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Ecology of bryophytes of damp areas at "Giara di Gesturi" (Southern Central Sardinia)

Abstract

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During the survey on the state of bryofloristic knowledge of the Pauli at the Giara di Gesturi (South Central Sardinia) 56 entities (50 *Bryophyta* and 6 *Marchantiophyta*) were found. Chorological and ecological considerations have been also made.

Introduction

In this contribution are contained preliminary data on the bryoflora of the areas with stagnant fresh water on the Giara di Gesturi (Southern Central Sardinia), a biotope of great naturalistic interest situated between the geographic areas of lower Marmilla and Sarcidano.

The Giara (Fig. 1) is an elongated basaltic tableland whose the main axis is oriented NW-SE; it covers some 42 km^2 at an average altitude of 550 m asl. Its origin is connected with the last Miocene volcanic phenomena, with Monte Zeppara Manna (580 m) to the NW and Monte Zepparedda (609 m) to the SE representing the centres from which lava erupted. The water regime is determined by springs (*mitzas*), torrential water courses (*spendulas*) and, in the depressed areas, by numerous endorheic basins of varying size, known as "*pauli*". Such pools of water, which in winter reach a depth of 30 to 40 cm, are favoured by the presence of clays deriving from *in situ* alteration (weathering) of the basaltic lithotypes. The seasonal pluviometric trend is characterized by minimum rainfall in summer and maximum rainfall in autumn, mean annual rainfall goes from 745 mm to 850 mm. In summer, evaporation, together with permeability connected with cracks in the basalts, causes complete drying up of the *pauli*. On the basis of bioclimatic indices, the territory can be considered as falling within the mesomediterranean thermotype and subhumid ombrotype (Rivas-Martínez & al. 1999). Mean annual temperatures are on the order of 13-15°C. Snowfall on the tableland is not rare (Mossa & al. 1989).

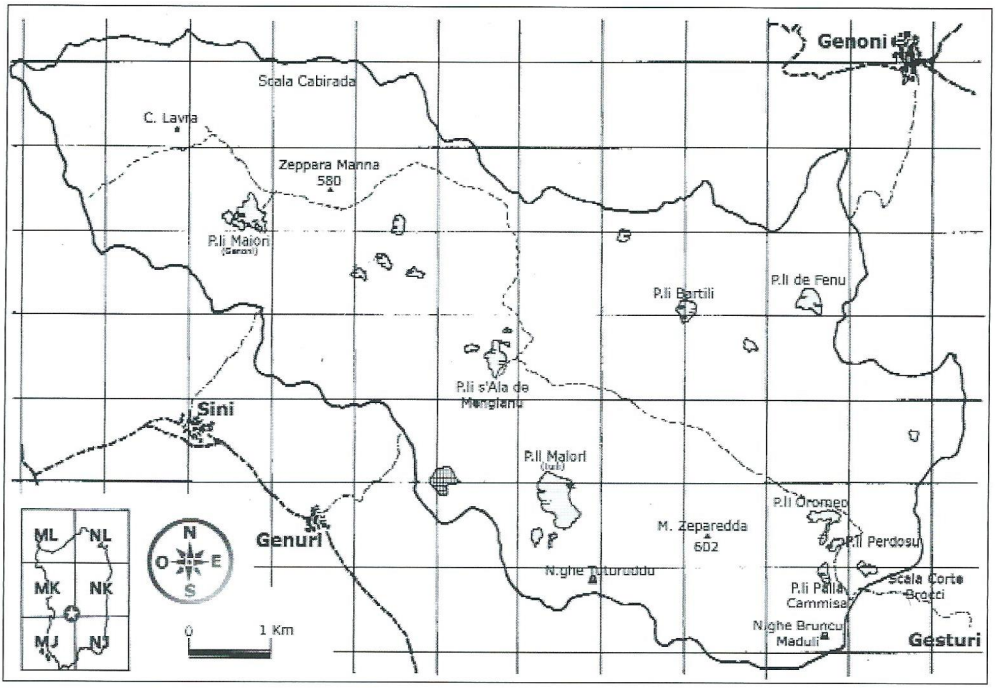

Fig. 1. Map of Giara di Gesturi.

