ARTICLES

Mediterranean Botany
ISSNe 2603-9109

EDICIONES COMPLUTENSE

https://dx.doi.org/10.5209/mbot.61002

Wetland vegetation of the Tarsia Lake Regional Nature Reserve (Calabria, southern Italy)

Giovanni Maiorca[1] Alessandro Crisafulli[2], Domenico Puntillo[3], Giuseppe Signorino[4] & Giovanni Spampinato[5]

Received: 28 January 2019 / Accepted: 28 January 2020 / Published online: 6 March 2020

Abstract. A phytosociological analysis of Tarsia Lake Regional Nature Reserve was carried out within a research project dealing with the vegetation of southern Italian wetlands. Twenty-four plant communities (19 associations and five communities not yet assigned to formal rank) were attributed to 17 alliances, 14 orders, and 11 classes. Most associations resulted as common in the Mediterranean area; however, as a response to the peculiarity of the local climatic and edaphic factors, some phytocoenoses were found as typical throughout central Europe but not observed in southern Italy, yet. Currently, this area is preserving a considerably interesting flora and vegetation for both naturalistic and phytogeographic reasons. Therefore, an appropriate monitoring and protection plan is needed in order to counteract the ongoing severe anthropogenic pressure.
Keywords: Calabria; southern Italy; Tarsia Lake; wetland vegetation.

Contribución al conocimiento de la vegetación de los humedales de Calabria (sur de Italia): la Reserva Natural Regional del Lago di Tarsia

Resumen. Como parte de un plan de investigación para la vegetación de humedales del sur de Italia, se realizó un análisis fitosociológico de la Reserva Natural Regional del Lago de Tarsia. Veinticuatro comunidades (19 asociaciones y cinco comunidades) han sido asignadas a 17 alianzas, 14 órdenes y 11 clases. La mayoría de las asociaciones resultan comunes en el área mediterránea. No obstante, en respuesta a los factores climáticos y edáficos particulares, en el área de estudio hay algunas fitocenosis típicas de Europa central, que aún no se han observado en el sur de Italia. Actualmente, esta área conserva una flora y vegetación de considerable interés naturalista. Por consiguiente, se necesita un plan adecuado de monitoreo y protección para contrarrestar la presión antropogénica severa.
Palabras clave: Calabria; sur de Italia; Lago de Tarsia; vegetación de humedales.

Introduction

Wetland ecosystems include an important piece of European biodiversity. They provide ecological feasibility to a number of habitats, thus allowing, for instance, a remarkable animal species diversity: birds can take advantage of nesting and migratory flyway areas as well as dragonflies and amphibians find suitable living conditions in such places (Silva *et al.*, 2007). As a consequence of a strong climatic variability, the number of wetland types in the Mediterranean area is high, ranging from large river deltas and lagoons along the North shore to salty and temporary marshes in the South, where water occurs only for a few months.

Many plants find suitable living conditions only in wet places, which are therefore unique habitats for protection of rare and threatened plant species and communities, then requiring priority actions for conservation (Silva *et al.*, 2009; Molina *et al.*, 2009). Unfortunately, over the last 100 years, the Mediterranean coast area has lost about half wetland habitats, as a result of several forms of anthropogenic pressures (Silva *et al.*, 2007). Human-mediated activities also made wetland habitats highly vulnerable to invasion by alien plants (Liendo *et al.*, 2016) and induced palustrine ecosystems to decline (Gigante *et al.*, 2014; Lastrucci *et al.*, 2017).

In order to develop the knowledge on wetlands vegetation, several Italian and European projects and initiatives have been launched, such as MedWet (2018), WetVegEurope (2018), etc. The wetland flora and vegetation of southern Italy have recently induced a deeper scientific interest, and studies have been carried out to increase the knowledge of these particular ecosystems, especially in Sicily (Brullo & Furnari, 1976; Barbagallo *et al.*, 1979; Minissale & Spampinato, 1987; Brullo & Spampinato, 1990; Brullo *et al.*, 1994; Brullo

[1] Regional Agency for Agricultural Development of Calabria (ARSAC). Viale Trieste 95. I-87100 Cosenza. Italy. Email: herbarium.meridianum@gmail.com
[2] Department of Chemical, Biological, Pharmaceutical and Environmental Science, University of Messina. Viale Stagno d'Alcontres 31, I-98166 Messina. Italy. Email: acrisafulli@gmail.com
[3] Natural History Museum and Botanical Garden, University of Calabria. I-87030 Arcavacata di Rende. Italy. Email: domenicopuntillo@virgilio.it
[4] 153 Annandale Rd. SE10 0JY London. United Kingdom. Email: forest.signorino@gmail.com
[5] Department of Agraria, Mediterranean University of Reggio Calabria. Loc. Feo di Vito. I-89124 Reggio Calabria. Italy. Email: gspampinato@unirc.it

& Sciandrello, 2006; Pavone *et al.*, 2007; Sciandrello *et al.*, 2016; Minissale *et al.*, 2017; Guarino *et al.*, 2019), but also in Apulia (Beccarisi *et al.*, 2006, 2007; Ernandes *et al.*, 2006, 2007, 2008, 2017; Di Pietro *et al.*, 2009; Ernandes & Marchiori, 2013) and Campania (La Valva & Astolfi, 1988; Gafta, 1991; Pedrotti & Gafta, 1992; Strumia, 2004).

