Relevant habitats neglected by the Directive 92/43 EEC: the contribution of Vegetation Science for their reappraisal in Sicily

Riccardo Guarino¹, Salvatore Pasta², Giuseppe Bazan¹, Alessandro Crisafulli³, Orazio Caldarella⁴, Gian Pietro Giusso Del Galdo⁵, Alessandro Silvestre Kristina², Vincenzo Iardì¹, Antonino La Mantia⁴, Corrado Marceño⁵, Pietro Minissale⁵, Saverio Sciandrello⁵, Leonardo Scuderi⁶, Giovanni Spampinato⁶, Angelo Troia¹, Lorenzo Gianguzzi¹⁰

1 Department of Biological, Chemical and Pharmaceutical Sciences and Technologies (STEBICEF), University of Palermo, Italy
2 Institute of Biosciences and BioResources (IBBR), Italian National Research Council (CNR), Unit of Palermo, Italy
3 Department of Chemical, Biological, Pharmaceutical and Environmental Sciences (CHIBIOFARAM), University of Messina, Italy
4 Via Maria SS. Mediatrice 38, Palermo, Italy
5 Department of Biological, Geological and Environmental Sciences (BIGEA), University of Catania, Italy
6 Via Giotto 64, Palermo, Italy
7 Department of Botany and Zoology, Faculty of Science, Masaryk University, Brno, Czech Republic
8 Via Andromaca 60, Trapani, Italy
9 Department of Agricultural Sciences, Mediterranean University of Reggio Calabria, Italy
10 Department of Agricultural, Food and Forest Sciences (SAAF), University of Palermo

Corresponding author: Riccardo Guarino (riccardo.guarino@unipa.it)

Subject editor: Daniela Gigante ♦ Received 6 December 2021 ♦ Accepted 19 December 2021 ♦ Published 31 December 2021

Abstract

Field investigation carried out by the Sicilian botanists in the last 20 years enabled them to identify eight habitat types of high biogeographic and conservation interest, neglected by the Directive 92/43, which deserve ad hoc conservation measures. For each of these habitats, a syntaxonomic interpretation of the corresponding plant communities, their main ecological, physiognomic and syndynamic traits and a list of diagnostic species are provided. Their classification into the macrotypes listed in the Annex I of the Directive 92/43 and the respective correspondence in EUNIS habitat classification are proposed. The habitats here described integrate those already proposed by the Italian Botanical Society, with the hope of an adequate recognition at national at supranational level.

Keywords

Habitat Directive, Natura 2000, Nature conservation, Sicily

Introduction

The Natura 2000 sites form a pan-European network for the in situ protection of species and habitats, recognized as conservation targets “of Community Importance” on the basis of Directive 92/43 EEC, which represents the most important regulatory instrument for the conservation of natural and semi-natural ecosystems in Europe (Evans 2012).

Designed to support the long-term survival of Europe’s most valuable species and habitats, Natura 2000 sites constitute an environmental network to be managed through initiatives that should also fulfil socio-cultural and economic requirements at the local scale, with the general aim at achieving the best balance between ecological integrity and requirements of people living and working nearby (Tsiafouli et al. 2013; Linnell et al. 2015).

Even if originating from a species-specific concept (Kirk et al. 2016), the term “habitat” is frequently used to designate an integral unit, supporting ecological functions and species assemblages (Morrison and Mathewson 2015). This happens both in the EUNIS habitat classifi-
cation (Rodwell et al. 2018) and in the Directive 92/43 EEC. Vascular plant communities are crucial to define EU habitats, both because plants are the least vagile and most visible component of terrestrial ecosystems, and because the vegetation cover and classification are the criteria by which the habitats of the Directive 92/43 (henceforth: Habitat Directive) are identified, delimited and mapped.

The census of natural habitats from the same Directive has given new impetus to basic taxonomic, syndynamic and ecological research, involving different disciplines (Blondet et al. 2017). Among these, vegetation science offered a significant contribution, considering that the units codified in the Annex I of the Habitat Directive often refer to the species composition and the structure of plant communities and sometimes explicitly refer to phytosociological units (Loidi et al. 2007; Tomaselli et al. 2016; Angelini et al. 2018; Attorre et al. 2018).

The explicit mention of some syntaxa by the Habitat Directive is important, also because this implicitly recognizes one fundamental postulate of phytosociology, that is: each phytocoenosis corresponds to a specific range of variability of environmental factors. Phytosociological studies carried out across the entire Sicilian territory during the last three decades pointed out the biogeographical importance of several habitats that deserve to be included in the Annex I of the same Directive. This paper aims to introduce these habitats and to discuss about the urgent need for their adequate recognition.

Material and Methods

Study area

The Sicilian Natura 2000 network counts on 245 protected sites, unevenly distributed throughout the island (Fig. 1). Among the Italian regions, Sicily is the one hosting the largest surface area of Special Areas of Conservation (SAC, based on the Habitat Directive), and Special Protection Areas (SPA, based on the Directive 79/409). These protected areas cover approximately a surface of 4710 km², corresponding to 18.3% of the Sicilian territory, sea excluded (www.mite.gov.it). Altogether, Sicily hosts 71 habitats listed in the Directive 92/43, of which 18 have priority conservation status. Additionally, 46 species from Annex II of the same Directive and 92 birds from the Directive 79/409 are recorded in Sicily.

The main feature of Sicily is a great geomorphologic and bioclimatic diversity, which originate ecological gradients of different intensity, also influenced by the distance from the sea and by the orientation and elevation of mountain ranges. In general, the natural patchiness of the Sicilian landscapes has been increased up to critical levels by human activities (Gianguzzi et al. 2016; Guarino and Pasta 2017).

Land use and human demography have significantly changed during the last seven decades, as a consequence...
of the mechanization of agriculture, the decline of extensive land use and traditional agriculture. Emblematic, in this case, is the almost complete abandonment of terraced fields (Barbera et al. 2009). The development of new economic sectors, like tourist services and infrastructure, promoted the concentration of people within a few miles from the coastline, with an ever-increasing impact on coastal habitats (Guarino and Guglielmo 2010). On the other hand, many lands which were used by agriculture or husbandry until recent times are currently abandoned, particularly in the mountain districts. For these reasons, two main kinds of Sites of Community Importance can be found in Sicily: those occurring on mountains are on average quite large; the coastal ones, instead, are on average rather small and set up in the attempt to save the savable, i.e. the few coastal stretches escaped from the massive urbanization which took place in recent decades as a consequence of the human migration coastwards (Mikhaylov et al. 2018). Indeed, the conservation and management of the Sicilian coastal sites, exposed to the pressure of strong economic interests, is quite problematic and poses several specific issues (Pasta et al. 2017; Guarino et al. 2021; Sciandrello et al. 2021).

