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Outlines of the bryophyte vegetation of Vulcano (Aeolian Islands, Sicily)

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Abstract
A phytosociological study on the bryophyte vegetation of the Vulcano Island is presented. Some associations and two bryophyte communities are found; they are included in the phytosociological classes *Barbuletea unguiculatae* Mohan 1978, *Cladonio-Lepidozietea reptantis* Jezek & Vondrácek 1962 em. Marstaller 1993, *Racomitrietea heterostichi* Neumayr 1971, *Grimmietea anodontis* Hadàc et Vondrácek in Jezek et Vondrácek 1962, and *Frullanio dilatatae-Leucodontetea sciuroidis* Mohan 1978. The data came out from this study show the condition of an island under strong anthropic pressure.

Key words: Aeolian islands, bryophytes, phytosociology, Sicily, syntaxonomy, Vulcano.

Riassunto
Lineamenti della vegetazione briofitica di Vulcano (Isole Eolie, Sicilia). Viene presentato uno studio fitosociologico sulla briovegetazione dell'isola di Vulcano. Sono state rinvenute diverse associazioni e due aggruppamenti di pertinenza delle classi fitosociologiche *Barbuletea unguiculatae* Mohan 1978, *Cladonio-Lepidozietea reptantis* Jezek & Vondrácek 1962 em. Marstaller 1993, *Racomitrietea heterostichi* Neumayr 1971, *Grimmietea anodontis* Hadàc et Vondrácek in Jezek et Vondrácek 1962, e *Frullanio dilatatae-Leucodontetea sciuroidis* Mohan 1978. I dati emersi dallo studio briovegetazionale mettono in luce la realtà di un'isola sottoposta ad un intenso disturbo antropico.

Parole chiave: briofite, fitosociologia, isole Eolie, Sicilia, sintassonomia, Vulcano.

Introduction

Vulcano, the southern most of the Aeolian islands is, due to its size, (22 km2) the third island of the archipelago after Lipari and Salina. With a maximum altitude of 500 m, the current island is only a small part of a larger volcano that extends up to about 1 Km deep and whose activity started in the upper Pleistocene, alternating phases of magmatic emission and volcanic-tectonic collapse and thus generating a complex morphology.

However, even if Vulcano has attracted notable interest for its landscape and naturalistic value, it has not been sufficiently and adequately investigated bryologically. The current knowledge is based on recent, though incomplete, floristic data from an ecological-applicative study (Privitera & Puglisi, 2001), on less recent contributions (Herzog, 1961; Lübenau & Lübenau, 1970) or antique records enclosed in check-lists regarding wider territories (Bottini, 1903, 1907; Zodda, 1904). No information is known on the bryovegetation, whose knowledge today is always more requested as an aid in evaluating the health of the environment for eventual attempts in the territorial management. On account of this lack, research in this area was started that has identified some bryovegetational aspects that are able to give an explicative picture of the bryophyte vegetation of the island that is undergoing heavy anthropic pressure.

Environmental characteristics

From the geological-vulcanological point of view, Vulcano, which originated about 120,000 years ago, is one of the most recent islands of the Aeolian archipelago, followed only by Stromboli, which formed about 40,000 years ago. In the first phase of sub-surface magmatic activity the primordial volcano was formed, with the emission of lava of the "aa" type and whose products are visible today along the western, eastern and southern coastlines. There then followed the collapse of the summit of the edifice with the subsequent formation of an ample depression, the Caldera del Piano, with a diameter of about 2.5 Km, mostly covered by the products of successive eruptions. In the current structure it is possible to distinguish three distinct morphological units. The first, to the south, is formed by some layer-volcanoes (Monte Aria, Monte Saraceno, Monte Luccia) and by the Caldera del Piano

that represents the primordial area of the volcano. The second unit, in the centre, is formed by the Caldera della Fossa with the Vulcano Fossa, with two craters (Fossa I and Fossa II). The third unit is formed by Vulcanello (123 m) with its three craters aligned in a NE-SW direction; this is the most recent structure that was formed at the beginning of the II century BCE, first as a morphologically separate unit and then, later, connected to the island by a thin sandy isthmus.

As all the other islands of the archipelago, Vulcano is characterized by lava rocks, with a prevalence of trachytic and trachyolitic rocks. There are few heights and these do not reach high altitude; the maximum is at the southern most point, Monte Aria (500 m). From the last eruption (1888-1890) the island has had an intense and diffused fumarolic activity, above all near the volcano Fossa and within its crater; other thermal manifestations (fumaroles and hot mud), even if less evident, can be found near the Porto di Levante and at Vulcanello. The high sulfur content and the acidity of the emissions prevents the establishment of bryophytes, as, instead, happens in other fumarolic areas of the Mediterranean (Brullo *et al*., 2001, 2004).

The climate is typically Mediterranean. In particular, from the data of the meteorological station located at "Il Piano" (420 m a.s.l.) the average annual temperature is 16.6°C and the average annual precipitation is 564.3 mm. According to the classification of Rivas Martinez *et al*. (1991), Vulcano shows an upper dry thermo-Mediterranean bioclimate.