In Calabria, wetlands have been studied mainly in protected areas (Brullo & Spampinato, 1997, 1999; Brullo *et al.*, 2001, 2003; Bernardo *et al.*, 2002, 2012; Maiorca *et al.*, 2002, 2005, 2007; Caridi *et al.*, 2006; Gargano *et al.*, 2007; Cameriere *et al.*, 2008; Gangale & Uzunov, 2014; Spampinato *et al.*, 2019). Although the number and width of such habitats have been significantly reduced over the last century as a consequence of land reclamation and anthropogenic activities, especially in coastal areas, nevertheless we can still observe some such areas preserving hygrophilous plant communities, where very rare and peculiar species are growing (Cesca & Peruzzi, 2001; Spampinato *et al.*, 2007).

As a part of a research carried out within the Calabrian wetland vegetation, a specific study was implemented in the marshland of Tarsia Lake Regional Nature Reserve.

Materials and Methods

Study area

Tarsia Lake is an artificial basin used for crop irrigation during summer, where hygrophilous vegetation occurs differing from those observable in close places under more natural conditions. It was originated after a dam building in the Middle Valley of the River Crati, close to Tarsia village (Figure 1). A plant biodiversity mapping of Tarsia Lake and neighboring areas had previously carried out (Maiorca *et al.*, 2013; Caridi *et al.*, 2015).

Figure 1. Topographic map of Tarsia Lake area.

The lake supplies water for crop irrigation in the Sibari Plain, primarily citrus orchards. In the past, during the maximum summer flood, the basin covered an area of about 170 hectares, thus supplying a volume of 16 million m^3 of water (maximum depth of the lake: 9 m). Currently, due to salting, the volume decreased to 6 million m^3, with an average depth of 1.82 m (Infusino *et al.*, 2014). The water level varies according to dam opening and closing over the year. Over winter, the dam is open, and the lake is empty; at the beginning of spring, you can see a wide swamp crossed by the meanders of the Crati River, where the marsh vegetation grows. Then, in March, the dam is closed, and over summer the lake fills up completely. Consequently, only a small surface of the marsh area remains visible. The geological substratum of the Tarsia lake is characterized by Holocene deposits of sand and clay, rarely gravelly (Anon., 1958–1962).

The climate of the study area is typically Mediterranean, the climate diagram (Figure 2) showing an average annual temperature of 16°C and an average annual rainfall of 762.8 mm, especially distributed between autumn and winter, with a summer dryness of 3.5 months (Maiorca *et al.*, 2013). According to Rivas-Martínez (1996–2019), the bioclimate is Mediterranean Pluviseasonal oceanic, with a lower mesomediterranean thermotype and a lower subhumid ombrotype. For more details, see also Pesaresi *et al.* (2014).

The waters of the lake are generally eutrophic to mesotrophic, with a salt content that may vary depending on weather conditions (Chidichimo, 1991). The seasonality of the Tarsia basin induces periodic cycles of phosphorus accumulation and erosion. Furthermore, these artificial waters, compared to the natural, show a lower susceptibility to eutrophic phenomena due to water withdrawal from the bottom, which allows the mass of water to be renewed (Infusino *et al.*, 2014).

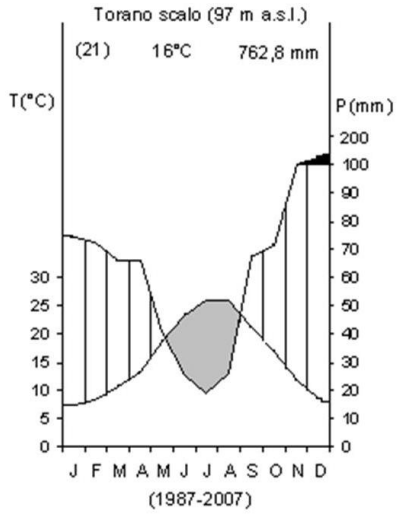

Figure 2. Climate diagram of Torano Scalo meteorological station.

Data collection and analysis

From 2009 to 2015, 78 unpublished relevés of vegetation were carried out according to the phytosociological method (Pignatti & Mengarda, 1962; Braun-Blanquet, 1964). The phytosociological approach, as well as the correspondence of vegetation to local phyto-toponyms, has been considered as an useful tool for the natural resources management, according to various authors (Brullo *et al.*, 1999; Cano *et al.*, 2017; Piñar Fuentes *et al.*, 2017; Pott, 2011; Spampinato *et al.*, 2017, 2018; Vila-Viçosa *et al.*, 2015).

Major importance was given to the minimum surface of each relevé, in order to avoid detecting ecotones or mosaics, which are very frequent in wetland vegetation. Abundance coefficients were transformed into the ordinal scale, according to Van der Maarel (1979). The multivariate analysis of relevés was performed using SYN-TAX 2000 software (Podani, 2001). A hierarchical classification method (UPGMA) was performed using the chord distance coefficient as a measure of relevès dissimilarity. A single relevé of *Salicetum albo-brutiae* was reported from literature (Brullo & Spampinato, 1997): it was not included in the cluster analysis. The groups of relevés, resulting from the hierarchical classification, were arranged in seven tables, corresponding to the types of wetland vegetation observed. The syntaxonomical nomenclature followed the Code of Phytosociological Nomenclature (Weber *et al*., 2000). The syntaxonomical system proposed by Biondi *et al*. (2014) for Italy was mainly adopted, as integrated by Mucina *et al.* (2016). The plants listed in the tables were identified based on Flora d'Italia (Pignatti, 2017-2018). Plant nomenclature was the same as in Bartolucci *et al.* (2018) for native species, and Galasso *et al.* (2018) for the alien species. The non-vascular plant nomenclature was used according to Cortini-Pedrotti (2001-2006) for *Bryophyta*, and Guiry & Guiry (2018) for *Xanthophyceae*. Subspecific names were reported only when differing from nominal.