Survey approach

The vegetation survey aimed at identifying the Sicilian habitats neglected by the Directive 92/43 was based both on phytosociological literature and on-site investigations conducted according to the Braun-Blanquet phytosociological approach (Braun-Blanquet 1964; Westhoff and van der Maarel 1978). The habitat description, syntaxonomic classification and designation of diagnostic species was carried out based on expert knowledge, supported by literature data and by the Expert System for the European EUNIS habitats (Chytrý et al. 2020).

The identification and nomenclature of vascular plants was based on Pignatti et al. (2017–2019), whereas the animal species names mentioned throughout the text follow Ruffo and Stoch (2005). The syntaxonomic nomenclature follows Mucina et al. (2016) and subsequent updates for Sicily (Guarino et al. 2017). The bioclimatic units refer to Bazan et al. (2015).

Results

Among the relevant habitats neglected by the Directive 92/43 EEC, which deserve greater attention to ensure their conservation in Sicily, it is worth mentioning:

a) relict communities dominated by plants at the edge of a wider distribution range, such as: the birch woods of *Betula pendula* subsp. *etnensis* (*Cephalanthero longifolii-Betuletum etnensis*), restricted to the supramediterranean vegetation belt of Mount Etna (Brullo et al. 2012); the forest nuclei dominated by *Celtis tournefortii* subsp. *aetnensis* (*Pistacio terebinthi-Celtidetum aetnensis*), restricted to Sicani Mts., Nebrodi Mts. and Mount Etna (Gianguzzi et al. 2014b) or by *Ostrya carpinifolia*, scattered on the main mountain ranges of the island (Brullo et al. 2012); the broomfields with *Cytisus scoparius*, *Teline monspessulana* and *Adenocarpus* spp. occurring under cool and humid climatic conditions on the acidic soils of Etna, Nebrodi and Peloritani Mts.; the vegetation of dripping and shady rocky faces with *Woodwardia radicans*, occurring in few gorges of the Peloritani Mountains (Crisafulli 2007).

b) some outstanding habitats barely taken into account by the Directive and not adequately protected by national and regional laws, linked to localized and peculiar geomorphological units and hosting several vegetation units. This is the case of the annual swards and perennial grasslands, the sedge communities and the brackish temporary ponds co-occurring near the mud volcanoes and badlands of Macalube di Aragona, Terrapilata, Vulcanelli di Adriano, etc. (Pasta 2001; Brullo et al. 2010, 2013); the vegetation of the gypsum outcrops of southern and inner Sicily (Guarino and Pasta 2017; Musarella et al. 2018).

c) traditional landscapes shaped by century-long agro-forestry practices, such as the dehesa-like communities dominated by *Ceratonia siliqua* on the Hyblaean Plateau (SE-Sicily). This would reinforce the unit 63 of the Directive, i.e., sclerophyllous grazed forests (dehesas), currently recognizing only the habitat 6310 (“Dehesas with evergreen *Quercus* spp.”).

The eight habitats described here integrate those already identified and proposed as additions to the Habitat Directive by the Italian Botanical Society (Table 1; Genovesi et al. 2014). Each of the newly proposed habitats is commented more in detail in the forms reported below.

1) Sicilian gypsum outcrops

**Motivation:** The plant communities growing on gypsum are a clear example of the strict relationship between substrate and vegetation, as many plant species grow exclusively or preferentially on such peculiar substrates (Escudero et al. 2015, Musarella et al. 2018). Gypsum habitats have historically been perceived as sterile, degraded areas with no special conservation interest that needed to be afforested or that could be used as dumping sites for urban waste (Escudero et al. 2015). Nowadays, they are acknowledged as habitats worth preserving due to their high number of endemic or exclusive plants (Escudero et al. 2015). However, these same communities represent often a largely underrated or ignored habitat, with serious consequences for both flora and fauna conservation (Musarella et al. 2018).

As already highlighted in Musarella et al. (2018), for the vascular flora, and Puglisi et al. (2020) for bryophytes, the Italian gypsum habitats could be included in the Habitat 1520* (Iberian gypsum steppes) extending its current definition in the Manual of Habitat interpretation, also
with the addition of the Italian vascular and moss gypsophytes. Similarly, the habitat has been recently recognized in Cyprus (Manolaki Vogiatzakis 2017), at the opposite side of the Mediterranean Basin, and it stretches northwards up to the submediterranean gypsum outcrops of the Northern Apennine.

**Macrotypes:** 15 Salt and gypsum inland steppes

**Name:** Sicilian gypsum outcrops.

**Description:** Garrigues, perennial grasslands and annual swarms colonizing gypsum-rich shallow soils and gypsum outcrops in the southern and central part of Sicily, under thermo- and mesomediterranean climatic conditions. These plant assemblages include several gypsophilous species, mainly belonging to the families Lamiaeae (genera Micromeria, Teucrium, Thymus, Thymbra), Cistaceae (Fumana, Helianthemum), Asteraceae (Centaurea, Jurinea, Santolina, Frankenia) and Brassicaceae (Alyssum, Erysimum, Matthiola). All of them are adapted to several environmental stresses, such as: long-lasting seasonal drought, base-rich substrates (especially in the most eroded sites and on lithosols), high solar radiation, exacerbated by the high reflectance of rock outcrops.

**Diagnostic sentence:** Garrigues, grasslands and annual swarms colonizing gypsum-rich substrates of the hilly areas of inner and southern Sicily.

**List of diagnostic species:** In addition to the species already listed as gypsum-specialists by Musarella et al. (2018) and Puglisi et al. (2020): Chaenorhinum rupestre, Festuca gypsophila, Sedum gypsicola subsp. trinacriae, Petrosedum ochroleucum subsp. mediterraneum, many other species prefer gypsum-rich substrates in Sicily, although not being exclusive of this substrate type. This is the case of: Astragalus caprinus subsp. huettii, Brassica villosa subsp. tinei, Diplotaxis crassifolia, Echinaria capitata var. todaroana, Erysimum metlesicisii, Gypsophila arrostii subsp. arrostii, Scabiosa parviflora.

**Dynamic contacts:** Although gypsum outcrops have for long time been interpreted as the result of the extreme degradation and erosion of previously forested areas, this is probably true only for gently sloping or almost flat areas. Indeed, some small and scattered evergreen (Quercus ilex) or semideciduous (Quercus pubescens) oak forest fragments still occur nowadays on the deeper gypsum-rich soils of central and southern Sicily (Bazan et al. 2006; Brullo et al. 2009).

As for the steps of progressive vegetation dynamics on gypsum-rich soils, in the absence of disturbance almost bare rock outcrops only hosting moss- and lichen-rich communities are gradually covered with annual gypsophilous sward (Sedo-Ctenopion gypsophilae). If pedogenesis is not hindered by frequent disturbances, new therophytic assemblages (referred to Stipion retortae or Plantagini-Catapodion balearici) can develop and evolve towards perennial grasslands (Hyparrhenion hirtae under thermomediterranean bioclimatic conditions, Avenulo-Ampelodesmosmin under meso-mediterranean, Charybdiido-Ashphodelion under high grazing pressure). The most mature communities currently found on gypsum-rich substrates are garrigues, framed into the alliance Cisto-Ericion multiflorae.