The phanerogamic vegetation is mostly represented by maquis and garrigue (Ferro & Furnari, 1970; Brullo & Furnari, 1994). In particular, the shrubby vegetation with *Erica arborea* L., *Cistus* sp. pl., *Spartium junceum* L., *Genista tyrrhena* Valsecchi, *Cytisus aeolicus* Guss., referable to *Genistetum tyrrhenae* (Brullo, Di Martino, Marcenò 1977) Brullo in Brullo & Furnari 1993, is the most spread. This association is referred to the alliance *Calicotomao villosae-Genistion tyrrhenae* Biondi 2000, syntaxon described for Tyrrhenian islands and south-western Tyrrhenian coasts (Biondi, 2000). The ephemeral meadows of the *Helianthemetea guttati* (Br.-Bl. In Br.-Bl., Roussine & Nègre 1952) Rivas Goday & Rivas-Martinez 1963 em. Rivas Martinez 1978, occurring in the clearings of the shrubby vegetation, are very common too. The woodlands, referable to *Erico-Quercetum ilicis* Brullo, Di Martino & Marcenò 1977, are very rare and limited to some areas of the inland.

Material and Methods

The field work has been made during the years 1998 and 2002. The bryovegetational analysis has been carried out following the phytosociological method of Braun-Blanquet (1964); the cover-abundance has been reported according to the following values: + (<1%), 1 (1-10%), 2 (10.1-25%), 3 (25.1-50%), 4 (50.1-75%), 5 (75.1-100%). Overall, sixty relevés have been carried out in different localities (Fig. 1) and on different types of substrata: soil, stone walls, rocks, and tree cortex.

Syntaxonomic arrangement, name of syntaxa and of syntaxa authors follows mostly Marstaller's synsystematic (1993); the nomenclature of the species is that reported by Aleffi & Schumacker (1995) for liverworts and Cortini Pedrotti (2002) for mosses.

Results

The examination of the phytosociological relevés has allowed finding some associations and communities that will be discussed later.

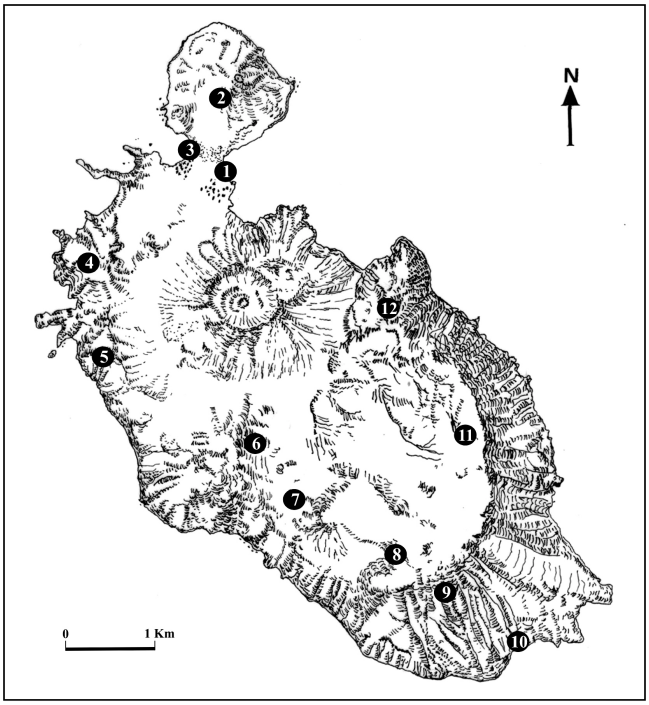

Fig. 1 – Vulcano Island. Location of the investigated areas: 1. Porto di Levante; 2. Vulcanello; 3. Porto di Ponente; 4. M. Lentia; 5. Scogli di Capo Secco; 6. M. Saraceno; 7. Menichedda; 8. Il Piano; 9. Serra delle Felicicchie; 10. Gelso; 11. Piano di Luccia; 12. Capo Grillo

BARBULETUM CONVOLUTAE Hadàc & Šmarda 1944 (Tab. 1)

This association is found at Porto di Levante, Scogli di Capo Secco and Vulcanello along the beaten pathways, in open and uncultivated areas. Ecologically, it is a terricolous, xerophilous or meso-xerophilous association. *Barbula convoluta* Hedw. and *Didymodon acutus* (Brid.) K. Saito are characteristic species of association; to these, other terricolous species are associated, for the most part ruderal, such as *Weissia controversa* Hedw. and *Didymodon vinealis* (Brid.) R. H. Zander, characteristics of alliance, *Bryum capillare* Hedw., characteristic of higher units. *Barbuletum convolutae* is included in the alliance *Grimaldion fragrantis* Šmarda & Hadàc 1944, a syntaxon belonging to the order *Barbuletalia unguiculatae* v. Hübschmann 1960 of the class *Barbuletea unguiculatae* Mohan 1978.

LUNULARIETUM CRUCIATAE Giacomini 1950 (Tab. 2)

This association is more demanding in edaphic humidity than the previous one; the syntaxon has been found in gardens and green areas where it is diffused in the spaces between paving stones. As regards the ecology, it is a terricolous, meso-xerophilous, strongly

Tab. 1 – *Barbuletum convolutae* Hadàc & Šmarda 1944

Relevès number	1	2	3	4	5	6	P
Surface (dmq)	6	5	5	8	8	5	r
Altitude (m)	-	-	-	160	-	30	e
Cover (%)	75	65	70	30	35	70	s.
Number of species	5	4	4	4	4	4	
Charact. and diff. species of the association							
Barbula convoluta Hedw.	4	3	4	2	2	4	6
Didymodon acutus (Brid.) K. Saito	+	1	.	+	1	1	5
Charact. and diff. species of the *Grimaldion fragrantis* all., the *Barbuletalia unguiculatae* order and the *Barbuletea unguiculatae* class							
Bryum capillare Hedw.	.	2	+	1	1	+	5
Didymodon vinealis (Brid.) R. H. Zander	1	+	1	.	.	.	3
Weissia controversa Hedw.	.	.	.	.	1	.	1
Other species							
Tortella flavovirens (Bruch) Broth.	.	.	+	1	.	1	3
Fossombronia husnotii Corb.	1	.	.	.	.	.	1
Tortula subulata Hedw. var. subinermis (Brid.) Wilson	1	.	.	.	.	.	1