Results and Discussion

The hierarchical classification recognized 25 groups of relevés (dissimilarity value: 0,9; Figure 3). 24 groups corresponded to 19 associations and five communities not assigned to formal rank; one group corresponded to a variant of the *Holoschoenetum vulgaris* association (see Table 6). On the whole, 24 plant communities were identified and attributed to 17 alliances, 14 orders, and 11 classes.

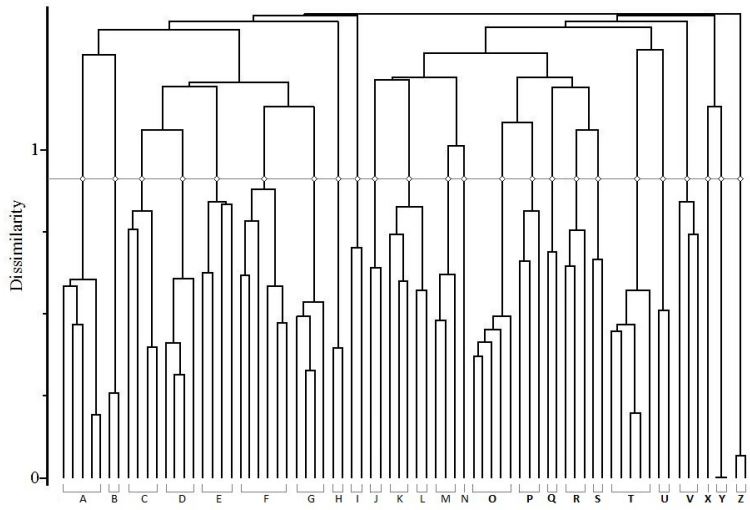

Figure 3. Dendrogram resulting from the cluster analysis of relevés. A, *Riccia glauca* comm.; B, *Botrydietum granulati*; C, *Rumici maritimi-Ranunculetum scelerati*; D, *Callitrichetum palustris*; E, *Helosciadietum nodiflori*; F, *Filaginello uliginosae-Veronicetum peregrinae*; G, *Limosella aquatica* comm.; H, *Charetum vulgaris*; I, *Isoëtetum duriei*; J, *Polygono salicifolii-Phragmitetum comunis*; K, *Typhetum angustifoliae*; L, *Typho angustifoliae-Schoenoplectetum tabernaemontani*; M, *Typhetum latifoliae*; N, *Sparganium neglec*tum comm.; O, Bidenti tripartitae-Polygonetum mitis; P, *Galio elongati-Juncetum inflexi*; Q, *Loto tenuis-Paspaletum paspaloidis*; R, *Holoschoenetum vulgaris*; S, *Holoschoenetum vulgaris* var. with *Juncus inflexus*; T, *Polygono lapathifolii-Xanthietum italici*; U, *Salix alba* and *Populus alba* comm.; V, *Tamarix africana* comm.; X, *Ceratophylletum demersi*; Y, *Potamogetonetum nodosi*; Z, *Lemnetum gibbae*.

Submerged, free-floating and rooted-floating aquatic vegetation

Charetum vulgaris Corillion 1957 (Table 1, rel. 1, 2). A submerged aquatic plant community characterised by the dominance of *Chara vulgaris* (*Charophyta*). The *Chara sp.pl.* associations are generally linked to oligo-mesotrophic stagnant waters, shallow (up to 3 m), limpid, and rich in nutrients, but relatively poor in phosphates that inhibit their development (Hrivnák *et al.*, 2005). This association colonises submerged pools in Tarsia Lake over spring, whereas it decreases or disappears over summer due to maximum flooding.

Lemnetum gibbae Miyawaki et J. Tüxen 1960 (Table 1, rel. 3, 4). An annual association of pleustophytic plant, with a thick floating layer of *Lemna gibba*. It is usually located in areas smaller than 1 m^2. *Lemna gibba* and *Spirodela polyrrhiza* have an ecological optimum in stagnant eutrophic waters with a high level of phosphates and basic pH (Sburlino *et al.*, 2004). This association is widespread in Europe (Šumberová, 2011a), but it is not common in southern Italy since reported only in Sicily (Brullo *et al.*, 1994) and in Calabria (Crisafulli *et al.*, 2010).

Ceratophylletum demersi Hild 1956 (Table 1, rel. 5). A floating submerged plant community dominated by *Ceratophyllum demersum*, located on the upmost layers of the waterbody. This association shows a summer vegetative development and prefers shallow eutrophic waters, steading or slightly flowing. *Ceratophyllum demersum* is a euriecious species that endure a wide range of ecological conditions, as anoxia or high temperature of the water during summer. It is often located on water bodies influenced by human activities causing eutrophication and turbidity of water (Rodwell, 1995; Maiorca *et al.*, 2007).

Table 1. Submerged, free-floating and rooted-floating aquatic vegetation. *Charetum vulgaris* Corillion 1957 (rel. 1,2) (*Charion vulgaris*, *Charetalia hispidae*, *Charetea fragilis*) *Lemnetum gibbae* Miyawaki et J. Tüxen 1960 (rel. 3,4) (*Lemnion minoris*, *Lemnetalia minoris*, *Lemnetea minoris*); *Ceratophylletum demersi* Hild 1956 (rel. 5), *Potamogetonetum nodosi* (Soó 1960) Segal 1964 (rel. 6,7) (*Potamogetonion pectinati*, *Potamogetonetalia pectinati*, *Potamogetonetea pectinati*); *Callitrichetum palustris* (Dihoru 1975 n.n.) Burescu 1999 (rel. 8-11) (*Ranunculion aquatilis*, *Callitricho hamulatae-Ranunculetalia aquatilis*, *Potamogetonetea pectinati*)