---

### Table 1. Synoptic table resuming all the new habitat proposals from Sicily, their macrotype according to the Habitat Directive and the corresponding habitats in the EUNIS habitat classification.

<table>
<thead>
<tr>
<th>MACROTYPE - Habitat Directive code</th>
<th>New proposed Habitat</th>
<th>EUNIS 2021 code</th>
<th>EUNIS habitat classification</th>
<th>Proposed by Genovesi et al. 2014</th>
<th>Proposed <em>hoc loco</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Salt and gypsum inland steppes</td>
<td>Sicilian gypsum outcrops</td>
<td>S65</td>
<td>F6.7 Mediterranean gypsum scrub</td>
<td>-</td>
<td>—</td>
</tr>
<tr>
<td>15 Salt and gypsum inland steppes</td>
<td>Mud volcanoes and badlands in the evaporitic outcrops of Sicily</td>
<td>S66</td>
<td>F6.8a</td>
<td>Mediterranean haloph-colonial scrub</td>
<td>-</td>
</tr>
<tr>
<td>31 Standing water</td>
<td>Fresh water sedge- and reedbeds</td>
<td>Q51</td>
<td>C5.1a</td>
<td>T. helophyte bed</td>
<td>-</td>
</tr>
<tr>
<td>32 Running water</td>
<td>Montane brooks of southern Apennines and Sicily</td>
<td>C21a</td>
<td>C2.1a</td>
<td>Base-poor spring and spring brook</td>
<td>-</td>
</tr>
<tr>
<td>51 Sub-Mediterranean and temperate scrub</td>
<td>Sclerophyllous Sicilian broomfields</td>
<td>S33</td>
<td>F3.1c</td>
<td>Lowland to montane temperate and submediterranean genistoid scrub</td>
<td>-</td>
</tr>
<tr>
<td>63 Schizophyllous grassy forests</td>
<td>Small woods dominated by Celtis tournesortii subsp. acneanalis</td>
<td>S51</td>
<td>F5.1</td>
<td>Mediterranean maquis and arborescent matorral</td>
<td>-</td>
</tr>
<tr>
<td>63 Schizophyllous grassy forests</td>
<td>‘Chaise’ with Ceratonia silicia of south-eastern Sicily</td>
<td>T24</td>
<td>G2.4</td>
<td>Olea europea-Ceratonia silicia forest</td>
<td>-</td>
</tr>
<tr>
<td>63 Schizophyllous grassy forests</td>
<td>Centuries-old olive groves with evergreen oaks and arborecent matorral</td>
<td>T24</td>
<td>G2.4</td>
<td>Olea europea-Ceratonia silicia forest</td>
<td>-</td>
</tr>
<tr>
<td>72 Other rocky habitats</td>
<td>Shady dripping cliffs with Woodwardia radicans and other large ferns</td>
<td>U3D</td>
<td>H3.4</td>
<td>Wet inland cliff</td>
<td>-</td>
</tr>
<tr>
<td>72 Other rocky habitats</td>
<td>Mediterranean dripping cliffs</td>
<td>U3D</td>
<td>H3.4</td>
<td>Wet inland cliff</td>
<td>-</td>
</tr>
<tr>
<td>72 Other rocky habitats</td>
<td>Water springs with moss-rich vegetation on siliceous or carbonatic substrates</td>
<td>C21b</td>
<td>C2.1a</td>
<td>Base-poor spring and spring brook</td>
<td>-</td>
</tr>
<tr>
<td>92 Mediterranean deciduous forests</td>
<td>Birch woodlands of Mount Etna</td>
<td>T1D</td>
<td>G1.9b</td>
<td>Southern European mountain Betula and Populus tremula forest on mineral soils</td>
<td>-</td>
</tr>
<tr>
<td>92 Mediterranean deciduous forests</td>
<td>Ostrya carpinifolia woods of Sicily</td>
<td>T1A</td>
<td>G1.7b</td>
<td>Mediterranean thermophilous deciduous forest</td>
<td>-</td>
</tr>
</tbody>
</table>

2) Mud volcanoes and badlands in the evaporitic outcrops of Sicily

Motivation: Already studied by early naturalists such as Pliny the Elder and eminent geologists like Deodat de Dolomieu and Charles Lyell, around 15 mud volcanoes occur in the inland areas of Sicily. Mud volcanoes alternate an almost continuous degassing activity and episodes with ejection of large quantities of mud. The protection of these absolute naturalistic highlights gave birth to many protected areas worldwide, namely in the SE-European and middle-central Asian countries bordering the Black and the Caspian Sea, in the Indian Ocean and in the Americas. In Italy, mud volcanoes also occur in Emilia-Romagna, Marche, Tuscany and Latium regions. Some of them are nature reserves, such as the “Salse di Nirano” in Emilia-Romagna, whilst many others are lacking any protection.

Like other poorly vegetated but geologically peculiar habitats (e.g. 8320: Fields of lava and natural excavations), the Sicilian mud volcanoes and badlands are worth being included in the 92/43 EEC Directive as a whole, not only for their naturalistic and aesthetic value, but also for their increasing vulnerability, exacerbated by absent destinations (e.g., waste dumping grounds, go kart and motocross trails) and disturbances such as wildfires, overgrazing by domestic herbivores, unsustainable cereal crop cultivation practices, reforestation with alien trees, which currently compromise many of these unique, hostile habitats by accelerating the natural erosive processes affecting them.

Because many mud volcanoes and badlands are located in poorly investigated areas, their occurrence has often been overlooked and, consequently, they have not been included in the Sicilian Natura 2000 network. Indeed, some Sicilian endemics, like Triandrom sorrentinoi (Aster sorrentinii), Limonium calcarae, Allium agrigentium, Malva agrigentina only grow on badlands or close to mud volcanoes. Of these species, Triandrom sorrentinoi is the only one mentioned in the Annex II of the 92/43 EU Directive. All these plant species, classified as critically endangered or vulnerable according to IUCN criteria, are currently experiencing a rapid shrinkage, and some have already gone extinct, as in the case of Puccinellia gussonei. Hence, the inclusion of Sicilian badlands in the 92/43 EEC Directive is urgently required also for plant conservation purposes.