Tab. 2 – *Lunularietum cruciatae* Giacomini 1950

Relevès number	1	2	3	4	5	6	P
Surface (dmq)	10	15	10	10	15	15	r
Altitude (m)	250	250	300	-	-	-	e
Cover (%)	75	70	85	80	60	95	s.
Number of species	5	5	7	5	3	4	
Charact. and diff. species of the association							
Lunularia cruciata (L.) Lindb.	3	3	4	4	3	5	6
Charact. and diff. species of the *Grimaldion fragrantis* all., the *Barbuletalia unguiculatae* order and the *Barbuletea unguiculatae* class							
Bryum capillare Hedw.	1	1	2	1	.	+	5
Didymodon vinealis (Brid.) R. H. Zander	2	.	.	+	1	.	3
Fossombronia caespitiformis De Not. ex Rabenh.	2	.	.	1	.	.	2
Phaeoceros laevis (L.) Prosk.	.	.	1	.	.	1	2
Other species							
Targionia hypophylla L.	1	.	.	1	+	1	4
Ceratodon purpureus (Hedw.) Brid.	.	1	+	.	.	.	2
Scleropodium touretii (Brid.) L. F. Koch	.	+	+	.	.	.	2
Gongylanthus ericetorum (Raddi) Nees	.	2	.	.	.	.	1
Anomobryum julaceum (P. Gaertn. & al.) Schimp.	.	.	1	.	.	.	1
Cephaloziella divaricata (Sm.) Schiffn.	.	.	+	.	.	.	1

nitrophilous community. The characteristic species is the thalloid liverwort *Lunularia cruciata* (L.) Lindb., very frequent on beaten ground and, in general, in habitats with a strong anthropic pressure. To this, other liverworts are associated to confirm the mesophilous character of this vegetational aspect; in particular, *Fossombronia caespitiformis* De Not. ex Rabenh. and *Phaeoceros laevis* (L.) Prosk., characteristic of higher units, as well as *Targionia hypophylla* L., *Gongylanthus ericetorum* (Raddi) Nees. *Lunularietum cruciatae* is included in the alliance *Grimaldion fragrantis* of the order *Barbuletalia unguiculatae*.

DIDYMODONTO VINEALIS-TORTULETUM MURALIS Privitera & Puglisi 1996 (Tab. 3)

The association is widespread on dry and exposed stone walls covered by a layer of soil; it is a ruderal association, terri-saxicolous, photophilous, typically urbaniphilous, very diffused in anthropic areas. *Tortula muralis* is the differential of association, to which some terricolous species, characteristics of higher units, are associated; they are: *Didymodon vinealis*, characteristic of alliance, *Bryum bicolor* Dicks., *B. capillare* Hedw., *Trichostomum brachydontium* Bruch, and *Pottia starckeana* (Hedw.) Müll. Hal., characteristics of order and class. Syntaxonomically, it belongs to *Grimaldion fragrantis* of the order *Barbuletalia unguiculatae*. It is to emphasize that the vegetational aspect found on Vulcano shows an elevated number of urbaniphilous species, such as *Tortula muralis* Hedw., *Didymodon vinealis*, *Bryum capillare*, *B. bicolor*, *B. caespiticium* Hedw. and *B. argenteum* Hedw.

WEISSIETUM CONTROVERSAE Marstaller 1988 (Tab. 4)

It is the most diffused association found on Vulcano Island, where it grows on level ground and slopes in the ambit of the shrubby formations of *Erica arborea* L. and *Cistus* sp.pl., in the uncultivated areas with *Quercus virgiliana* (Ten.) Ten. and in the few natural woody areas of *Erico-Quercetum ilicis*. The association, terricolous and photo-sciophilous, is floristically dominated by *Weissia controversa*, guide species to which a set of higher unit characteristics are associated, such as *Didymodon vinealis*, characteristic of alliance, *Bryum capillare*, *B. bicolor*, *Fissidens viridulus*, *Trichostomum brachydontium*, *Fossombronia caespitiformis*. As regards the syntaxonomy, it is included in the alliance *Grimaldion fragrantis* of the order *Barbuletalia unguiculatae*.

RHYNCHOSTEGIETUM MEGAPOLITANI Puglisi 1995 (Tab. 5)

This association is found on dry and very shade soil under ephemeral meadows and within the shrubby vegetation of the *Genistetum tyrrhenae*, where it is most abundant. Ecologically, it is a terricolous, xerophilous, markedly sciophilous association. *Rhynchostegietum*

Tab. 3 – *Didymodonto vinealis–Tortuletum muralis* Privitera & Puglisi 1996

Relevès number	1	2	3	4	5	6	P
Surface (dmq)	3	5	5	2	5	5	r
Altitude (m)	-	-	-	-	250	-	e
Cover (%)	50	50	40	70	50	50	s.
Inclination (°)	30	-	50	-	-	50	
Exposition	S	-	S	-	-	SW	
Number of species	4	4	5	5	4	4	
Diff. species of the association							
Tortula muralis Hedw.	2	3	2	4	3	3	6
Charact. and diff. species of the *Grimaldion fragrantis* all., the *Barbuletalia unguiculatae* order and the *Barbuletea unguiculatae* class							
Didymodon vinealis (Brid.) R. H. Zander	2	1	1	.	1	.	4
Bryum bicolor Dicks.	1	.	.	1	+	1	4
Trichostomum brachydontium Bruch	.	1	1	.	.	.	2
Bryum capillare Hedw.	.	.	.	+	1		2
Pottia starckeana (Hedw.) Müll. Hal.	.	.	1	.	.	.	1
Other species							
Bryum caespiticium Hedw.	.	1	.	.	.	1	2
Bryum argenteum Hedw.	1	.	.	.	.	+	2
Tortella flavovirens (Bruch) Broth.	.	.	1	+	.	.	2
Fossombronia pusilla (L.) Nees	.	.	.	1	.	.	1