Altitude (m asl)	50	50	50	50	50	50	50	50	50	50	50
Plot size (m^2)	0,5	0,5	0,5	0,5	5	5	5	5	5	5	5
Cover (%)	100	100	100	100	100	90	90	90	90	90	90
Species N.	2	3	2	2	3	2	2	5	4	4	4
Relevé N.	1	2	3	4	5	6	7	8	9	10	11
Characteristics of associations											
Chara vulgaris	4	4	.	.	.	.	.	.	.	.	.
Lemna gibba	.	.	3	4	.	.	.	.	.	.	.
Spirodela polyrhiza	.	.	3	3	.	.	.	.	.	.	.
Potamogeton nodosus	.	.	.	.	1	4	4	.	.	+	.
Callitriche palustris	.	1	.	.	.	.	.	5	5	4	5
Ceratophyllum demersum	.	.	.	.	4	.	.	.	.	.	.
Other species											
Phragmites australis	.	.	.	.	+	+	+	.	.	.	.
Glyceria notata	.	.	.	.	.	.	.	1	+	.	1
Juncus hybridus	.	.	.	.	.	.	.	2	1	2	.
Paspalum distichum	+	.	.	.	.	.	.	.	+	.	.
Rumex maritimus	.	.	.	.	.	.	.	.	.	+	+

Other species: *Veronica anagallis-aquatica* + in 2; *Scrophularia nodosa* +, *Symphyotrichum squamatum* 1 in 8; *Helosciadium nodiflorum* 1 in 11.

Localities: 1,2: Marinetto, 30.04.2012; 3,4: C.da Pellizzari, 14.07.2015; 5: Macchia d'Acci, 14.07.2015; 6,7: C.da Pellizzari, 14.07.2015; 8-11: Marinetto, 14.07.2015.

Potamogetonetum nodosi (Soó 1960) Segal 1964 (Table 1, rel. 6, 7). A rooted-floating aquatic plant community dominated by *Potamogeton nodosus,* which forms a uniform and laminar layer of floating leaves, from which the inflorescences emerge. In Tarsia Lake this phytocoenosis is monospecific and is related to shallow waters, muddy and rich in organic material, slowly flowing but not stagnant (Maiorca *et al.*, 2007). This association is affected by water level variations, and it is present over summer when the lake is filled up.

Callitrichetum palustris (Dihoru 1975 n.n.) Burescu 1999 (Table 1, rel. 8–11). A submerged plant community dominated by *Callitriche palustris*. In the study area, it is sporadically associated with submerged forms of some helophytes, such as *Veronica anagallis-aquatica* e *Glyceria*

notata. This phytocoenosis achieves the highest level of development between late winter to spring. It prefers clear, oligotrophic waters, at pH 7-8, stagnant, or slow-flowing (Schotsman, 1967). In spring, *Callitriche palustris* grows on very damp muds showing a particular emerged *habitus*.

Thallophytic communities on silty soils

Riccia glauca community (Table 2, rel. 1–5). A bryophyte-dominated community characterized by *Riccia glauca*, associated with *Physcomitrella patens*, *Sphaerocarpus globosus,* and *Physcomytrium pyriforme*. This is a pioneer community growing in spring on eutrophic silty loams with basic pH, very damp but not submerged. This community shows similarities with *Riccio cavernosae-Physcomitrelletum patentis* All. ex v. Hübschm. 1957 corr. v.d. Dunk 1972, widespread in European countries and also reported in northern Italy (Cortini Pedrotti & Aleffi, 1990), and in other Italian associations with *Riccia sp. pl.* (Puglisi *et al.*, 2015).

Botrydietum granulati Hübschmann 1957 (Table 2, rel. 6, 7). A phytocoenosis spread on silty soils, characterised by the dominance of *Botrydium granulatum* (*Ochrophyta*), with a sporadic presence of *Riccia glauca*. *Botrydium granulatum* is widespread in irrigated soils, banks of ponds, lakes, and rivers of central Europe (Ettl, 1978). In the study area, this phytocoenosis come into contact with *Riccia glauca* communities, sharing many ecological characteristics. However, *Botrydietum granulati* needs more humidity or a longer period of water submersion. This association is known for northern Italy (Cortini Pedrotti & Aleffi, 1990) and Abruzzo (Aleffi, 1992) and it is reported for the first time in Calabria.

Table 2. Thallophytic communities on silty soils. *Riccia glauca* comm. (rel. 1-5); *Botrydietum granulati* Hübschmann 1957 (rel. 6,7) (*Physcomitrellion patentis*, *Diplophylletalia albicantis*, *Cladonio digitatae-Lepidozietea reptantis*)

Plot size (dm^2)	1	1	1	4	4	4	4
Altitude (m asl)	53	53	53	53	53	53	53
Cover (%)	80	90	90	100	100	40	80
Species N.	7	6	6	6	6	6	5
Relevé N.	1	2	3	4	5	6	7
Characteristics of associations or communities							
Riccia glauca	2	2	1	4	5	1	1
Physcomitrella patens	.	3	2	2	2	.	.
Botrydium granulatum	.	.	.	.	.	4	5
Characteristics of upper units							
Physcomitrium pyriforme	3	3	3	4	3	.	.
Sphaerocarpos michelii	1	2	2	.	1	.	.
Other species							
Veronica peregrina (seedlings)	+	1	1	+	+	+	+
Gnaphalium uliginosum	+	.	.	+	+	.	.
Juncus hybridus	+	+	+	.	.	.	.
Myosurus minimus	.	.	.	.	.	1	+
Veronica anagallis-aquatica (seedlings)	.	.	.	.	.	+	+
Cardamine parviflora	.	.	.	.	+	+	.