Vegetation

From the vegetational viewpoint, there are woodland formations connected with the series of holm-oak stands, with a dominance of *Quercus suber* L., secondary bush formations, garrigues, prairies and damp and semiarid meadows, which give the Giara an environmental diversity typical of the Mediterranean area. The vegetation of the *pauli*, which can be attributed to the classes *Littorelletea* Br.-Bl. & Tx. 1943 and *Isoeto-Nanojuncetea* Br.-Bl. & Tx. 1943, is strongly conditioned by seasonal changes in the water level. Vegetation types ranges from a prevalence of hydrophyt to another one dominated by hygrophyt that in turn are replaced by therophyt during the dry season. In winter the *pauli* are flooded and the surface of water doesn't present vegetation while with the arrive of warmth it is covered by a white prairie of *Ranunculus aquatilis* L. that sometimes forms coenosis with *Eryngium corniculatum* Lam. and/or *Baldellia ranunculoides* (L.) Parl. With disappearing of water on the substrate still wet *Isolepsis cernua* (Vahl) R. & S. settles both in monospecific popolation and in coenosis with *Eryngium corniculatum* and *Baldellia ranunculoides*. In this latter case *Mentha pulegium* L. and some nitrophilous species like *Pulicaria vulgaris* Gaertner and *P. sicula* (L.) Moris also appear. In addition, in places highly affected by grazing, therophytic meadows of *Heliotropium supinum* L. also occur. During the summer the vegetation of *pauli* is instead characterized by *Eryngium barrellieri* Boiss. and by population of *Crypsis alopecuroides* (Pill. & M.) Schrader (Mossa & al. 1989).

Bryoflora

Below, the species are given following the systematic order of the moss and liverwort checklists for Italy (Aleffi & Schumacker 1995; Cortini Pedrotti 2001). For each taxon ecology, chorology and the relevant gathering sites are also given. Nomenclature conforms to Grolle (1983) for liverworts, and to Corley & al. (1981) and Corley & Crundwell (1991) for mosses. As concerns authors' names, we used Brummit & Powell (1992), for ecology Dierssen (2001), for growth forms Mägdefrau (1982), for life strategies During (1979) and for chorological elements Düll (1983, 1984, 1985, 1992) and Sérgio & al. (1994).

MARCHANTIOPHYTA

Frullaniaceae

Frullania dilatata (L.) Dumort. [temp] – moderately hygrophyt to moderately xerophyt, from moderately sciophyt to moderately photophyt, acidophyt to subneutrophyt, mesothermophyt.
Pauli s'Ala 'e Mengianu, Pauli Bartili, on bark.

Ricciaceae

Riccia bifurca Hoffm. [submed] - hygrophyt to highly xerophyt, photophyt, subneutrophyt, mesothermophyt to considerably thermophyt.
Pauli Bartili, on soil.

Riccia canaliculata Hoffm. [s.temp] - hygrophyt to mesophyt, photophyt, acidophyt, mesothermophyt.
Pauli 'e Fenu, on soil

Riccia michelii Raddi [med] - mesophyt to moderately xerophyt, photophyt, acidophyt.
Pauli Palla 'e Cammisa, Pauli Perdosu, Pauli Oromeo, Pauli Bartili, Pauli s'Ala 'e Mengianu, on soil.

Riccia nigrella DC. [oc-med] - moderately hygrophyt to highly xerophyt, photophyt, acidophyt to basiphyt, highly thermophyt.
Pauli Bartili, on soil.

Riccia sorocarpa Bisch. [temp]- mesophyt to moderately xerophyt, photophyt, acidophyt to basiphyt, tempindifferent.
Pauli Palla 'e Cammisa, Pauli Perdosu, Pauli Bartili, on soil.

BRYOPHYTA

Archidiaceae

Archidium alternifolium (Hedw.) Schimp. [suboc] - moderately hygrophyt to moderately xerophyt, photophyt, moderately acidophyt to subneutrophyt, mesothermophyt to highly thermophyt.
Pauli Bartili, on soil.

Fissidentaceae

Fissidens taxifolius Hedw. [temp] - mesophyt, moderately sciophyt to moderately photophyt, moderately acidophyt to subneutrophyt, mesothermophyt.
Pauli s'Ala 'e Mengianu, on soil.

Dicranaceae

Dicranella howei Renauld & Cardot [oc-med] - xerophyt, photophyt, basophyt, thermophyt.
Pauli Maiori (Tuili), on soil.

Ditrichaceae

Cheilothela chloropus (Brid.) Limpr. [oc-med] - xerophyt, photophyt, subneutrophyt.
Pauli Maiori (Tuili), on soil.

Pottiaceae

Syntrichia laevipila Brid. [suboc-submed] - xerophyt, photophyt, subneutrophyt, mesothermophyt to considerably thermophyt.
Pauli Bartili, on bark.

Syntrichia princeps (De Not.) Brid. [oc-submed] - mesophyt to highly xerophyt, moderately sciophyt to highly photophyt, acidophyt to basiphyt, thermophyt.
Pauli Maiori (Genoni), on soil; Pauli Perdosu, Pauli 'e Fenu, on rock.

Tortula muralis Hedw. [temp] - mesophyt to considerably xerophyt, moderately sciophyt to highly photophyt, subneutrophyt to basiphyt, mesothermophyt to considerably thermophyt.
Pauli s'Ala 'e Mengianu, on soil and on rock.