megapolitani is characterized by the pleurocarpous moss *Rhynchostegium megapolitanum* (Weber & D. Mohr) Bruch & *al*., a sub-Mediterranean species that floristically and physiognomically dominates the association; to which *Pleurochaete squarrosa* (Brid.) Lindb. is associated, faithfully present, and *Scleropodium touretii* (Brid.) L. F. Koch, both characteristics of alliance, *Bryum capillare* and *Trichostomum brachydontium*, characteristics of higher unities. *Rhynchostegietum megapolitani* is included in the alliance *Homalothecio aurei-Plurochaetion squarrosae* (Ros & Guerra, 1987) Marstaller 1993 of the order *Barbuletalia unguiculatae*; this alliance groups communities with Mediterranean distribution and penetration up to the Atlantic coasts.

Tab. 4 – *Weissietum controversae* Marstaller 1988

Relevès number	1	2	8	3	4	5	6	7	P
Surface (dmq)	5	4	5	5	5	3	5	5	r
Altitude (m)	50	410	320	350	250	250	400	400	e
Cover (%)	60	65	80	40	80	80	75	50	s.
Inclination (°)	30	30	-	-	-	-	40	-	
Exposition	S	SE	-	-	-	-	SE	-	
Number of species	5	5	5	4	4	4	4	4	
Charact. and diff. species of the association									
Weissia controversa Hedw.	3	3	4	2	4	4	4	3	7
Charact. and diff. species of the *Grimaldion fragrantis* all., the *Barbuletalia unguiculatae* order and the *Barbuletea unguiculatae* class									
Bryum capillare Hedw.	1	+	1	.	+	.	1	.	5
Fissidens viridulus (Sw.) Wahlenb.	.	2	.	.	1	.	.	+	3
Trichostomum brachydontium Bruch	.	+	.	.	.	.	+	1	3
Bryum bicolor Dicks.	.	.	+	1	.	1	.	.	3
Didymodon vinealis (Brid.) R. H. Zander	.	.	2	1	.	.	.	.	2
Fossombronia caespitiformis De Not. ex Rabenh.	1	.	.	.	.	.	.	.	1
Other species									
Pleuridium acuminatum Lindb.	.	.	.	.	2	2	.	.	2
Scleropodium touretii (Brid.) L. F. Koch	.	.	.	1	.	.	.	+	2
Southbya nigrella (De Not.) Henriq.	1	.	.	.	.	.	.	.	1
Tortella flavoviens (Bruch) Broth.	1	.	.	.	.	1	.	.	2
Timmiella anomala (Bruch & Schimp.) Limpr.	.	.	1	.	.	.	1	.	2
Rhynchostegium megapolitanum (Weber & D. Mohr) Bruch *et al.*	.	1	.	.	.	.	.	.	1

Tab. 5 – *Rhynchostegietum megapolitani* Puglisi 1995

Relevès number	1	2	3	4	5	6	P
Surface (dmq)	5	5	5	10	8	5	r
Altitude (m)	50	50	50	50	250	300	e
Cover (%)	60	70	80	90	45	75	s.
Number of species	3	4	4	5	3	4	
Charact. and diff. species of the association							
Rhynchostegium megapolitanum (Weber & D. Mohr) Bruch *et al.*	4	3	4	5	3	4	6
Charact. and diff. species of the *Homalothecio aurei-Pleurochaetion squarrosae* all., the *Barbuletalia unguiculatae* order and the *Barbuletea unguiculatae* class							
Pleurochaete squarrosa (Brid.) Lindb.	1	2	+	1	1	2	6
Bryum capillare Hedw.	.	1	2	.	.	+	3
Trichostomum brachydontium Bruch	.	.	.	1	+	.	2
Scleropodium touretii (Brid.) L. F. Koch	.	.	.	1	.	.	1
Other species							
Hypnum cupressiforme Hedw.	+	2	2	2	.	.	4
Ceratodon purpureus (Hedw.) Brid.	.	.	.	.	.	1	1

TORTELLA FLAVOVIRENS-TRICHOSTOMUM BRACHYDONTIUM VAR. *LITTORALE* community (Tab. 6)

In the cavities and cracks of the rocky crags with sandy soil accumulated, along the coast and with penetration towards the inland, a community with *Tortella flavovirens* (Bruch) Broth. and *Trichostomum brachydontium* Bruch var. *littorale* (Mitt.) C. E. O. Jensen is found; the last one is a not common moss with a coastal distribution. Both taxa are characteristics of *Tortellion flavovirentis* Guerra ex Guerra & Puche 1984, a psammophilous alliance with a Mediterranean-Atlantic distribution. Besides these species we find *Bryum bicolor*, *B. capillare*, *Trichostomum brachydontium*, characteristics of higher units. For its ecology and floristic composition, this syntaxon is to refer to the alliance *Tortellion flavovirentis* of the order *Barbuletalia unguiculatae*.