Other species: *Spergularia bocconei* + in 1; *Callitriche palustris* 2 in 4; *Nostoc* sp. + in 5.
Localities: 1-7: Marinetto, 30.04.2012.

Pioneer ephemeral vegetation of temporary ponds and muds

Isoetetum duriei Br.-Bl. 1935 (Table 3, rel. 1, 2). A spring-time temporary plant community dominated by *Isoëtes duriei* and *I. histrix*. It is localized on small surfaces, fast drying in spring. This phytocoenosis is linked to a Meso-mediterranean bioclimate with a circum-Mediterranean distribution (Brullo & Minissale, 1998). It has been detected on acidic soil in small damp depressions inside the garrigues with *Cistus monspeliensis*, surrounding the lake.

Filaginello uliginosae-Veronicetum peregrinae Molero Brion. & Romo 1988 (Table 3, rel. 3–8). Hygro-Nitrophilous paucispecific vegetation growing in spring on moist sandy silts structured by annual species, where the neophyte *Veronica peregrina* shows high coverage values. In summer, this association should be replaced by the *Bidentetea* plant communities on drained soil, but this does not happen to the study area due to the summer submersion of the lake shores (Figure 3). This phytocenosis, described in Catalonia (Molero Briones & Romo, 1988), was not yet known in Italy, although *Veronica peregrina* is already known to the flora of many Italian regions (Galasso *et al*., 2018).

Limosella aquatica community (Table 3, rel. 9–12). *Limosella aquatica* is an annual plant growing on muddy margins of ponds and lakes, ditches and streams, along paths and in

temporary pools (Ali & Rhazi, 2010). It prefers mesotrophic to eutrophic substrata rich in nourishing elements. This community shows floristic affinities with the associations of the *Nanocyperetalia* found in this area. However, there are no characteristic species of *Limosella aquatica* associations known to European territory with temperate bioclimates. In these territories *Limosella aquatica* characterizes many communities distributed on marshy environments, often peaty, or along the rills and the bays of lakes with weakly flowing waters (Brullo & Minissale, 1998).

Table 3. Pioneer ephemeral vegetation of temporary ponds and muds. *Isoëtetum duriei* Br.-Bl. 1935 (rel. 1,2) (*Isoëtion durieui*, *Isoëtetalia durieui*, *Isoëto-Nanojuncetea*); *Filaginello uliginosae-Veronicetum peregrinae* Molero Brion. & Romo 1988 (rel. 3-8) (*Nanocyperion flavescentis*, *Nanocyperetalia flavescentis*, *Isoëto-Nanojuncetea*); *Limosella aquatica* comm. (rel. 9-12) (*Eleocharition soloniensis*, *Nanocyperetalia flavescentis*, *Isoëto-Nanojuncetea*).

Altitude (m asl)	60	60	53	54	54	53	53	53	53	53	53	53
Plot size (m^2)	0	0	1	1	1	1	1	1	1	1	0	0
Exposure	E	SE	-	-	-	-	-	-	-	-	-	-
Slope (°)	8	5	-	-	-	-	-	-	-	-	-	-
Cover (%)	40	70	50	80	90	70	70	80	50	30	75	50
Species N.	3	8	11	14	18	9	7	6	8	6	6	6
Relevé N.	1	2	3	4	5	6	7	8	9	10	11	12
Characteristics of associations and communities												
Isoëtes durieui	1	2	.	.	.	.	.	.	.	.	.	.
Isoëtes histrix	.	+	.	.	.	.	.	.	.	.	.	.
Veronica peregrina	.	.	3	4	4	4	3	5	1	+	2	1
Gnaphalium uliginosum	.	.	+	.	+	+	2	3	.	.	.	.
Limosella aquatica	.	.	.	.	.	.	.	.	3	3	3	3
Characteristics of upper units												
Juncus hybridus	.	.	4	4	2	+	1	.	1	1	3	2
Alopecurus aequalis	.	.	2	2	1	+	.	2	,	1	1	+
Myosurus minimus	.	.	.	3	3	.	.	.	+	.	.	.
Spergularia bocconei	.	.	.	1	1	+	.	.	.	.	.	.
Mentha pulegium	.	.	.	+	.	.	.	.	.	.	.	.
Aira elegantissima	+	.	.	.	.	.	.	.	.	.	.	.
Juncus capitatus	.	+	.	.	.	.	.	.	.	.	.	.
Other species												
Rumex maritimus	.	.	+	1	+	1	1	1	1	1	.	.
Veronica anagallis-aquatica	.	.	+	1	+	2	1	1	1	.	+	1
Cardamine parviflora	.	.	1	2	2	1	2	2	+	.	.	.
Callitriche palustris	.	.	.	+	.	.	.	.	1	1	1	1
Medicago polymorpha	.	.	+	.	2	.	.	.	.	.	.	.
Trifolium campestre	.	.	.	+	+	.	.	.	.	.	.	.
Calendula arvensis	.	.	.	+	+	.	.	.	.	.	.	.
Trifolium nigrescens	.	.	.	+	1	.	.	.	.	.	.	.
Trifolium resupinatum	.	.	.	.	2	1	+	.	.	.	.	.

Other species: *Euphorbia helioscopia* + in 1; *Sherardia arvensis*, *Serapias lingua*, *Bellis annua*, *Lysimachia arvensis* and *Selaginella denticulata* + in 2;, *Helosciadium nodiflorum* and *Rorippa palustris* +, *Juncus articulatus* 1 in 3; *Nasturtium officinale* + in 4; *Poa annua*, *Raphanus raphanistrum* and *Rhagadiolus stellatus* +, *Trifolium fragiferum* 3 in 5.