Pottia intermedia (Turner) Fürnr. [temp] - mesophyt to moderately xerophyt, photophyt, moderately acidophyt to subneutrophyt, moderately thermophyt.
Pauli Oromeo, on soil.

Pottia truncata (Hedw.) Bruch. & Schimp. [temp] - mesophyt, photophyt, moderately acidophyt to subneutrophyt, mesothermophyt.
Pauli Palla 'e Cammisa, Pauli Maiori (Genoni), on soil; Pauli s'Ala 'e Mengianu, on soil and on rock.

Barbula unguiculata Hedw. [temp] - moderately hygrophyt to xerophyt, highly photophyt, moderately acidophyt to subneutrophyt, moderately cryophyt to moderately thermophyt.
Pauli Palla 'e Cammisa, Pauli Oromeo on soil.

Pseudocrossidium hornschuchianum (Schultz) R.H. Zander [submed-suboc] - mesophyt to considerably xerophyt, highly photophyt, subneutrophyt, mesothermophyt to considerably thermophyt.
Pauli Maiori (Tuili), on soil.

Didymodon insulanus (De Not.) M. O. Hill [submed-suboc] - moderately hygrophyt to mesophyt, sciophyt to moderately photophyt, subneutrophyt, moderately cryophyt to mesothermophyt.
Pauli 'e Fenu, on soil and on rock; Pauli s'Ala 'e Mengianu, Pauli Maiori (Tuili), on rock.

Didymodon luridus Hornsch. [submed] - xerophyt, photophyt, basophyt, thermophyt.
Pauli s'Ala 'e Mengianu, on soil.

Didymodon spadiceus (Mitt.) Limpr. [temp-mont] - hygrophyt, moderately sciophyt to moderately photophyt, basophyt, considerably cryophyt to thermophyt.
Pauli s'Ala 'e Mengianu, on soil.

Trichostomum brachydontium Bruch. [oc-med] - mesophyt to xerophyt, moderately sciophyt to photophyt, moderately acidophyt to basiphyt, mesothermophyt to moderately thermophyt.
Pauli Palla 'e Cammisa, on soil and on rock.

Pleurochaete squarrosa (Brid.) Lindb. [submed] - xerophyt, photophyt, basophyt, thermophyt.
Pauli Maiori (Tuili), Pauli s'Ala 'e Mengianu, on soil and on rock; Pauli Palla 'e Cammisa, on soil.

Cinclidotaceae

Cinclidotus mucronatus (Brid.) A.L.M. Guim. [submed-suboc] - hygrophyt to mesophyt, photophyt, subneutrophyt, thermophyt.
Pauli Maiori (Tuili), on rock; Pauli Palla 'e Cammisa, Pauli 'e Fenu, on soil.

Grimmiaceae

Grimmia laevigata (Brid.) Brid. [submed-suboc-mont] - xerophyt, photophyt, acidophyt to subneutrophyt, thermophyt.
Pauli 'e Fenu, Pauli s'Ala 'e Mengianu, Pauli Maiori (Genoni), Pauli Maiori (Tuili), on rock; Pauli Palla 'e Cammisa, on rock and on soil.

Grimmia lisae De Not. [med-oc] - hygrophyt to mesophyt, sciophyt, moderately acidophyt to subneutrophyt.
Pauli s'Ala 'e Mengianu, on rock.

Grimmia pulvinata (Hedw.) Sm. [temp] - xerophyt, photophyt, moderately acidophyt to basiphyt, mesothermophyt to thermophyt.
Pauli Palla 'e Cammisa, Pauli s'Ala 'e Mengianu, on rock.

Grimmia trichophylla Grev. [temp (-mont)] - moderately hygrophyt to moderately xerophyt, moderately sciophyt to photophyt, acidophyt to subneutrophyt, mesothermophyt.
Pauli 'e Fenu, on rock; Pauli Maiori (Genoni), Pauli s'Ala 'e Mengianu, Pauli Maiori (Tuili), on soil and on rock; Pauli Oromeo, on soil.

Funariaceae

Funaria hygrometrica Hedw. [temp] - moderately hygrophyt to mesophyt, moderately sciophyt to photophyt, modertamente acidophyt to subneutrophyt.
Pauli Oromeo, Pauli s'Ala 'e Mengianu, on soil.

Bryaceae

Epipterygium tozeri (Grev.) Lindb. [suboc-med] - hygrophyt to mesophyt, sciophyt to photophyt, moderately acidophyt to subneutrophyt, moderately thermophyt.
Pauli 'e Fenu, on soil.

Bryum alpinum With. [suboc-submed-mont] - hygrophyt to mesophyt, photophyt, acidophyt to subneutrophyt, moderately cryophyt to mesothermophyt.
Pauli s'Ala 'e Mengianu, on soil.