FUNARIETUM HYGROMETRICAE Engel 1949 (Tab. 7)

Funarietum hygrometricae is found in the study areas on open level soil at "Il Piano", Monte Saraceno, Vulcanello. It is a pioneer association typical of nitrified or burnt soils and thus indicated as a pyrophilous association. Characteristic species of association is *Funaria hygrometrica*, at the same time characteristic of the alliance *Funarion hygrometricae* Hadàc in Klika ex v. Hübschmann 1957 and the order *Funarietalia hygrometricae* v. Hübschmann 1957; these syntaxa, with peculiar ecological features, are characterized by very few species. To *Funaria hygrometrica*, *Bryum bicolor*, *Barbula unguiculata*, *Fissidens viridulus*, *Trichostomum brachydontium*, characteristics of the class *Barbuletea unguiculatae*, are associated.

Tab. 6 – *Tortella flavovirens-Trichostomum brachydontium* var. *littorale* community

Relevès number	1	2	3	4	5	6	P
Surface (dmq)	3	3	4	3	5	5	r
Altitude (m)	-	-	-	-	50	-	e
Cover (%)	75	65	90	70	45	55	s.
Number of species	6	4	4	3	5	4	
Tortella flavovirens (Bruch) Broth.	2	3	5	4	2	+	6
Trichostomum brachydontium Bruch var. littorale (Mitt.) C. E. O. Jens.	1	1	+	.	+	1	5
Charact. and diff. species of the *Barbuletalia unguiculatae* order and the *Barbuletea unguiculatae* class							
Bryum bicolor Dicks.	3	2	1	1	2	3	6
Bryum capillare Hedw.	1	.	1	.	+	.	3
Trichostomum brachydontium Bruch	.	.	.	.	.	1	1
Weissia controversa Hedw.	.	.	.	1	.	.	1
Other species							
Fossombronia pusilla (L.) Nees	1	.	.	.	.	.	1
Tortula muralis Hedw. var. aestiva Hedw.	1	.	.	.	.	.	1
Gongylanthus ericetorum (Raddi) Nees	.	.	.	.	1	.	1
Fossombronia husnotii Corb.	.	+	.	.	.	.	1

Tab. 7 – *Funarietum hygrometricae* Engel 1949

Relevès number	1	2	3	4	5	P
Surface (dmq)	5	5	3	5	5	r
Altitude (m)	400	300	300	250	300	e
Cover (%)	30	30	70	60	30	s.
Number of species	4	4	5	5	5	
Charact. and diff. species of the association and of the *Funarion hygrometricae* all.						
Funaria hygrometrica Hedw.	2	2	4	3	2	5
Charact. and diff. species of the *Barbuletea unguiculatae* class						
Bryum bicolor Dicks.	.	1	.	1	+	3
Fissidens viridulus (Sw.) Wahlenb.	+	+	.	1	.	3
Barbula unguiculata Hedw.	1	.	.	.	.	1
Trichostomum brachydontium Bruch	.	.	.	.	1	1
Other species						
Tortula muralis Hedw.	.	1	1	.	.	2
Hypnum cupressiforme Hedw.	.	.	2	.	.	1
Tortella flavovirens (Bruch) Broth.	.	.	.	2	.	1
Didymodon vinealis (Brid.) R. H. Zander	.	.	.	.	1	1
Gongylanthus ericetorum (Raddi) Nees	.	.	.	1	.	1
Tortula muralis Hedw. var. aestiva Hedw.	.	.	1	.	.	1
Weissia controversa Hedw.	.	.	1	.	.	1
Rhynchostegium megapolitanum (Weber & D. Mohr) Bruch *et al.*	.	.	.	.	+	1
Scleropodium touretii (Brid.) L. F. Koch	+	.	.	.	.	1

GONGYLANTHUS ERICETORUM community (Tab. 8)

On humid and shady soil, a terricolous, acidophilous community dominated by the liverwort *Gongylanthus ericetorum* is found; to this species *Pleuridium acuminatum* Lindb., abundantly present, and *Epipterygium tozeri* (Grev.) Lindb., characteristics of the alliance *Dicranellion heteromallae* (Philippi 1956) Philippi 1963, are associated, as well as *Cephaloziella divaricata*, characteristic of the order *Diplophylletalia albicantis* Philippi 1963. This community, the most mesophilous among those found at Vulcano, is the only one linked exclusively to natural habitat. Due to the floristic composition and due to the ecological features it is to place in the above mentioned syntaxa.

Tab. 8 – *Gongylanthus ericetorum* community

Relevès number	1	2	3	4	5	P
Surface (dmq)	3	3	5	4	3	r
Altitude (m)	60	250	250	250	250	e
Cover (%)	85	75	50	75	70	s.
Number of species	5	4	3	2	5	
Gongylanthus ericetorum (Raddi) Nees	3	3	2	2	+	5
Charact. and diff. species of the *Dicranellion heteromallae* all., the *Diplophylletalia albicantis* order and the *Cladonio-Lepidozietea reptantis* class						
Pleuridium acuminatum Lindb.	.	3	3	4	4	4
Cephaloziella divaricata (Sm.) Schiffn.	1	2	.	.	1	3
Epipterygium tozeri (Grev.) Lindb.	.	.	.	.	1	1
Other species						
Archidium alternifolium (Hedw.) Schimp.	4	.	+	.	.	2
Bryum capillare Hedw.	1	.	.	.	.	1
Ceratodon purpureus (Hedw.) Brid.	.	1	.	.	.	1
Fossombronia caespitiformis De Not. ex Rabenh.	.	.	.	.	1	1
Fossombronia husnotii Corb.	+	.	.	.	.	1

GRIMMIETUM COMMUTATO-CAMPESTRIS v. Krusenstjerna 1945 (Tab. 9)