Localities: 1,2: provincial road 197, Km 1, 22.01.2012; 3: Marinetto, 18.03.2009; 4,5: Casa Scarola, 16.04.2009; 6-12: Marinetto, 30.04.2012.

Hygro-nitrophilous pioneer vegetation of muddy-sandy river-bed

Bidenti tripartitae-Polygonetum mitis (Roch. 1951) T. Tüxen 1979 (Table 4, rel. 1–5). A nitrophilous therophytic plant community, observed in summer, on loamy and wet soils with high water availability. In the study area, it is characterized by *Bidens frondosa*, as a variant of the *Bidenti tripartitae-Polygonetum mitis* association, reported for most of Italian territory (Pedrotti, 1988; Venanzoni & Gigante, 2000) and in Calabria, for the mouth of the Crati river (Maiorca *et al*., 2005, 2007). In addition to *Bidens frondosa*, this association is enriched with alien species, such as *Eclipta prostrata*, *Symphyotrichum squamatum,* and *Cyperus eragrostis*.

Rumici maritimi-Ranunculetum scelerati Oberdorfer 1957 (Table 4, rel. 6–9). It is an annual therophytic association growing from spring to summer on clayey-muddy soils, dry in summer, and with high levels of nitrates, as well as many other *Bidentetea* associations (Biondi *et al.*, 2014). *Ranunculus sceleratus* and *Rumex maritimus* are abundant together with many other less widespread species, among which the rare euro-Asiatic *Cardamine parviflora* should be remembered. *Rumici maritimi-Ranunculetum scelerati* is well distributed in Eurasian countries, mainly in eastern Europe (Šumberová, 2011b).

Table 4. Hygro-nitrophylous pioneer vegetation of muddy-sandy river-bed. *Bidenti tripartitae-Polygonetum mitis* (Roch. 1951) T.Tüxen 1979 var. with *Bidens frondosa* (rel. 1-5), *Rumici maritimi-Ranunculetum scelerati* Oberdorfer 1957 (rel. 6-9) (*Bidention tripartitae*, *Bidentetalia tripartitae*, *Bidentetea tripartitae*); *Polygono lapathifolii-Xanthietum italici* Pirola & Rossetti 1974 (rel. 10-14) (*Chenopodion rubri*, *Bidentetalia tripartitae*, *Bidentetea tripartitae*)

Altitude (m asl)	54	54	54	54	54	53	53	53	53	58	58	55	55	55
Plot size (m^2)	15	15	15	15	15	25	25	25	25	25	25	25	25	25
Cover (%)	80	80	90	90	80	80	95	100	100	80	80	90	90	80
Species N.	16	13	16	15	16	10	12	13	12	12	12	11	10	11
Relevé N.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Characteristics of associations														
Persicaria dubia	2	1	1	1	2	.	.	.	.	.	.	.	.	.
Bidens frondosa	4	4	2	3	2	.	.	.	.	.	.	.	.	.
Rumex maritimus	.	.	.	.	.	4	3	3	4	.	.	.	.	.
Ranunculus sceleratus	.	.	.	.	.	+	3	4	2	.	.	.	.	.
Alopecurus aequalis	.	.	.	.	.	1	3	3	2	.	.	.	.	.
Xanthium italicum	.	.	.	.	.	.	.	.	.	3	4	4	3	2
Characteristics of upper units														
Persicaria lapathifolia	2	1	1	2	1	.	.	.	.	+	2	2	1	3
Rumex sanguineus	1	1	2	1	2	.	.	.	.	.	.	.	.	.
Rumex crispus	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dittrichia viscosa	.	.	.	.	.	.	.	.	.	2	3	3	4	2
Artemisia verlotiorum	.	.	.	.	.	.	.	.	.	2	2	3	1	1
Bidens tripartita	.	.	.	.	.	.	.	.	.	1	+	+	1	2
Tussilago farfara	.	.	.	.	.	.	.	.	.	+	+	+	1	+
Other species														
Mentha aquatica	2	2	2	2	2	.	.	.	.	+	+	1	.	1
Holcus lanatus	1	1	+	1	+	.	.	.	.	+	1	1	+	+
Paspalum distichum	.	.	+	.	+	.	2	+	.	.	.	.	.	.
Symphyotrichum squamatum	2	1	1	2	2	1	.	.	.	.	.	.	.	.
Cyperus eragrostis	2	2	3	3	2	.	.	.	.	.	.	.	.	.
Eclipta prostrata	1	+	1	2	1	.	.	.	.	.	.	.	.	.
Juncus inflexus	1	2	1	1	1	.	.	.	.	.	.	.	.	.
Lycopus europaeus	1	+	+	1	1	.	.	.	.	.	.	.	.	.
Juncus hybridus	.	.	.	.	.	2	1	1	2	.	.	.	.	.
Glyceria notata	.	.	.	.	.	.	2	1	+	.	.	.	.	.
Callitriche palustris	.	.	.	.	.	+	2	1	+	.	.	.	.	.
Helosciadium nodiflorum	.	.	.	.	.	1	2	+	+	.	.	.	.	.
Potentilla reptans	1	1	+	+	1	.	.	.	.	.	.	.	.	.
Veronica peregrina	.	.	.	.	.	3	+	+	2	.	.	.	.	.
Equisetum telmateia	.	.	.	.	.	.	.	.	.	+	1	1	+	+
Prunella vulgaris	.	.	.	.	.	.	.	.	.	+	+	+	.	+
Veronica anagallis-aquatica	.	.	.	.	.	.	2	2	2	.	.	.	.	.
Juncus articulatus	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Eupatorium cannabinum	.	.	.	.	.	.	.	.	.	1	.	.	+	+
Cardamine parviflora	.	.	.	.	.	3	.	.	1	.	.	.	.	.
Catabrosa aquatica	.	.	.	.	.	.	1	2	.	.	.	.	.	.
Trifolium fragiferum	1	.	1	+	.	.	.	.	.	.	.	.	.	.
Clinopodium vulgare subsp. *arundanum*	.	.	.	.	.	.	.	.	.	+	+	+	.	.
Polypogon monspeliensis	+	+	.	.	+	.	.	.	.	.	.	.	.	.