Bryum bicolor Dicks. [submed] - mesophyt to moderately xerophyt, photophyt, subneutrophyt to basiphyt, mesothermophyt to considerably thermophyt.
Pauli s'Ala 'e Mengianu, on rock; Pauli Maiori (Genoni), on soil.

Bryum capillare Hedw. [temp] - mesophyt to xerophyt, moderately sciophyt to photophyt, subneutrophyt to basiphyt, considerably cryophyt to considerably thermophyt.
Pauli Maiori (Tuili), Pauli Bartili, Pauli Oromeo, on soil; Pauli s'Ala 'e Mengianu, by the drinking trough; Pauli Maiori (Genoni), on rock and on soil.

Bryum pseudotriquetrum (Hedw.) P. Gaertn. & *al.* [temp] - hygrophyt, moderately sciophyt to photophyt, subneutrophyt, considerably cryophyt to mesothermophyt.
Pauli s'Ala 'e Mengianu, Pauli Maiori (Tuili), on soil.

Bryum radiculosum Brid. [suboc-med] - xerophyt, photophyt, basophyt, thermophyt.
Pauli Bartili, on soil.

Bryum subelegans Kindb. [temp] - moderately hygrophyt to moderately xerophyt, sciophyt, moderately acidophyt to subneutrophyt.
Pauli Maiori (Genoni), on soil.

Bartramiaceae

Bartramia pomiformis Hedw. [bor (-mont)] - moderately hygrophyt to mesophyt, sciophyt, acidophyt, moderately cryophyt to mesothermophyt.
Pauli Maiori (Tuili), on soil.

Bartramia stricta Brid. [suboc-med] - xerophyt, moderately sciophyt to photophyt, acidophyt to subneutrophyt, thermophyt.
Pauli s'Ala 'e Mengianu, on rock.

Orthotrichaceae

Orthotrichum tenellum Bruch. ex Brid. [suboc-submed] - xerophyt, photophyt, subneutrophyt.
Pauli s'Ala 'e Mengianu, on bark.

Leucodontaceae

Pterogonium gracile (Hedw.) Sm. [suboc-submed-mont] - moderately hygrophyt to moderately xerophyt, moderately sciophyt to photophyt, subneutrophyt, mesothermophyt to considerably thermophyt.
Pauli Palla 'e Cammisa, Pauli 'e Fenu, Pauli Maiori (Tuili), on rock;

Amblystegiaceae

Leptodictyum riparium (Hedw.) Warnst. [temp] - hygrophyt to temporary submerged, moderately sciophyt to moderately photophyt, subneutrophyt.
Pauli Palla 'e Cammisa, Pauli 'e Fenu, Pauli s'Ala 'e Mengianu, Pauli Maiori (Genoni), Pauli Maiori (Tuili), on moist soil by basaltic boulders; Pauli Maiori (Tuili), on rock.

Brachytheciaceae

Homalothecium aureum (Lag.) H. Rob. [med-mont] - xerophyt, photophyt, basophyt, thermophyt.
Pauli Palla 'e Cammisa, on rock.

Homalothecium sericeum (Hedw.) Bruch. & al. [temp] - xerophyt, moderately sciophyt to photophyt, basophyt, mesothermophyt to considerably thermophyt.
Pauli Oromeo, Pauli s'Ala 'e Mengianu, on rock; Pauli Maiori (Genoni), on rock and on soil.

Isothecium myusuroides Brid. [suboc(-submed)] - moderately hygrophyt to mesophyt, sciophyt, acidophyt to subneutrophyt, mesothermophyt.
Pauli s'Ala 'e Mengianu, on rock.

Brachythecium rutabulum (Hedw.) Bruch. & *al.* [temp] - moderately hygrophyt to mesophyt, sciophyt to moderately photophyt, acidophyt to subneutrophyt, mesothermophyt.
Pauli Maiori (Genoni), on soil .

Brachythecium velutinum (Hedw.) Bruch. & *al.* [temp] - mesophyt to moderately xerophyt, moderately sciophyt to photophyt, acidophyt to subneutrophyt, mesothermophyt.
Pauli Oromeo, on soil.

Scleropodium cespitans (Müll. Hal.) L. F. Koch [oc-submed] - mesophyt, moderately sciophyt to photophyt, subneutrophyt, moderately to considerably thermophyt.
Pauli Maiori (Tuili), on rock.

Scleropodium touretii (Brid.) L. F. Koch [oc-submed] - xerophyt, moderately sciophyt to photophyt, moderately acidophyt to subneutrophyt, moderately thermophyt.
Pauli s'Ala 'e Mengianu, on rock.

