asparagus stipularis* and *Lycium schweinfurtii*, and reaching the mean height of 70-80 cm. This vegetation shows some ecological and structural affinity with the *Lycio europaei-Limoniastrum monopetali*, association described for the Egyptian coast of Mareotis (Tadros & Atta 1958), and with the *Asparago stipularis-Limoniastrum monopetali*, occurring in Southern Sicily (Bartolo & al., 1982). The presence of *Lycium schweinfurtii* instead of, respectively, *Lycium europaeum* and *L. intricatum*, relatively, geographically differentiates quite well the Khrisi vegetation from the other ones. This is therefore described as a new association, named *Lycio schweinfurtii-Limoniastrum monopetali* (holotype: rel. 4, Tab. 4), which represents a S-Aegean vicariant of the Egyptian and the Sicilian ones. All these associations belong to *Salsolo-Peganon*, the S-Mediterranean alliance of the class *Pegano-Salsotea*. Where the disturbance caused by sea-waves during high tides is heavier, the *Lycio schweinfurtii-Limoniastrum monopetali* gives way to the therophytic vegetation of the class *Cakiletea maritimae*.

Aero-halophilous perennial vegetation (*Crithmo-Limonietea*)

The rocky coasts are colonized by a chamaephytic vegetation determined by the sea aerosol and characterized by *Cichorium spinosum*, *Crithmum maritimum*, *Frankenia hirsuta* and some species of *Limonium*, as *L. roridum* and *L. chrisianum*. This vegetation, for its ecologic and floristic features, clearly belongs to the class *Crithmo-Limonietea* and to the Mediterranean order *Crithmo-Limonietalia*. Within this order, basing on the richness of endemics which characterize this vegetation, some alliances have been described (Brullo & Furnari, 1988; Bartolo & Brullo 1993). For the East-Mediterranean area, Gèhu & al. (1992) proposed the alliance *Crithmo-Limonion graeci*. As highlighted by Meyer (1995), this name is invalid according to the Art. 3f of the Phytosociological code, as in the table of the association-type there is no *Limonium graecum* and therefore a new name, *Crithmo-Frankenion hirsutae*, was proposed by the same author. According to the Art. 15 and 17 of the above-mentioned code, the Meyer's name is invalid as well, since the name of the association indicated by the same author as nomenclatural type (*Anthemido-Limonietum graeci*) is invalid (Art. 3f), as in the relevé-typus *Anthemis rigida* does not appear. In addition, since *Frankenia hirsuta* is a circummediterranean element and *Limonium graecum*, as aforesaid, is an ambiguous name, we consider that is better not to convalidate the two above-mentioned names. Therefore a new alliance, *Cichorio spinosi-Limonion roridi* (holotype: *Limonietum chrisiani* ass. nova) is here proposed, whose characteristic species are: *Cichorium spinosum*, *Limonium roridum*, *L. ocymifolium*, *L. hyssopifolium*, *L. sieberi* and *Salsola aegaea*, all of them widely distributed in the Eastern Mediterranean basin. The new alliance can be considered an eastern vicariant of the *Crithmo-Limonion* Molinier 1934, having a W-Mediterranean distribution, and of the *Crucianellion rupestris* Brullo & Furnari 1988, occurring in the C-Mediterranean area. The *Cichorio spinosi-Limonion roridi* is represented by Khrisi islet by the new association *Limonietum chrisiani* (holotype: rel. 4, Tab. 5), characterized by the endemic *Limonium chrisianum*.

Salt marsh vegetation (*Sarcocornietea fruticosae*)

The retrodunal salt marshes are colonized by an extremely selected halophilous plant

community, whose members tolerate the periodical inundation by sea-water of their growing-sites, as well as the complete dessiccation that give rise to halomorphic soils, characterized by a high saline concentration in the upper stratum. *Aeluropus lagopoides* and *Limonium roridum* dominate this vegetation, whose mean height is about 30 cm. Both the species have been chosen to give name to a new association, the *Aeluropo-Limonietum roridi* (holotype: rel. 3, Tab. 6), which for its ecological requirements and for the occurrence of *Aeluropus lagopoides* and *Limonium virgatum* can be ascribed to the *Arthrocnemion glauci* alliance grouping the hyperhalophyllous vegetation occurring in salt marshes of S-Mediterranean and Saharo-Arabian regions, linked to an arid or hyper-arid bioclimate. The new association is closely related to other S-Mediterranean ones characterised as well by the dominance of *Aeluropus lagopoides* which goes with several endemic *Limonium*, such as the *Aeluropo-Limonietum intermedii*, described by Bartolo *et al.* (1988) from Lampedusa island and the *Aeluropo-Limonietum rubescentis*, described by Barbagallo *et al.* (1990) from S-Tunisia.