Macrotype: 15 Salt and gypsum inland steppes
Name: Mud volcanoes and badlands in the evaporitic outcrops of Sicily
Description: Mud volcanoes with almost continuous degassing activity and patchy halo-tolerant xerophytic vegetation colonizing the top, the slopes and the base of the steep to gently sloping and rounded badlands. Such vegetation occurs on marly, clayey-marly and salty-clayey substrates of the geological unit “Formazione Gesso-Solfifera”, including several sedimentary materials accumulated during the Messinian Salinity Crisis. This habitat is mostly concentrated in the inner part of Sicily and hosts both xerophilous and hygrophilous grassland communities, adapted to face different severe and counteracting stress factors (e.g., winter soil waterlogging and oxygen shortage, summer water shortage and cracking). Sicilian mud volcanoes occur in the Province of Agrigento, Caltanissetta and Catania (Cangemi · Madonia, 2014). Some of these went destroyed during the last century, including the ones forming the famous lake Naphpta, near Palagonia, home of the divine twins Palikoi, feared and venerated by central-eastern Sicilians already three thousand years ago. Clayey and marly badlands are more widespread throughout the island, in the provinces of Agrigento, Caltanissetta, Enna and Catania,
with minor spots in the provinces of Trapani and Palermo (Brullo et al. 2010, 2013; Pasta Guarino 2017).

**Diagnostic sentence:** Thermo- to mesomediterranean sparsely vegetated clayey and marly evaporitic outcrops, badlands and mud volcanoes of Sicily (local names: sali nelle, calanchi, vulcanelli, macalube, caldare).

**List of diagnostic species:** Lygeum spurianum, Caroxylon agrigentium, Tripolium sorrentinii, Limonium calcarae, Limonium opulenta, Malva agringitina, Allium agringitum (incl. A. castellanaense), Scabiosa parviflora, Moricandia arvensis, Erucia longirostris, Cardopatium corymbosum, Tyrrhimus leucographus, Scorzoneroideas muelleri subsp. muelleri, Sphenopus diversicus, Trifolium congestum, Anthemis muricata, Astragalus raphaelis, Senecio leucanthemifolius subsp. pectinatus.

**Dynamic contacts:** Mud volcanoes are bare areas, totally devoid of vascular plant cover, but they may host interesting algal communities. The halo-nitrophilous scrub communities of the harshest badlands (Salsoletum agrigentinae) are dominated by few species adapted to face the hyperarid conditions and the intense erosion of the steep slopes. Some sub-nitrophilous plant communities referred to Artemision arborescentis may occur on more humid badlands under meso-mediterranean bioclimatic conditions. The drought stress-tolerant communities, framed into Moricandio-Lygeion spurii (Lygeo spurii-Stipetalia tenacissimae), are dominated by few hemicyryptophytes and are rich in narrow endemics. On clayey or loamy compact soils, Lygeum-dominated grasslands are often intermingled with halo-subnitrophilous sparse ephemeral frames framed into Frankenien-Pulverulaeae (Saginetalia maritimae), also colonising the gently sloping margins of temporary ponds, while the bare ridges and the steepest eroded slopes are characterised by the uneven cover of therophytic assemblages referred to Gaudinio fragilis-Podospermm cani. Badlands and mud volcanoes may form complex landscapes hosting a patchwork of hygrophilous communities referred to Charetea fragilis, Isoeto-Nanojuncetalia, Juncetalia maritimii, Phragmito-Magnocaricetalia and Nerio-Tamaricetalia.


**3) Meso- and supramediterranean acidophilous Sicilian broomfields**

**Motivation:** The meso- and supramediterranean acidophilous Sicilian broomfields represent the most south-eastern and isolated stands of pertaining to a group of plant communities with Iberian-Atlantic distribution. The chief species of this vegetation type spread in Sicily during the hypothermal period following the last glacial event (during the Atlantic and Subboreal chronozones, see Orombelli Ravazzi, 2002) and have persisted in local areas where the summer aridity is buffered by orographic moisture condensation and water-rich acidic soils. This vegetation type migrated through southern France and along the Tyrrhenian side of the Apennines and Calabrian Massifs, until reaching north-western Sicily (De Beaulieu et al. 2005). Here, the isolated populations in some cases gave rise to new, autonomous lineages as a consequence of the geographic isolation and the adaptation to mountain ecosystems (Sciandrello et al. 2015). Owing to the biogeographical interest and the occurrence of exclusive endemic species, this habitat deserves adequate protection.

**Macrotypes:** 51 Sub-Mediterranean and temperate scrub

**Name:** Meso- and supramediterranean acidophilous Sicilian broomfields

**Description:** Mesophilous forest fringes and shrublands dominated by Pteridium aquilinum and genistoid nanophanerophytes with flexible and elongated green branches, growing on humid, non-eroded, nutrient-poor acidic soils. The dominant species, thanks to the symbiosis with nitrogen-fixing bacteria, play an important role in soil-formation processes. Such vegetation is widespread in the western territories of the Mediterranean, sub-Atlantic and Atlantic regions, often as seral stages replacing oak-dominated mixed deciduous woods. In Sicily, it is rather common along the Peloritani and Nebrodi moun-
tains and on Mount Etna, on soils deriving from quartz sandstones, metamorphic siliceous rocks and volcanic debris, within the meso- and supramediterranean subhumid to hyperhumid bioclimatic belts (Bartolo et al. 1994; Guarino 1998; Siracusa 1997; Gianguzzi 1999). The vegetation included in this habitat thrives particularly well on sea-facing submontane and mountain slopes, where it benefits from the condensation of moist air currents rising from the sea.

**Diagnostic sentence:** Mesophyllous forest fringes and shrublands dominated by *Pteridium aquilinum* and genistoid nanophanerophytes, growing on nutrient-poor acidic soils, within the meso- and supra-Mediterranean, subhumid to hyperhumid bioclimatic belt.

**List of diagnostic species:** *Cytisus infestus*, *Cytisus scoparius*, *Cytisus villosus*, *Erica arborea*, *Genista etnensis*, *Orobanche rapum-gensetia*, *Pteridium aquilinum*, *Spartium junceum*, *Teline monspessulana*, *Thymus longicaulis*, *Tuberaria lignosa* and the following endemic Sicilian or Calabrian-Sicilian species: *Adenocarpus commutatus*, *Anthemis messanensis*, *Euphorbia corallioioides*, *Fritillaria messanensis* and *Viola aethnensis*.

**Dynamic contacts:** Vegetation dynamically related to mesophyllous woods (particularly *Erico-Quercetum virgilianae* and *Teucrio siculo-Quercetum ilicis*) and thickets of *Ericion arboreae*. On summit windyridges it represents the primary vegetation, forming a patchwork with herb-dominated pasturelands ascribed to the *Plantaginion cupanii* (Molinio-Arrhenatheretea) and, if overgrazed, with transitional stages of *Pteridio-Tanacetetum siculi* (Onopordetalia acanthi).