Rhynchostegium confertum (Dicks.) Bruch. & al. [submed-suboc] - moderately hygrophyt to mesophyt, sciophyt, subneutrophyt, mesothermophyt.
Pauli s'Ala 'e Mengianu, on soil and on rock.

Rhynchostegium megapolitanum (Weber & D. Mohr) Bruch. & *al.* [submed] - moderately hygrophyt to xerophyt, moderately sciophyt to photophyt, subneutrophyt, moderately thermophyt.
Pauli Bartili, on soil.

Rhynchostegium riparioides (Hedw.) C.E.O. Jensen [temp] - hygrophyt, moderately sciophyt to photophyt, moderately acidophyt to basiphyt, mesothermophyt to considerably thermophyt.
Pauli Maiori (Tuili), on rock.

Eurhynchium praelongum (Hedw.) Bruch. & *al.* var. *praelongum* [temp] - hygrophyt, sciophyt, moderately acidophyt to subneutrophyt, mesothermophyt.
Pauli Maiori (Tuili), Pauli s'Ala 'e Mengianu, on soil.

Eurhynchium pulchellum (Hedw.) Jenn. [subbor-mont] - mesophyt to xerophyt, moderately sciophyt to photophyt, moderately acidophyt to subneutrophyt, moderately thermophyt.
Pauli s'Ala 'e Mengianu, on rock.

Eurhynchium speciosum (Brid.) Jur. [temp] - moderately hygrophyt to mesophyt, moderately sciophyt to moderately photophyt, moderately acidophyt to subneutrophyt, mesothermophyt to moderately thermophyt.
Pauli 'e Fenu, on soil.

Rhynchostegiella curviseta (Brid.) Lindb. [submed-suboc] - hygrophyt to xerophyt, sciophyt, moderately acidophyt to basiphyt, moderately thermophyt.
Pauli Bartili, on soil.

HYPNACEAE

Hypnum cupressiforme Hedw. [temp] - mesophyt to moderately xerophyt, moderately sciophyt to moderately photophyt, acidophyt to subneutrophyt, tempindifferent.
Pauli Oromeo, on rock and on bark; Pauli s'Ala 'e Mengianu, Pauli Maiori (Genoni), Pauli Maiori (Tuili), on rock; Pauli Perdosu, Pauli Bartili, on bark; Pauli 'e Fenu, on rock and on soil.

Hypnum resupinatum Taylor [oc] - mesophyt, sciophyt, acidophyt, mesothermophyt.
Pauli s'Ala 'e Mengianu, Pauli Maiori (Genoni), Pauli Maiori (Tuili), on soil.

Results and Discussion

From the bryological viewpoint vegetational-floristic data don't exist with the exception of a low number of samplings reported by Cortini Pedrotti & Troiano (1985). The present investigation provides a more complete information on the bryophitic component of the tableland. In total 87 entities there have been recorded (Cogoni & al. 2003) of which 56 (64% of the total) belonging to the classes *Bryophyta* (50 entities) and *Marchantiophyta* (6 entities) occur along the edges of the pauli The most frequently represented family is that

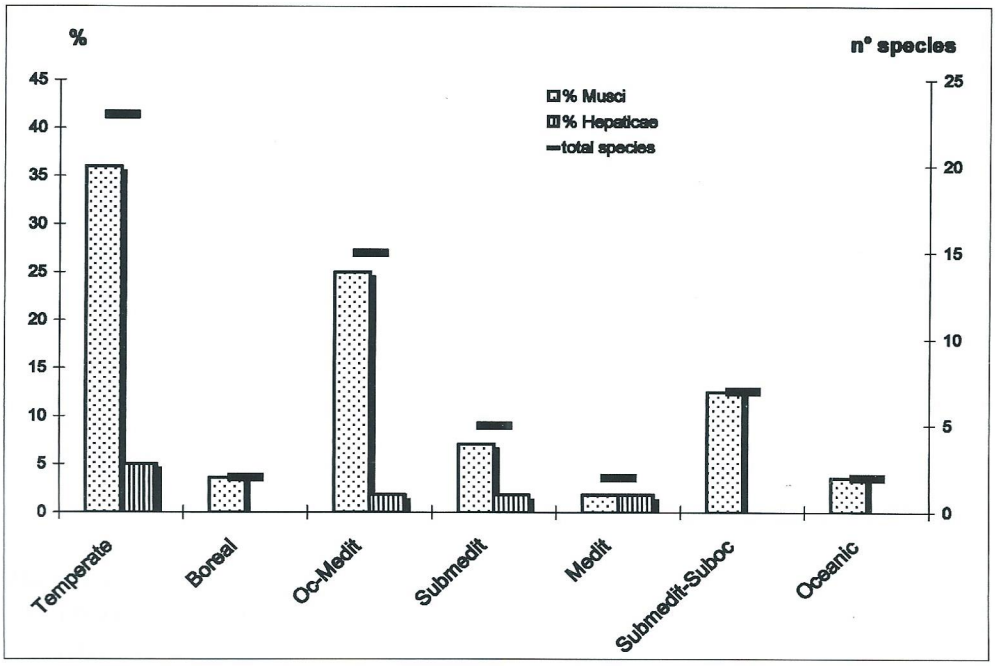

Fig. 2. Chorological spectrum of Pauli.