Other species: *Cynodon dactylon* +, *Verbena officinalis* 1 in 1; *Melissa officinalis* subsp. *altissima* + in 3; *Cynodon dactylon* +, *Melissa officinalis* subsp. *altissima* 1 in 4; *Cynodon dactylon* + in 5; *Nasturtium officinale* + in 6; *Trifolium resupinatum* + in 8; *Berula erecta* and *Myosurus minimus* + in 9; *Pulicaria dysenterica* 1 in 3, + in 5; *Epilobium hirsutum* + in 11, 13.

Localities: 1-5: Casa Scarola, 14.07.2015; 6-9: Marinetto, 03.04.2009; 10,11: Masseria Rizzuti, 14.07.2015; 12-14: Macchia d'Acci, 14.07.2015.

Table 5. Marsh vegetation. *Polygono salicifolii-Phragmitetum comunis* Barbagallo, Brullo & Furnari 1979 (rel. 1,2), *Typhetum angustifoliae* (Allorge 1921) Pignatti 1953 (rel. 3-5), *Typho angustifoliae-Schoenoplectetum tabernaemontani* Br.-Bl. & Bolòs 1957 (rel. 6,7), *Typhetum latifoliae* Nowiński 1930 (rel. 8-10) (*Phragmition communis*, *Phragmitetalia australis*, *Phragmito australis-Magnocaricetea elatae*); *Sparganium neglectum* comm. (rel. 11) (*Glycerio fluitantis-Sparganion neglecti*, *Nasturtio officinalis-Glyceretalia fluitantis*, *Phragmito australis-Magnocaricetea elatae*); *Helosciadietum nodiflori* Maire 1924 (rel. 12-15) (*Apion nodiflori*, *Nasturtio officinalis-Glyceretalia fluitantis*, *Phragmito australis-Magnocaricetea elatae*).

Altitude (m asl)	53	55	52	55	55	52	52	53	53	53	55	53	53	53	53
Plot size (m^2)	30	30	15	15	15	10	10	15	15	15	5	15	15	25	25
Cover (%)	100	100	100	100	100	90	90	100	100	100	90	80	80	100	80
Species N.	6	5	15	11	7	12	8	11	12	10	12	4	6	8	7
Relevé N.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Characteristics of associations and communities															
Phragmites australis	5	5	1	+	.	.	.	+	+	.	.	.	.	.	.
Persicaria decipiens	2	2	3	1	1	1	2	2	1	1	.	.	.	.	.
Typha angustifolia	.	.	5	5	5	4	4	.	.	.	.	.	.	.	.
Schoenoplectus tabernaemontani	.	.	.	.	.	2	3	.	.	.	.	.	.	.	.
Typha latifolia	.	.	.	.	.	.	+	3	4	4	2	.	.	.	.
Sparganium neglectum	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.
Helosciadium nodiflorum	+	.	1	.	.	.	.	.	+	+	1	1	1	1	+
Veronica anagallis-aquatica	.	.	.	.	.	.	.	.	.	.	.	3	2	5	5
Characteristics of upper units															
Galium palustre subsp. *elongatum*	.	2	2	+	2	1	2	1	1	2	3	.	.	.	.
Mentha aquatica	2	.	1	.	1	+	.	1	1	2	2	.	.	.	.
Lycopus europaeus	+	.	1	.	.	.	.	+	1	+	1	.	.	.	.
Alisma plantago-aquatica	.	.	.	.	.	2	.	2	.	1	.	.	.	.	.
Lythrum salicaria	.	.	.	1	.	.	.	2	1	1	.	.	.	.	.
Glyceria notata	.	.	1	.	.	1	.	.	.	.	.	.	1	3	+
Nasturtium officinale	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Other species															
Paspalum distichum	.	.	1	2	1	3	3	+	1	.	.	.	1	3	+
Symphyotrichum squamatum	.	+	+	1	.	.	1	.	1	1	.	.	.	.	.
Rumex maritimus	.	.	3	1	+	.	.	+	+	.	.	.	.	.	.
Lythrum junceum	.	.	+	+	.	+	.	.	+	.	1	.	.	.	.
Alopecurus aequalis	.	.	.	.	.	.	.	.	.	.	.	2	3	.	.
Polypogon monspeliensis	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.
Juncus hybridus	.	.	.	.	.	.	.	.	.	.	.	3	+	1	2
Potentilla reptans	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.
Rumex sanguineus	+	.	.	.	.	+	1	.	.	.	1	.	.	1	+
Equisetum palustre	.	.	+	.	.	.	.	2	.	1	3	.	.	.	.

Other species: *Holcus lanatus* + in 2; *Agrostis stolonifera* 1 in 3; *Cyperus badius* + in 4; *Epilobium tetragonum* + in 6; *Cirsium creticum* subsp. *triumfettii* and *Lotus pedunculatus* 1, *Epilobium hirsutum* 2 in 11; *Juncus articulatus* 1 in 14.