4) Small woods dominated by *Celtis tournefortii* subsp. *aetnensis*

**Motivation:** *Celtis tournefortii* is a widely distributed species ranging along the south-eastern border of continental Europe, from the southern slopes of Caucasus to the Balkan and Aegean regions (Browicz Zielinski 1984; Tutin 1991; Boratyński et al. 1992). The Sicilian populations of the species, referred to the subsp. *aetnensis*, represent the most western and isolated outpost of its distribution range, testifying Miocene connections between the Balkan and Tyrrenhenian territories (Montelucci 1972; Tomaselli 1972; Pezzetta 2010). These Sicilian populations show a circumscribed and fragmentary distribution, occupying refuge habitats of remarkable phytogeographic interest, worthy to be preserved.

**Macrotype:** 63 Sclerophyllous grazed forests

**Name:** Small woods dominated by *Celtis tournefortii* subsp. *aetnensis*

**Description:** Small woods dominated by *Celtis tournefortii* subsp. *aetnensis*, 3–6 m tall, distributed in scattered patches of 200–400 square meters, from 380 m to 1340 m a.s.l., between the upper dry thermomediterranean and the sub-humid supramediterranean bioclimate. The stands occur on stony sites with different outcropping rocks, such as the lava flows (locally named “sciare”) on the south-western slopes of Mount Etna, quartz sandstones (southern slopes of the Nebrodi Mts. and Madonie Mts., near Gangi), marly-limestone scree (Sicani Mountains and lower part of the southern slope of Rocca Busambra), up to the summit ridges of Rocca Busambra, on cryoturbated calcareous-dolomitic outcrops (Troia 1997; Schichchi Marino 2011; Gianguzzi et al. 2014).

**Diagnostic sentence:** Small woods dominated by *Celtis tournefortii* subsp. *aetnensis*, associated with *Pistacia terebinthhus* and evergreen species and lianas of the Mediterranean scrub. These woods consist of relict, scattered patches settled in xeric and stony habitats, between the dry thermomediterranean and the sub-humid supramediterranean bioclimatic belts.

**List of diagnostic species:** Small woods dominated by *Celtis tournefortii* subsp. *aetnensis*, *Pistacia terebinthhus*, *Olea europaea* var. *sylvestris*, *Asparagus albus*, *Clematis crihosa*, *Silmix aspera*, *Ruta chalepensis* (*Pistacio terebinthi-Celtidetum aetnensis* - *tymicum*); *Rhamnus alaternus*, *Phillyrea latifolia* (*-rhamnetosum alaterni*); *Pholmis fruticosa* (*-phomidetosum fruticosae*); *Artemisia arboreascens* (*-armentisetosum arborescentis*).

**Dynamic contacts:** The vegetation at issue tends to have a primary character and plays an important ecological role in stabilizing screes and detrital fans, representing the most evolved aspect of the “Sicilian hilly and submontane, detrital, indifferent edaphic, thermo-mesomediterranean subhumid series of the *Pistacio terebinthi-Celtideto aetnensis* sigmetum”. This edaphophilous series is strongly affected by frequent rock falls and landslides and by local microclimatic conditions, with remarkably wide daily and annual temperature ranges. Towards the central part of the detrital fan, the *Pistacio terebinthi-Celtideto aetnensis* sigmetum gets in catenal contact with the shrubby and herbaceous vegetation of the scree microgeoseries, while at the edge of the its habitat, the sigmetum can be in contact with woodlands dominated, either by: a) *Quercus ilex* (habitat 9340), linked to rocky habitats with deeper soil (e.g., *Aceri campstris-Quercetum ilicis* on the Sicani Mountains, as well as *Teucrio siculo-Quercetum ilicis* on Mount Etna); b) *Quercus pubescens* s.l. (habitat 91AA - Eastern white oak woods), on deeper and more evolved soils (e.g., *Oleo sylvestris-Quercetum virgilianae* on the Sicani Mountains and Rocca Busambra, as well as *Celtido aetnensis-Quercetum virgilianae* and *Festuco heterophyl-
læc-Quercetum congestae on Mount Etna). In the upper part of its growing sites, the Pistacio terebinthi-Cellidio actensis signetum can also be in contact with the vegetation of rocky cliffs (habitat 8210, calcareous rocky slopes with chasmophytic vegetation), or with the Mediterranean maquis ascribed to the habitat 5330 (Euphorbia dendroides-maquis), with the perennial and annual dry grasslands of the habitat 6220* (Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea) or with the thermoxeric sclerophilous woods ascribed to the habitat 9320 (Olea and Ceratonia forests).


5) "Chiuse" with Ceratonia siliqua of south-eastern Sicily

Motivation: The so-called chiuse represent a cultural landscape of the south-eastern Sicily, characterised by an intricate network of dry limestone walls delimiting regular polygons where pastureland or thermo-Mediterranean garrigue are shaded by a very open canopy of carob trees (Bianca 1881; Ente Fauna Siciliana 2003; D’Amato 2018). Local agro-pastoral practices, mostly based on a biennial rotation system, maintain good levels of productivity with no need of chemicals for soil fertilization or against weeds and pathogens. Such extensive land use, combined with the lower impact of cattle grazing with respect to other domestic herbivores, is responsible for the high species richness recorded within chiuse (Baumel et al. 2018). Although chiuse host few preferential/differential plant species, they are home to many rare, protected, and endemic plants, like the orchids Ophrys calliantha, Ophrys discors and Ophrys lumalata, the last being a priority species according to 92/43 EEC Directive. Chiuse also represent an important habitat for prey birds (e.g., Buteo buteo, Falco tinnunculus, Tyto alba), for the Sicilian Rock Partridge (Alectoris graeca subsp. whitakeri) and for several important migratory birds (e.g., Alauda arvensis, Coturnix coturnix).

Macrotype: 63 Sclerophyllous grazed forests

Name: "Chiuse" with Ceratonia siliqua of south-eastern Sicily

Description: The native status of the island’s carob populations is still under debate (Ramón-Laca 2004; Viruel et al. 2020): in fact, ancient documents never mention forest communities dominated by carob trees, while many of them attest the extensive cultivation of this species since the XVII century after huge forest clearings (e.g., in the territory of Vittoria, once part of the Countee of Modica). The construction of these fenced areas is intimately related to the stony and rugged characteristics of the Hyblaean Plateau. Since ancient times, to enhance agro-pastoral activities local inhabitants used to create stone mounds along border of their properties. These mounds were gradually transformed into dry limestone walls to delimit crop fields, tree groves, or, more frequently, agro-silvo-pastoral complex ecosystems with crop fields and pastures and an uneven and scattered olive, almond, azerole and more frequently carob tree cover, with average low density of (often huge and aged) individuals (10-20 plants per hectare). This complex landscape and its cultural landmarks (stone walls, terraced groves, etc.) are generally well preserved; they were able to survive across the centuries and to face modernity because local rural economy, after experiencing some decades of economic crisis between 1970s and 2000s, re-started thanks to brilliant marketing initiatives (e.g., eco-tourism) valorising local agro-pastoral activities and products. For instance, the toasted flower obtained from carob pods is used to produce the famous “chocolote of Modica”, while these pastures feed the free-roaming cows of a local breed called “modicana”, producing the renowned “caciocavallo ragusano” cheese. Another traditional knowledge linked to carob trees is the local culinary use of Laetiporus sulphureus (whose vernacular name is “funcia ri carrûa”), a mushroom frequently associated with Ceratonia siliqua.