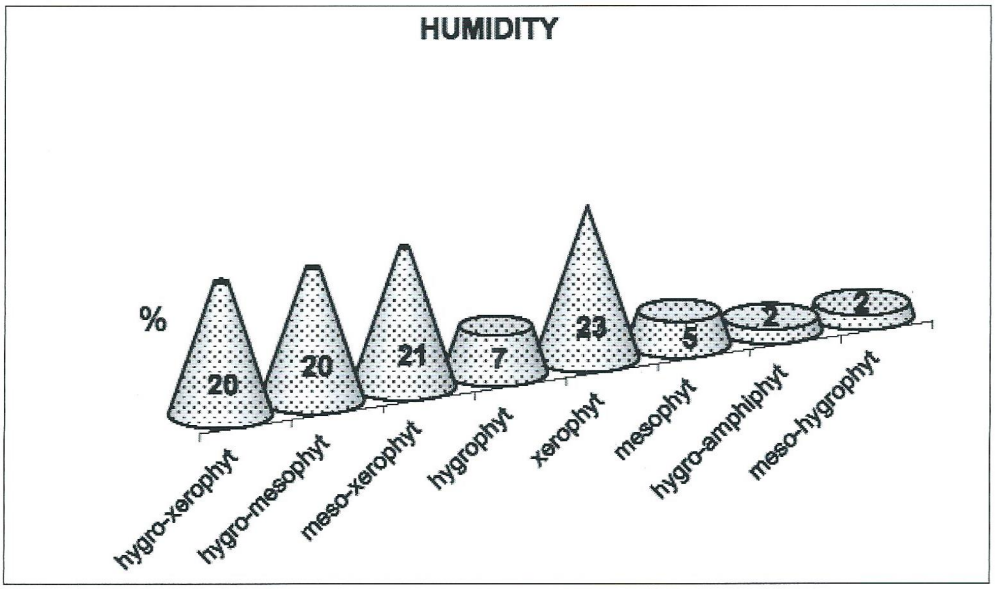

Fig. 3. Ecological spectra: humidity.

of the *Brachyteciaceae* (14 entities), followed by that of the *Pottiaceae* (12 entities). The few liverworts found belong mostly to the genus *Riccia*, an epigaeic species destined to disappear in the driest season.

The number of entities in the different *pauli* goes from a minimum of 4 collected in Pauli Perdosu to a maximum of 28 found in Pauli S'Ala 'e Mengianu. Deeper and wider than the others, Pauli S'Ala 'e Mengianu, presents a bigger surface at the disposal of the development of these criptogams especially in their vegetative period.

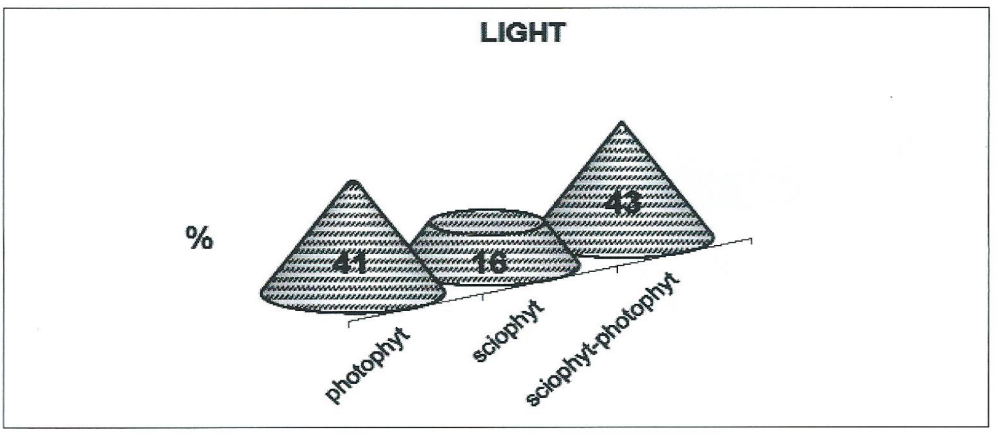

Fig. 4. Ecological spectra: light.