Grimmietum commutato-campestris is found at Capo Grillo, M. Lentia and Vulcanello on dry and exposed volcanic rocks. Ecologically, it is a saxicolous, photophilous, thermo-xerophilous association. The association shows a typically pioneer character appearing, in the process of lava colonisation, immediately after the communities of lichens that are the first stage and with which the association is almost always in competition. The characteristic species is *Grimmia laevigata* (Brid.) Brid. (*Grimmia campestris* synonym of *G. laevigata*), to which are associated other *Grimmiaceae* species characteristic of higher units, such as *Grimmia trichophylla* Grev. and *G. affinis* Hornsch., characteristics of the alliance *Grimmion commutatae* v. Krusenstjerna 1945, and *Racomitrium heterostichum* (Hedw.) Brid., characteristic of higher units. As regards the syntaxonomy, it is referred to the alliance *Grimmion commutatae* of the order *Grimmietalia commutatae*, syntaxa belonging the epilithic and acidophilous class *Racomitretea heterostichi* Neumayr 1971.

Tab. 9 – *Grimmietum commutato-campestris* v. Krusenstjerna 1945

Relevès number	1	2	3	4	P
Surface (dmq)	5	5	5	3	r
Altitude (m)	250	250	140	50	e
Cover (%)	70	50	60	50	s.
Inclination (°)	40	50	-	50	
Exposition	SE	W	-	SE	
Number of species	3	4	4	6	
Charact. and diff. species of the association					
Grimmia laevigata (Brid.) Brid.	4	3	3	3	4
Charact. and diff. species of the *Grimmion commutatae* all., the *Grimmietalia commutatae* order and the *Racomitrietea heterostichi* class					
Grimmia trichophylla Grev.	1	1	2	1	4
Racomitrium heterostichum (Hedw.) Brid.	.	1	.	+	2
Grimmia affinis Hornsch.	.	.	+		1
Other species					
Bryum caespiticium Hedw.	.	1	.	1	2
Bryum capillare Hedw.	1	.	1	.	2
Cephaloziella divaricata (Sm.) Schiffn.	.	.	.	1	1
Tortella flavovirens (Bruch) Broth.	.	.	.	+	1

TORTULETUM MARGINATAE v. Hübschmann 1973 (Tab. 10)

On artificial walls, along the vertical surfaces where the accumulation of soil is not possible, *Tortuletum marginatae* is found. It is a saxicolous, basiphilous, meso-xerophilous association, with an urbaniphilous character. This association is characterized by *Tortula marginata* (Bruch & Schimp.) Spruce, to which *Tortula muralis*, *T. muralis* Hedw. var. *aestiva* Hedw., *Grimmia pulvinata* (Hedw.) Sm., characteristics of higher unities, are associated.

Tortuletum marginatae is referred to the alliance *Grimmion tergestinae* Šmarda 1947 of the order *Grimmietalia anodontis* Šmarda 1947; this alliance and order are included in the class *Grimmietea anodontis* Hadàc et Vondrácek in Jezek et Vondrácek 1962, that groups epilithic and basiphilous communities.

SYNTRICHIETUM LAEVIPILAE Ochsner 1928 (Tab. 11)

Syntrichietum laevipilae is an epiphytic association found in the medium and medium-high parts of the trunks of *Quercus ilex* L., *Q. virgiliana*, *Fraxinus ornus* L. at the localities Il Piano and Serra delle Felicicchie. From the ecological point of view, it is a thermophytic, xerophilous association. Floristically, the dominant species is *Syntrichia laevipila* Brid., to which is associated a set of species strictly corticolous, such as *Orthotrichum diaphanum* Brid., *O. tenellum* Bruch ex Brid., *O. pumilum* Sw., characteristics of alliance, *Hypnum resupinatum* Taylor, *Frullania dilatata* (L.) Dumort., characteristics of higher unities. *Syntrichietum laevipilae* belongs to the *Syntrichion laevipilae*, the most xerophilous alliance of the epiphytic class *Frullanio dilatatae-Leucodontetea sciuroidis* Mohan 1978.

Tab. 10 – Tortuletum marginatae v. Hübschmann 1973

Relevès number	1	2	3	4	P
Surface (dmq)	3	5	5	5	r
Altitude (m)	-	-	-	-	e
Cover (%)	80	40	55	50	s.
Inclination (°)	90	90	90	90	
Exposition	NE	W	SW	S	
Number of species	3	3	5	3	
Charact. and diff. species of the association					
Tortula marginata (Bruch & Schimp.) Spruce	5	2	3	3	4
Charact. and diff. species of the Grimmietalia anodontis order and the Grimmietea anodontis class					
Tortula muralis Hedw.	1	.	1	.	2
Tortula muralis Hedw. var. aestiva Hedw.	.	.	1	1	2
Grimmia pulvinata (Hedw.) Sm.	.	2	.	.	1
Other species					
Bryum caespiticium Hedw.	+	1	.	1	3
Bryum ruderale Crundw. & Nyholm	.	.	1	.	1
Bryum capillare Hedw.	.	.	+	.	1

Tab. 11 – *Syntrichietum laevipilae* Ochsner 1928

Relevès number	1	2	3	4	5	P
Surface (dmq)	2	3	3	5	3	r
Altitude (m)	400	400	350	350	400	e
Cover (%)	60	65	60	55	65	s.
Inclination (°)	N	NE	W	SW	NE	
Essenza arborea	Qi	Qi	Qv	Fo	Qv	
Number of species	3	5	3	3	5	
Charact. and diff. species of the association						
Syntrichia laevipila Brid.	2	1	3	2	2	5
Charact. and diff. species of the *Syntrichion laevipilae* all., the *Orthotrichetalia* order and the *Frullanio dilatatae-Leucodontetea sciuroidis* class						
Orthotrichum diaphanum Brid.	3	3	1	2	2	5
Hypnum resupinatum Taylor	.	2	.	.	2	2
Frullania dilatata (L.) Dumort.	.	1	.	.	1	2
Orthotrichum tenellum Bruch ex Brid.	.	.	.	2	.	1
Orthotrichum pumilum Sw.	.	.	.	.	1	1
Other species						
Bryum capillare Hedw.	1	+				2
Hypnum cupressiforme Hedw.	.	.	2	.	.	1