During last decades many chiuse located near the coast have been transformed into greenhouses for vegetable production and have been lost forever. Today the major threats to these man-made ecosystems are the abandonment of the land and traditional practices. Due to progressive succession processes, this agro-silvo-pastoral system is slowly changing into an intricate Mediterranean maquis. In addition, another threat for the "chiuse", also featured in the national catalogue of the rural historical landscapes (https://www.reterurale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/14376), is the transformation of ancient farms to make new private estates with no respect for traditional building style and/or not using local stone material.

Diagnostic sentence: Extensive land-use typical of south-eastern Sicily, characterised by an intricate network of dry limestone walls delimiting regular polygons where pastureland or thermo-Mediterranean garrigue are shaded by a very open canopy of Ceratonia siliqua.


Dynamic contacts: Along the south-eastern coast of Sicily the chiuse with carob trees get in contact with the communities of the Peripliocn angustifolii and in particular with the association Calicotomo infestae-Rhoetum tripartitae or with the communities of the Oleo-Ceratonion (Myro communis-Pistacietum lentisci). In these contexts, the grazed chiuse host a mosaic of communities framed into the Echino-Galactition, perennial grasslands referred to the Hyparrhenietum hiro-pubescentis, annual grasslands (Plantagini coronopi-Catapodietum mari-
ni, Anthemido secundirameae-Allietum lehmanii and, on rocky outcrops, Thero-Sedetum caerulei). In the inland, the chiuse are characterized by scattered remnant downy oak forest stands ascribed to Oleanthus sylvestris-Quercetum virgilianae and perennial grassland communities issuing from woodland degradation (Avenulo-Ampelodesmion maurusianici).

**Phytosociological arrangement:** Oleanthus sylvestris-Quercetum virgilianae Standl. & Steyerm. 1930 [Pistacio lentisci-Rhamnetalia alaterni Rivas-Mart. 1975, Querceta ilicis Br.-Bl. ex A. Bolòs y Vayreda O. de Bolòs in A. Bolòs y Vayreda 1950].

6) Shady dripping cliffs with Woodwardia radicans and other large ferns

**Motivation:** The Mediterranean dripping cliffs are sometimes characterized by bryo-pteridophytic sciaphilous-hygrophilous communities hosting rare and endangered ferns of remarkable phytogeographic interest, such as Woodwardia radicans, Osmunda regalis, Pteris vittata, Pteris cretica, Asplenium scolopendrium, many of them included in Italian Red List or Atlases of threatened species (Conti et al. 1992, 1997; Scoppola & Spampinato 2005; Rossi et al. 2013).

Woodwardia radicans is a conservation target included in Annex II of Directive EEC 43/92 and in the IUCN Red List with the status of “Endangered” for the Mediterranean basin (De Belair 2010) and “Vulnerable” for Europe (Christenhusz et al. 2017). In Sicily, according to IUCN criteria it is considered an “Endangered” species (Spampinato et al. 2008), a status recently confirmed (Crisafulli et al. 2021).

The need for a specific habitat type concerning shady dripping cliffs had already been highlighted by Spampinato & Puglisi (2009) in the drafting of the Italian Manual for the Interpretation of habitats under 92/43 EEC Directive. Up to now the bryo-pteridophytic communities of the class Adiantetalia are not recognized as a habitat of Community interest, although they are important for the conservation of various hygrophilous and rupicolous species.

Due to climate change and the diversion of water flows for agricultural or urban purposes, the extent of this habitat is continuously decreasing in Sicily: for instance, it has disappeared on Mount Etna since a century and is now found exclusively in a few localities in the Peloritani Mountains (Crisafulli et al. 2021).

**Macrotype:** 83 Other rocky habitats

**Name:** Shady dripping cliffs with Woodwardia radicans and other large ferns

**Description:** Dense, three-layered vegetation consisting of a dense moss carpet, thickly covered by the fronds of Adiantum capillus-veneris, in turn loosely covered by the fronds of large ferns, such as Woodwardia radicans, Pteris vittata, Osmunda regalis, Phyllytis scolopendrium, thriving near waterfalls and/or on shady rocky faces located in narrow ravines and gorges, constantly dripping with clear and well oxygenated freshwater (Brullo et al. 1989), in northeastern Sicily (Tyrrenhian side of the Peloritani Mountains, no longer present on Mount Etna), within the thermo- and mesomediterranean bioclimate.

**Diagnostic sentence:** Bryo-pteridophytic communities with large ferns, covering rocky faces located in narrow and shady ravines and gorges within the thermo- and mesomediterranean bioclimate.

**List of diagnostic species:** Woodwardia radicans, Adiantum capillus-veneris, Asplenium scolopendrium, Dryopteris affinis, Osmunda regalis, Pteris cretica, Pteris vittata, Struthiopteris spicant, Bryum pseudotriquetrum (Hedw.) P. Gaertn., B. Mey. Scherb. Eucladium verticillatum (Hedw.) Bruch Schimp., Didymodon tophacens (Brid.) Lisa, Pellia endiviifolia (Dicks.) Dumort., Conocephalum conicum (L.) Underw., Palustrirella commutata (Hedw.) Ochyra, Pilogrammium undulatum (Hedw.) T.J. Kop., Pellia epiphylla (L.) Corda, Thamnobryum alepecurum (Hedw.) Nieuwl. ex Gungale, Rhizomnium punctatum (Hedw.) T.J. Kop.

**Dynamic contacts:** This vegetation may come in contact with the forest communities ascribed to Habitat “9180*: Tilio-Acerion forests of slopes, screes and ravines*, mixed mesophitic broadleaved forests growing on steep rocky slopes or gorges and with the evergreen forests dominated by holm oaks of the habitat “9350 Quercus ilex and Quercus rotundifolia forests”. In areas affected by frequent fires, this habitat may come in contact with secondary woody communities such as tall shrublands dominated by Erica arborea.


7) Birch woodlands of Mount Etna

**Motivation:** The Betula etnensis woodlands of Mount Etna represent the most southern and isolated remnants of a vegetation which spread in Sicily during the cold phases of the Pleistocene and have locally persisted in restricted areas where the summer aridity is buffered by orographic moisture condensation, on well-drained acidic soils. The migration pattern of birch trees developed through southern France and along the Tyrrhenian side of the Apennines and Calabrian Massifs, until reaching Sicily (Agostini, 1981). Here, the isolated populations of birch gave rise to a new lineage, slightly diversified from Betula pendula, as a consequence of geographic isolation and adaptation to the new volcanic habitat (De Dato et al. 2020; Giusso del Galdo et al. 2021).
Owing to the biogeographical interest and the occurrence of narrow endemic species, the habitat dominated by Betula etnensis deserves adequate protection.