Perennial psammophilous vegetation (*Ammophiletea*)

The embryonal dunes along the sandy coasts of Khrisi are due to the action of perennial herbaceous species, forming an open phytocoenosis whose mean height reaches during summer a maximum of 45 cm. Among others, *Elytrigia rechingeri*, *Silene succulenta* and *Pancratium maritimum* play a relevant physiognomic role. The first two species, whose biogeographical relevance has been already mentioned, give the name to a new association, *Sileno succulentae-Elytrigietum rechingeri* (holotype: rel. 8, Tab. 7), which represents a S-Aegean vicariant of the *Sileno succulentae-Elymetum farcti* Gèhu & Gèhu-Frank 1986, widespread along the N-African coast (Gèhu & Gèhu-Frank 1986, Brullo & Furnari, 1988). The new association, linked to an inframediterranean arid bioclimate for the presence of *Silene succulenta* and *Hyoseris lucida* can be ascribed, as the aforementioned *Sileno succulentae-Elymetum farcti*, to the alliance *Aegialophilo-Silenion succulentae* Brullo & Furnari 1988, a S.E. Mediterranean vicariant of the *Ammophilion arundinaceae* Br.-Bl. 1933.

Therophytic nitro-psammophilous vegetation (*Cakiletea maritimae*)

On sandy coasts, a narrow belt along the shore is colonised by a psammophilous halo-nitrophilous annual vegetation whose species take advantage from the decomposition of the organic material beached by sea storms, that causes a noteworthy enrichment in nitrates of the substratum. This vegetation shows a relatively low cover percentage, with no competition among the species, and is characterised by the dominance of small plants of *Zygophyllum album*, assuming in this context a therophytic habit. In the optimal vegetative phase, the mean height of this phytocoenosis does not reach 40 cm. Owing to the abundance of *Cakile maritima*, *Salsola kali* and *Euphorbia peplis*, this vegetation belongs to the class *Cakiletea maritimae*, but the presence of *Zygophyllum album* lead us to describe a new association, markedly thermo-xerophilous, named *Cakilo-Zygophylletum albi* (holotype: rel. 3, Tab. 8) which can be considered a S-Mediterranean vicariant, linked to an inframediterranean arid bioclimate, of the *Salsolo-Cakiletum maritimae*, having more mesic exigences. On Khrisi the association comes generally into contact with the *Lycio schweifurtii-Limoniastretum monopetali* and with the *Sileno succulentae-Elytrigietum rechingeri*.

Syntaxonomical scheme

- QUERCETEA ILICIS** Br.-Bl. ex A. & O. Bolòs 1950
Pistacio-Rhamnetalia alaterni Rivas-Martínez 1975
Periplocion angustifoliae Rivas-Martínez 1975
Periploco angustifoliae-Juniperetum turbinatae Bartolo & al. 1988
Juniperion turbinatae Rivas-Martínez 1975 corr. Rivas-Martínez in Rivas-Martínez & al. 1988
Pistacio-Juniperetum macrocarpae Caneva, De Marco & Mossa 1981
- CISTO-MICROMERIETEA** Oberd. 1954
Sarcopoterietalia spinosi Eig 1939
Hyperico-Micromerion graecae Barbero & Quezel 1989
Coridothymo-Helianthemetum stipulati ass. nova
- PEGANO-SALSOLETEA** Br.-Bl. & O. Bolòs 1958
Salsolo-Peganetalia Br.-Bl. & O. Bolòs 1954
Salsolo-Peganion Br.-Bl. & O. Bolòs 1954
Lycio schweifurtii-Limonastretum monopetali ass. nova
- CRITHMO-LIMONIETEA** Br.-Bl. 1952
Crithmo-Limonietalia Molinier 1934
Cichorio-Limonion roridi all. nova
Limonietum chrisiani ass. nova
- SARCOCORNIETEA FRUTICOSAE** Br.-Bl. & R. Tx. ex A. Bolòs 1950
Sarcocornietalia fruticosae Br.-Bl. 1933
Arthrocnemion glauci Rivas-Martínez 1980
Aeluropo-Limonietum roridi ass. nova
- AMMOPHILETEA** Br.-Bl. & R. Tx. ex Westhoff & al. 1946
Ammophiletalia Br.-Bl. 1933
Aegialophilo-Silenion succulentae Brullo & Furnari 1988
Sileno succulentae-Elytrigietum rechingeri ass. nova
- CAKILETEA MARITIMAE** R. Tx. & Preising ex Br.-Bl. & R. Tx. 1952
Euphorbietalia peplis R. Tx. 1950
Euphorbion peplis R. Tx. 1950
Cakilo-Zygophylletum albi ass. nova

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