Qi: Quercus ilex; Qv: Quercus virgiliana; Fo: Fraxinus ornus

Syntaxonomical scheme

BARBULETEA UNGUICULATAE Mohan 1978
- BARBULETALIA UNGUICULATAE v. Hübschmann 1960
  - GRIMALDION FRAGRANTIS Smarda & Hadàc 1944
    - *Barbuletum convolutae* Hadàc & Smarda 1944
    - *Lunularietum cruciatae* Giacomini 1950
    - *Didymodonto vinealis-Tortuletum muralis* Privitera & Puglisi 1996
    - *Weissietum controversae* Marstaller 1988
  - HOMALOTHECIO AUREI-PLEUROCHAETION SQUARROSAE (Ros & Guerra 1987) Marstaller 1993
    - *Rhynchostegietum megapolitani* Puglisi 1995
  - TORTELLION FLAVOVIRENTIS Guerra ex Guerra & Puche 1984
    - *Tortella flavovirens-Trichostomum brachydontium* var. *littorale* community
- FUNARIETALIA HYGROMETRICAE v. Hübschmann 1957
  - FUNARION HYGROMETRICAE Hadàc in Klika ex v. Hübschmann 1957
    - *Funarietum hygrometricae* Engel 1949

CLADONIO-LEPIDOZIETEA REPTANTIS Jezek & Vondrácek 1962 em. Marstaller 1993
- DIPLOPHYLLETALIA ALBICANTIS Philippi 1963
  - DICRANELLION HETEROMALLAE (Philippi 1956) Philippi 1963
    - *Gongylanthus ericetorum* community

RACOMITRIETEA HETEROSTICHI Neumayr 1971
- GRIMMIETALIA COMMUTATAE Smarda et Vanek in Klika et Hadàc ex Smarda 1947
  - GRIMMION COMMUTATAE v. Krusenstjerna 1945
    - *Grimmietum commutato-campestris* v. Krusenstjerna 1945

GRIMMIETEA ANODONTIS Hadàc et Vondrácek in Jezek et Vondrácek 1962
- GRIMMIETALIA ANODONTIS Smarda 1947
  - GRIMMION TERGESTINAE Smarda 1947
    - *Tortuletum marginatae* v. Hübschmann 1973

FRULLANIO DILATATAE-LEUCODONTETEA SCIUROIDIS Mohan 1978
- ORTHOTRICHETALIA Hadàc in Klika & Hadàc 1944
  - SYNTRICHION LAEVIPILAE Ochsner 1928
    - *Syntrichietum laevipilae* Ochsner 1928

Conclusions

This investigation has provided data that show the situation of a Mediterranean island under intense anthropic pressure. In fact, there are many aspects of ruderal and anthropic vegetation, in some cases with a clear urbaniphilous character. The notable anthropic pressure, due, above all, to ever increasing tourism, has limited the establishment of natural bryophyte communities. In particular, in areas under heavy anthropic pressure the following associations are frequently found: *Didymodonto vinealis-Tortuletum muralis, Lunularietum cruciatae* of the *Barbuletea unguiculatae* class, *Tortuletum marginatae* of the *Grimmietea anodontis* class, typical associations of artificial habitats. Leaving the small urban agglomerations some not urbaniphilous associations are found that, however, reveal an environmental degradation, such as *Barbuletum convolutae* of the *Grimaldion fragrantis* alliance, typical of beaten pathways, *Funarietum hygrometricae* of the *Funarion hygrometricae*, an association with a strong nitrophilous character. From these *Weissietum controversae* and *Rhynchostegietum megapolitani* differ, the former is diffused inland, the latter mainly found at Vulcanello in the ambit of the phanerogamic association *Genistetum tyrrhenae*. More demanding in edaphic humidity is the community with *Gongylanthus ericetorum*, the only aspect exclusively linked to a natural habitat far from antrophic pressure.

On inland volcanic rocks, there is the epilithic association *Grimmietum-commutato campestris* of the *Racomitrietea heterostichi* class, while on the rocky crags of the coast line the community with *Tortella flavovirens* and *Trichostomum brachydontium* var. *littorale* is found.

In the few wooded areas *Syntrichetum laevipilae* is found, an epiphytic, thermophilous and xerophilous association of the *Frullanio dilatatae-Leucodontetea sciuroidis* class. It is to emphasize the faithful occurrence in this association of *Orthotrichum diaphanum*, an urbaniphilous species occurring with high cover values. Also the epiphytic vegetation, whose development in the Mediterranean territories is limited fundamentally by climatic characteristics, contributes to the revelation of an interference of an anthropic nature.

The associations found in the island of Vulcano are assembled in the Tab. 12.