**Macrotype**: 92 Mediterranean deciduous forests  
**Name**: Birch woodlands of Mount Etna  
**Description**: Mesophilous, edapho-xerophilous deciduous woodland physiognomically dominated by *Betula etnensis* Rafin., a narrow endemic tree species exclusively found on Mt. Etna, where it was probably more widespread in the past and has been exploited for centuries by local people, mainly for charcoal production (Strano 2010). This deciduous plant community is usually represented by open woods growing on volcanic scoriae, where the soil evolution is hampered by the severe climatic conditions and by the frequent volcanic events, such as tephras. This woodland type ranges between 1400 and 2000 m a.s.l., chiefly on the north-eastern slopes, showing its optimum within the upper supramediterranean humid-hyrophilic bioclimatic belt, with penetrations towards the oromediterranean belt (Brullo et al. 2012). This community exhibits a remarkably pioneer character, occurring within the area potentially occupied by the beech woods of the *Epipactido meridianalis-Fagetum sylvaticae* above 1800 m a.s.l.

**Diagnostic sentence**: Deciduous birch woods of *Betula etnensis*, growing on volcanic scoriae, restricted to the supramediterranean vegetation belt of the north-eastern slopes of Mt. Etna.

**List of diagnostic species**: *Cephalanthera longifolia*, *Adenocarpus bivonae*, *Betula etnensis*. Other frequent species: *Elymus panormitanus*, *Brachypodium sylvaticum*, *Calamagrostis epigejos*, *Festuca circummediterranea*, *Vicia villosa*, *Juniperus communis*, *Juniperus nigra*, *Acer campestre*, *Quercus virgiliana*, *Drymochloa drymeja*, *Juniperus hemisphaeriaca*, *Cytisus scoparius*, *Genista etnensis*, *Pinus nigra* subsp. *calabrca*, *Quercus congesta*, *Erysimum etnense*, *Secale strictum*, *Festuca circummediterranea*, *Juniperus communis*.  

**Dynamic Contacts**: This association comes in contact at lower altitudes with the edapho-xerophilous vegetation of *Daphno lauroleae-Pinetum calabricae*, at higher altitudes with the hedgehog-heaths ascribed to *Astragaleatum siculi* (Bagnato et al. 2014).


8) *Ostrya carpinifolia* woods of Sicily

**Motivation**: Sicily hosts the southwesternmost stands of *Ostrya carpinifolia*. This species is known for having gone through alternate phases of expansion/regression during the late Quaternary vegetation history of the Mediterranean Basin; last maximum expansion occurred between 8000 and 4500 years ago (Willis 1992; Tzedakis 1994; Denéle et al. 2000). The current distribution of the species in Sicily is restricted to steep valley slopes scattered in the main mountain ranges of the island, where it participates to extremely localized broadleaved deciduous mesophilic woods. The high biogeographical interest and the relict connotation of these woods impose to consider them an important conservation target for preserving the Sicilian biodiversity.

**Macrotype**: 92 Mediterranean deciduous forests  
**Name**: *Ostrya carpinifolia* woods of Sicily  
**Description**: Three-layered thermophilous and aero-hygrophilous broadleaved woods, thriving on steep valley slopes, gorges and tributary detrital fans, scattered in the main mountain ranges of Sicily on different soil parental materials, from limestone to acidic metamorphic and volcanic rocks. The canopy is dominated by thermophilous deciduous (with some evergreen) trees, among which *Ostrya carpinifolia* and sometimes *Acer obtusatum* provide the floristic and physiognomic characterization of this habitat. Under conditions of higher edaphic and environmental humidity, *Laurus nobilis* and *Tilia platyphyllos* are also frequent, whereas under greater lighting *Quercus ilex* and *Fraxinus ornus* also play an important role. These woods largely depend on moist and fresh microclimatic conditions and range between 200 and 1200 m a.s.l., with optimum within the meso- and supramediterranean humid bioclimate. This habitat is well represented in the main gorges of the Hyblaean plateau, along the eastern slope of Mount Etna and in the mountain ranges of NE-Sicily (Peloritani and Nebrodi Mts.; Brullo Markenburg 1985; Bartolo et al. 1992; Brullo et al. 1996; Minissale et al. 2007). The scattered occurrence of many isolated spots of *Ostrya carpinifolia* in the mountains near Palermo and on the Sicani Mts. (Markenburg and Ottonello 1993; Ventura et al. 1991; Marino and Iardi 2007; Castellano et al. 2009; Giardina et al. 2015) suggests that this habitat was once more widespread also in western Sicily.

**Diagnostic sentence**: Thermophilous and aero-hygrophilous broadleaved woods with *Ostrya carpinifolia*, colonizing steep valley slopes, gorges, and tributary detrital fans, within the meso- and supramediterranean humid bioclimate.


**Dynamic contacts**: On gently sloping sites, the *Ostrya carpinifolia* woods get in contact with the zonal forest vegetation of the surroundings, often represented by *Erico arboeae-Quercetum virgilianae*, *Sorbo torminalis-Quercetum virgilianae*, *Aceri campestri-Quercetum ilicis*, *Vicio cassubicae-Quercetum cerridis*, *Agropyro panora*.
mitani-Quercetum congestae, Arabido turritae-Quercetum congestae, Doro
tico orientali-Quercetum ilicis, Teucrio siculi-Quercetum ilicis, Ampelodesmo
mauritanici-Quercetum ilicis. Contacts are also established with the como
phytic vegetation of Bartramio-Polypondion cambrici and with the chasmophytic
vegetation of Tannobryo alopecu-
ri-Phyllitidetum scopolendri, which colonize the outcrop
ning rocks within the association.

**Phytosociological arrangement:** Aceretum obtusati-Os
tryetum carpinifoliae Brullo Marcenò 1985, Arabido
turritae-Quercetum congestae Brullo Marcenò 1985, Hi
eracio criniti-Acetetum actensis Brullo C. et al. 2012 [Til
io-Ostryon carpinifoliae Brullo, Scelsi Spampinato 2001,
Fagetalia sylvaticae Pawlowski in Pawlowski et al. 1928,
Carpino-Fagetetum sylvaticae Jacuks Passarge 1968]; Ostro
y carpinifoliae-Quercetum ilicis Lapraz 1975 [Fraxino or-
ni-Quercion ilicis Biondi, Casavecchia et Gigante in Bion-
di et al. 2013, Quercetalia ilicis Br.-Bl. ex Moliner 1934,
Quercetea ilicis Br.-Bl. ex A. Bolòs et O. de Bolos in A.
Bolòs y Vayreda 1950].