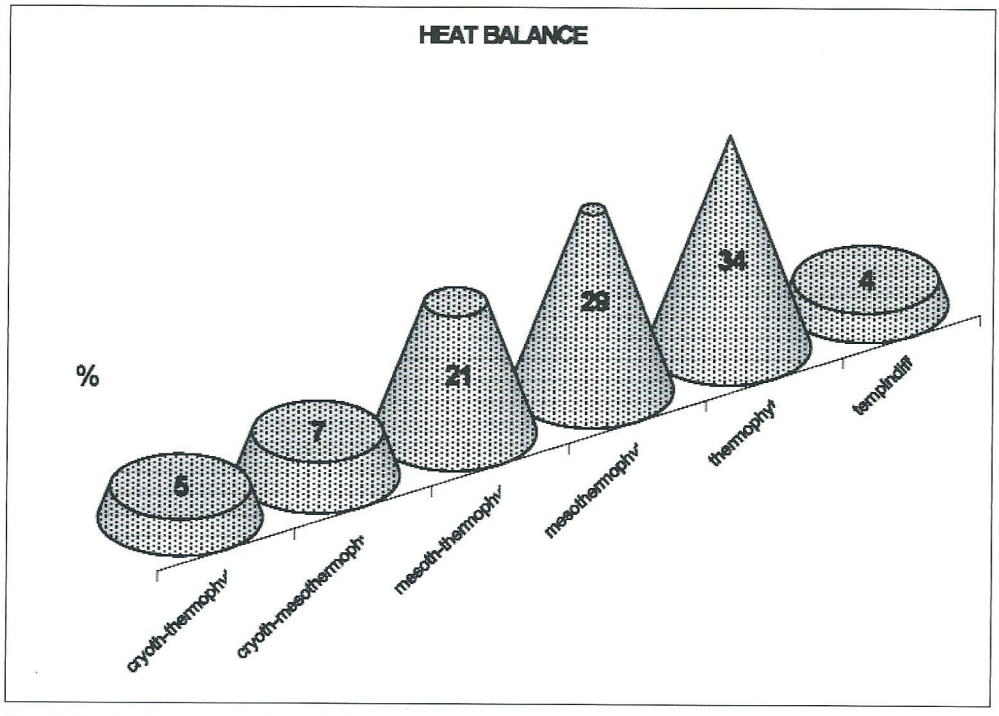

Fig. 5. Ecological spectra: heat balance.

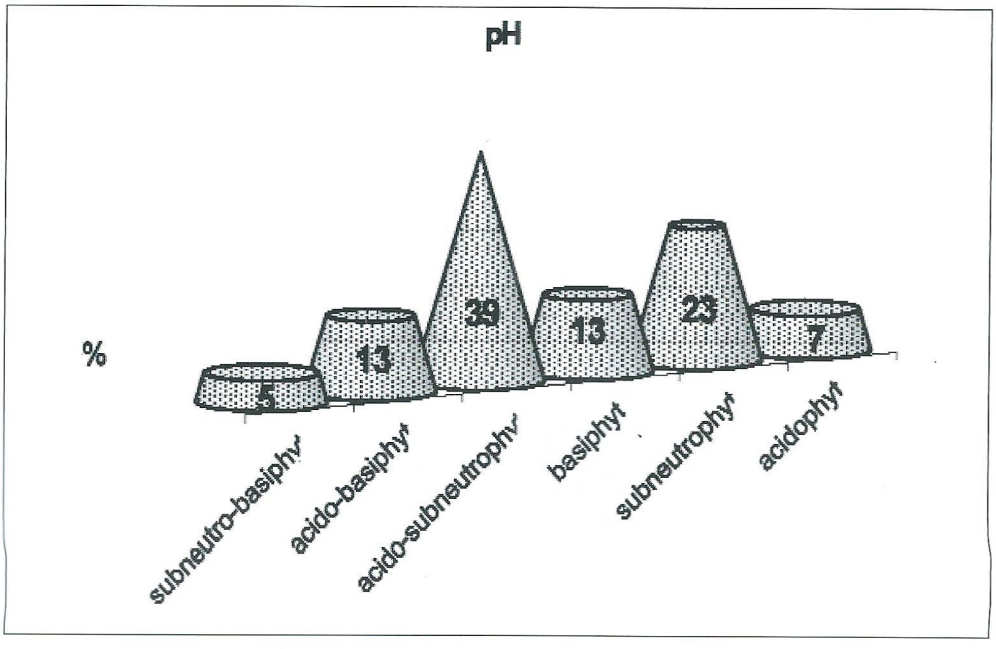

Fig. 6. Ecological spectra: pH.

The analysis of the chorological data (Fig. 2) points out the prevalence of the temperate element with 23 entities (41%), followed by the oceanic-Mediterranean element with 15 entities (27%).