Tab. 12 - Simplified Synoptic table of the bryophyte vegetation of Vulcano (other species not considered)

Association number	1	2	3	4	5	6	7	8	9
Number of the relevés									
Charact. and diff. species of the association									
Barbula convoluta	V	.	.	.	.	.	.	.	.
Didymodon acutus	V	.	.	.	.	.	.	.	.
Lunularia cruciata	.	V	.	.	.	.	.	.	.
Rhynchostegium megapolitanum	.	.	.	.	V	.	.	.	.
Grimmia laevigata	.	.	.	.	.	.	4	.	.
Tortula marginata	.	.	.	.	.	.	.	4	.
Syntrichia laevipila	.	.	.	.	.	.	.	.	V
Charact. and diff. species of the *Grimaldion fragrantis* alliance									
Didymodon vinealis	III	III	IV	II	.	.	.	.	.
Weissia controversa	I	.	.	V	.	.	.	.	.
Charact. and diff. species of the *Homalothecio aurei-Pleurochaetion squarrosae* alliance									
Pleurochaete squarrosa	.	.	.	.	V	.	.	.	.
Scleropodium touretii	.	.	.	.	I	.	.	.	.
Charact. and diff. species of the *Funarion hygrometricae* alliance									
Funaria hygrometrica	.	.	.	.	.	V	.	.	.
Charact. and diff. species of the *Barbuletalia unguiculatae* order and *Barbuletea unguiculatae* class									
Bryum capillare	V	V	II	IV	III	.	.	.	.
Trichostomum brachydontium	.	.	II	III	II	I	.	.	.
Bryum bicolor	.	.	IV	III	.	III	.	.	.
Fissidens viridulus	.	.	.	III	.	III	.	.	.
Fossombronia caespitiformis	.	II	.	I	.	.	.	.	.
Phaeoceros laevis	.	II	.	.	.	.	.	.	.
Barbula unguiculata	.	.	.	.	.	I	.	.	.
Pottia starckeana	.	.	I	.	.	.	.	.	.
Charact. and diff. species of the *Grimmion commutatae* alliance									
Grimmia trichophylla	.	.	.	.	.	.	4	.	.
Grimmia affinis	.	.	.	.	.	.	1	.	.
Charact. and diff. species of the *Grimmietalia commutatae* order and the *Racomitrietea heterostichi* class									
Racomitrium heterostichum	.	.	.	.	.	.	2	.	.
	.	.	.	.	.	.	.	.	.
Charact. and diff. species of the the *Grimmietalia anodontis* order and the *Grimmietea anodontis* class									
Tortula muralis	.	.	V	.	.	.	.	2	.
Tortula muralis var. aestiva	.	.	.	.	.	.	.	2	.
Grimmia pulvinata	.	.	.	.	.	.	.	1	.
Charact. and diff. species of the *Syntrichion laevipilae* alliance									
Orthotrichum diaphanum	.	.	.	.	.	.	.	.	V
Orthotrichum tenellum	.	.	.	.	.	.	.	.	I
Orthotrichum pumilum	.	.	.	.	.	.	.	.	I
Charact. and diff. species of the *Orthotrichetalia* order and the *Frullanio dilatatae-Leucodontetea sciuroidis* class									
Hypnum resupinatum	.	.	.	.	.	.	.	.	II
Frullania dilatata	.	.	.	.	.	.	.	.	II

1 – *Barbuletum convolutae*; 2 – *Lunularietum cruciatae*; 3 – *Didymodonto vinealis-Tortuletum muralis*; 4 – *Weissietum controversae*; 5 – *Rhynchostegietum megapolitani*; 6 – *Funarietum hygrometricae*; 7 – *Grimmietum commutato-campestris*; 8 – *Tortuletum marginatae*; 9 – *Syntrichietum laevipilae*.

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Appendix

Localities and relevés date

Tab. 1
Rel. 1, 2 Porto di Levante, 25/04/1998; rel. 3: Vulcanello, 26/04/1998; rel. 4: Scogli di Capo Secco, 26/04/1998; rel. 5, 6: Vulcanello, 03/05/2002.

Tab. 2
Rel. 1: Capo Grillo, 26/04/1998; rel. 2, 3 Piano di Luccia, 02/05/2002; rel. 4, 6: Porto di Levante (urban area): 25/04/1998.

Tab. 3
Rel. 1,2: Gelso, 26/04/1998; rel. 3, 4 Porto di Ponente, 24/4/1998; rel. 5: Capo Grillo, 03/05/2002; rel. 6: Porto di Levante (urban area), 25/04/1998.

Tab. 4
Rel. 1 Vulcanello, 26/04/1998; rel. 2: Il Piano, 25/04/1998; rel. 3: Menichedda, 24/04/1998; rel. 4: Serra delle Felicicchie, 03/05/2002; rel. 5, 6: Capo Grillo, 26/04/1998; rel. 7, 8: Il Piano, 02/05/2002.

Tab. 5
Rel. 1, 4: Vulcanello, 26/04/1998; rel. 5, 6: Piano di Luccia, 02/05/2002.

Tab. 6
Rel. 1, 3: Porto di Ponente, 26/04/1998; rel. 4: Porto di Ponente, 02/05/2002; rel. 5, 6: Vulcanello, 26/04/1998.

Tab. 7
Rel. 1: Il Piano, 25/04/1998; rel. 2, 4 M. Saraceno, 24/04/1998; rel. 5 Vulcanello, 26/04/1998.

Tab. 8
Rel. 1: Vulcanello, 26/04/1998; rel. 2, 4: Capo Grillo, 03/05/2002.

Tab. 9
Rel. 1, 2: Capo Grillo, 03/05/2002; rel. 3: M. Lentia, 03/05/2002; rel. 4: Vulcanello, 26/04/1998.

Tab. 10
Rel. 1: Porto di Levante (urban area), 25/04/1998; rel. 2: Gelso, 26/04/1998; rel. 3: Porto di Ponente, 02/05/2002.

Tab. 11
Rel. 1, 2: Il Piano, 25/04/1998; rel. 3, 4, 5: Serra delle Felicicchie, 03/05/2002.