**Discussion**

The combination of a phytosociological and phyto
geographical approach to habitat recognition represents
a convenient way to resolve the conundrum of habitat
identification. However, some appropriate additions to
the Habitat Directive would be highly desirable to ensure
adequate and explicit protection to the Sicilian habitats
listed above, that host rare species of phytogeographic
interest, highly localized edaphic specialists and, also,
historical rural landscapes shaped by traditional land uses.

Some of these habitats have been forced into compara-
ble units already codified by Directive 92/43 (http://vnr.
unipg.it/habitat/). However, an excessive "stretching" in
the habitat interpretation leaves room for ambiguity and
uncertainties in the correct identification and designation
of the conservation targets (Pasta La Mantia 2009).

For example, the recognition of the habitat here pro-
posed as "Meso- and supramediterranean acidophilous
Sicilian broomfields" would eliminate the interpretative
impasse that forces some of these formations, either,
into habitat 5330 (Thermo-Mediterranean and pre-des-
tert scrub), together with thermomediterranean broom
fields (retamares) in Sicily represented by coastal forma-
tions dominated by Retama raetam subsp. guisonei or by
Genista tyrrenhena, or, instead, into habitat 4090 (Endemic
oro-Mediterranean heaths with gorse), together with the
high-mountain vegetation dominated by Astragalus sicu-
lus or A. nebrodensis.

Similarly, the recognition of the habitats here proposed
as "Mud volcanoes and badlands in the evaporitic out-
crops of Sicily" and "Sicilian gypsum outcrops" would
allow to consider as a whole the mosaic of contiguous
habitats that characterize these so peculiar geomorpho-
logical units (similarly to what happens with the Habitat
8320 "volcanic outcrops and lava fields"). This would en
sure better protection also to the vegetation dominated
by some endemic taxa, such as Tripolium sorrentinoin
(Asteretum sorrentinii, see Brullo et al. 2010) or Astragalus
caprinus subsp. huetii (Astragalus huetii-Ampelodesmetum
mauritanici, see Minissale 1995), currently lumped into
the omni-comprehensive and ubiquitous habitat 6220
(Pseudo-steppe with grasses and annuals of the The-
ro-Brachypodietea).

The choice of using a "geology-based" criterion to
circumscribe the two above-mentioned habitats is jus
tified by the difficulty of separating the tiles of a mosaic
in which vegetation units ascribed to different phytoso-
ciological classes (such as Peganeto-Salsoletea, Lygeo-Stipe-
tea, Saginetea maritimae, Thero-Brachypodietea, Juncetea
maritimi and others) intermingle in very close spatial
contiguity. The opportunity to propose as autonomous
some of these vegetation units would require an in-depth
comparative analysis of their physiognomic and structural
characteristics, which is not always available apart few
exceptions (Brullo et al. 2013; Marcenò et al. 2019) and is
adventurous to pretend from an instrument, i.e. the Hab-
itat Directive, whose main purpose is identifying conser-
vation targets in the easiest and most practical possible
way. Moreover, designating mud volcanoes and badlands
as a whole habitat allows to safeguard the landscape uni-
cum and its root causes, which are eminently geological,
and to ensure an unitary impact assessment to any project
of "hydraulic-forestry amelioration" with accacias or euc-
alyptuses or, worst, to any transformation of these sites into
landfills, photovoltaic power plants, go-cart tracks and, in
the case of gypsum outcrops, also into intensive vineyards
after gypsum-grinding.

The habitat "mud volcanoes and badlands in the evap-
oritic outcrops of Sicily" is akin to the habitat already
proposed (Genovesi et al. 2014) as "halophilous and/or
subalophilous pioneer vegetation in badlands". However,
the badlands of Peninsular Italy host a somewhat different
vegetation from that of Sicily, as it lacks the shrub com-
ponent typical of the Peganeto-Salsoletea class. Therefore,
it was decided to propose a new habitat for Sicily.

Also, the habitat "Ostrya carpinifolia woods of Sicily" is
similar the habitat already proposed (Genovesi et al. 2014)
as "hop-hornbeam Italo-Balkan woods". However, the
latter has a floristic composition and ecological settings
quite different from those in Sicily and, with reference to
the EUNIS habitat classification, it is to be classified
among the “temperate and submediterranean thermo-
philous deciduous forest” (code: G1.7a) rather than the
“Mediterranean thermophilous deciduous forest” (code:
G1.7b), as it happens for the Sicilian stands.

Lastly, the habitat "Shady dripping cliffs with Wood-
wardia radicans and other large ferns" is similar to the
habitat “Mediterranean dripping cliffs”, also present in Sic-
ily and already proposed (Spampinato and Puglisi 2009;
Genovesi et al. 2014) to be integrated into the Habitats
Directive. However, it is considered appropriate to treat as
a separate habitat the Adiantetea vegetation characterized
by the presence of large ferns (such as Woodwurdia radi-
People’s perception of protected areas is, in most of the cases, limited to the recreational or aesthetic function of biotopes and biodiversity: a kind of “playground for ecologists” that can be used for outdoor activities and experiential marketing. This limited view should be widened through the use of protected areas as living labs for the environmental education, to raise the public awareness on the function of ecosystems. Unfortunately, managers and planners seem to be much more sensitive to the marketing and promotion of typical products and to the construction of infrastructure to improve accessibility and usability of these areas. This is not necessarily a negative aspect, but it can be so if it becomes the priority target for the development of protected areas (Guarino 2021). Too many habitats and natural sceneries have been irremediably spoiled by senseless interventions to “improve” accessibility and usability. This is the case, for example, of the renowned Etnean “Rifugio Sapienza” and surrounding areas, where thousands of absent-mindedly tourists are brought on Mt. Etna “to walk on the lava”, with best regards to the superficiality that already characterizes the average way of living of the urban people.

The only way to contrast these dangerous shortcuts is a correct and unambiguous designation of the conservation targets, accompanied by appropriate conservation measures, management plans, prioritized action framework, monitoring and periodical updating of the Habitat Directive in the light of the new achievements emerging from territorial research and thematic in-depth studies. Last but not least, substantial resources have to be invested in education and dissemination campaigns, in order to reach a societal consensus on the need for conservation of the Natura 2000 sites and the Sicilian biodiversity in general.

Conclusions

Aim of every protected area in the world is to promote in situ conservation strategies for threatened habitats and species. This should be done by the set up of a network of stakeholders, administrators and scientific experts which will support capacity building, management and policy actions. Unfortunately, these intentions are inevitably constrained by the lack of scientific knowledge on the ecosystem functioning and by the reality of limited economical resources. Conservation must therefore be based on the establishment of priorities, in order to determine how these limited resources could be best allocated (Guarino et al. 2011).


Lodi J, Ortega M, Orrantia O (2007) Vegetation science and the implementation of the habitat directive in Spain: up-to-now experiences and further development to provide tools for management. Fitosociologia 44(2, suppl. 1): 9–16