The processing of the ecological indexes (Figs. 3-6) shows the prevalence of the xerophytic species (23%) followed by a significant presence of the hygrophytic-mesophytic and hygrophytic-xerophytic entities (both 20 %) closely linked to the water-oscillation of the *Pauli*. In particular we find entities that are strictly hygrophyt (7%) such as *Rhynchostegium riparioides*, *Leptodictyum riparium* and *Cinclidotus mucronatus* which undergo periods of total submersion during the spring. Regarding the correlation with the other ecological factors sciophytic-photophytic species (43 %) prevail followed by thermophytic (34 %) and the acidophytic-subneutrophytic species (39 %).

Regarding growth forms, short turfs (46 %) and wefts (27 %) prevail, the latest ones are especially *Brachytheciaceae*. Concerning life strategies we have a dominion of colonist (35 %) and perennial (23 %) entities; to the first ones belong some pioneer species as *Bryum bicolor* and *Grimmia pulvinata* while the second ones are represented by species that tolerate fluctuations that characterize these environments.

Species with annual life strategy (11 %) are represented especially by liverworts belonging to *Riccia* genus that don't tolerate water stress in the driest season (During 1979).

The aim of AA. is to use these data to compare them with those of ecologically similar sites of Sardinia and with those of Corsican *padules* (Lorenzoni & Paradis 1996, 2000) and *mares temporaires* of South France (Hugonnot 2002).

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References

Aleffi, M. & Schumacker, R. 1995: Check-list and red-list of the liverworts (*Marchantiophyta*) and hornworts (*Anthocerotophyta*) of Italy. – Fl. Medit. **5:** 73-161.

Brummit, R. K. & Powell, C. E. (eds.) 1992: Authors of plant names. – Kew.

Cogoni, A., Flore, F., Adamo, C. & Scrugli, A. 2004: Bryological flora of the Giara di Gesturi tableland (southern-central Sardinia). – Braun-Blanquetia **34:** 51-58

Corley, M. F. V. & Crundwell, A. C. 1991: Additions and amendments to the mosses of Europe and the Azores. – J. Bryol. **16:** 337-356.

—, —, Düll, R., Hill, M. O. & Smith, A. J. E. 1981: Mosses of Europe and the Azores; an annotated list of species, with synonyms from the recent literature. – J. Bryol. **11:** 609-689.

Cortini Pedrotti, C. & Troiano, R. 1985: Contributo alla conoscenza dei muschi della Sardegna. - Boll. Soc. Sarda Sci. Nat. **24:** 123-147.

— 2001: New Check-list of the Mosses of Italy. – Fl. Medit. **11:** 23-107.

Dierâen, K. 2001: Distribution, ecological amplitude and phytosociological characterization of European bryophytes. – Berlin, Stuttgard.

Düll, R. 1983: Distribution of the European and Macaronesian liverworts (Hepaticophytina). – Bryol. Beitr. **2:** 1-115.

— 1984: Distribution of the European and Macaronesian mosses (*Bryophytina*). Part I. – Bryol. Beitr. **4:** 1-113.

— 1985: Distribution of the European and Macaronesian mosses (*Bryophytina*). Part II. – Bryol. Beitr. **5:** 110-232.
— 1992: Distribution of the European and Macaronesian mosses (*Bryophytina*). Annotations and Progress. – Bryol. Beitr. **8/9:** 1-223.
During, H. J. 1979: Life strategies of Bryophytes. – Lindebergia **5:** 2-18.
Grolle, R. 1983: Hepatics of Europe including the Azores: an annotated list of species, with synonyms from the recent literature. – J. Bryol. **12:** 403-459.
Hugonnot, M. V. 2002: Flore et Végétation bryologique. – Association Loisirs Botanique, Réserve Naturelle de Roque-Haute.
Lorenzoni, C. & Paradis, G. 1996: Description phytosociologique et cartographique de la végétation des zones humides du golfe de Rondinara (Corse du Sud). – Bull. Soc. Bot. Centre-Ouest, n. s., **27:** 151-178.
— & — 2000: Phytosociologie et phytocartographie de mares temporaires méditérranéennes: les Tre Padule de Suartonne (Corse). – Coll. Phytosoc. **26:** 571-593.
Mägdefrau, K. 1982: Life forms of bryophytes. – Pp. 45-58 in: Smith, A. J. E. (ed.): Bryophyte ecology. – London.
Mossa, L., Scrugli, A., Mulas, B., Fogu, M. C. & Cogoni, A. 1989: La componente geobotanica del Parco Giara di Gesturi. – Pp. 27-84 in: Sa Jara. Un'area di interesse naturalistico da salvaguardare. – Cagliari.
Rivas-Martínez, S., Sanchez-Mata, D. & Costa, M. 1999: North American Boreal and Western Temperate Forest Vegetation. – Itin. Geobot. **12:** 1-316.
Sérgio, C., Casas, C., Brugués, M. & Cros, R. M. 1994: Red List of Bryophytes of the Iberian Peninsula. – Lisboa.

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