Localities: 1: Gambarella, 03.07.2009; 2: between Tarsia cemetery and Marinetto, 10.09.2010; 3: Macchia d'Acci, 02.07.2009; 4,5: Between Tarsia cemetery and Marinetto, 03.07.2009; 6,7: Parco di Rende, 10.09.2010; 8-10: Casa Scarola, 14.07.2015; 11: Between Tarsia cemetery and Marinetto, 03.07.2009; 12: Gambarella, 16.04.2009; 13-15: Marinetto, 03.04.2009.

Polygono lapathifolii-Xanthietum italici Pirola & Rossetti 1974 (Table 4, rel. 10–14). Annual vegetation dominated by *Xanthium italicum*, which several species are associated with, showing low values of coverage, such as *Persicaria lapathifolia*, *Dittrichia viscosa*, *Artemisia verlotiorum,* and *Bidens tripartita*. It is a late-summer therophytic community growing on alluvial soils characterized by sandy or sandy-loam soil rich in nitrogen (Biondi *et al*., 2004). It is a pioneer plant community, which needs the soil to be periodically plowed in order to prevent competition with the perennial vegetation. This condition is guaranteed by periodic floods, which also carry organic deposits, which are essential for the development of this annual association.

Marsh vegetation

Polygono salicifolii-Phragmitetum comunis Barbagallo, Brullo & Furnari 1979 (Table 5, rel. 1, 2). A paucispecific community dominated by the common reed (*Phragmites australis*). This association was reported for Sicily (Barbagallo *et al.*, 1979), later found in Calabria, close to the Crati river mouth (Maiorca *et al.,* 2005; 2007). The common reed is a helophyte with a considerable ecological value (Landucci *et al*., 2013), it grows in various marshy environments: ditches with stagnant or slowly flowing water; banks of lakes with eutrophic waters; lagoons and water bodies with strong salinity oscillations. In the study area, this association were found on all the shores, especially where the river is tributary to

the lake. The *Polygono salicifolii-Phragmitetum* differs from the related *Phragmites australis* communities because it prefers unsalted and slightly stagnant waters.

Typhetum angustifoliae (Allorge 1921) Pignatti 1953 (Table 5, rel. 3–5). Marsh vegetation dominated by *Typha angustifolia* growing together with other helophytes on muddy waters and loam substrates, and tolerates wide changes of water level. In the study area, *Typhetum angustifoliae* showed the same distribution of the common reed communities, as it is in catenal contact with the *Polygono salicifolii-Phragmitetum* in the most submerged areas.

Table 6. Damp meadow vegetation. *Loto tenuis-Paspaletum paspaloidis* Biondi, Casavecchia & Radetic 2002 (rel. 1-4) (*Paspalo distichi-Agrostion semiverticillatae*, *Holoschoenetalia vulgaris*, *Molinio-Arrhenatheretea*); *Galio elongati-Juncetum inflexi* Minissale & Spampinato 1985 (rel. 5-7), *Holoschoenetum vulgaris* Br.-Bl. ex Tchou 1948 (rel. 8-14; *var with Juncus inflexus*, rel. 8,9) (*Agrostio stoloniferae-Scirpoidion holoschoeni*, *Holoschoenetalia vulgaris*, *Molinio-Arrhenatheretea*)

Altitude (m asl)	53	53	53	53	52	58	58	52	52	54	54	58	58	58
Plot size (m^2)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Coverage (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Species N.	22	16	17	11	25	21	16	19	15	15	16	21	14	15
Relevé N.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Characteristics of associations														
Lotus tenuis	1	1	.	1	.	.	.	.	.	.	.	.	.	.
Paspalum distichum	4	2	5	5	.	.	1	.	.	.	.	.	2	2
Juncus inflexus	.	.	.	1	4	4	5	3	2	.	.	.	.	.
Galium palustre subsp. *elongatum*	.	.	2	.	1	+	3	2	2	1	2	+	.	.
Scirpoides holoschoenus	.	.	1	2	.	.	.	4	4	5	4	5	4	5
Characteristics of upper units														
Potentilla reptans	.	.	3	2	2	1	1	1	1	1	1	1	3	2
Trifolium repens	5	3	1	.	2	1	.	.	.	.	+	2	2	1
Trifolium fragiferum	3	5	.	.	1	2	+	1	2	.	.	1	.	.
Lotus pedunculatus	.	.	.	.	2	2	+	+	+	.	+	.	.	.
Mentha longifolia	.	.	.	.	2	+	.	+	.	.	2	1	+	.
Plantago major	.	1	.	.	+	+	.	.	.	.	+	.	.	.
Holcus lanatus	.	.	+	.	1	.	+	1	.	.	.	.	.	.
Agrostis stolonifera	.	.	.	.	.	.	.	1	2	2	.	.	.	.
Carex otrubae	.	.	.	.	.	1	.	.	.	.	.	1	.	.
Trifolium lappaceum	.	.	.	.	.	.	.	.	.	.	.	.	+	1
Juncus effusus	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Bromus commutatus	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Polypogon monspeliensis	.	.	+	.	.	.	1	.	.	.	.	.	.	.
Mentha pulegium	1	+	.	.	.	1	.	.	.	.	.	.	.	.
Other species														
Symphyotrichum squamatum	1	1	3	1	1	+	2	1	+	2	.	+	1	+
Lythrum junceum	+	1	+	1	+	.	.	1	+	1	.	.	.	+
Mentha aquatica	1	1	.	.	3	+	1	1	3	2	.	.	.	1
Lycopus europaeus	.	.	2	1	2	1	.	3	1	.	.	1	+	1
Cirsium creticum subsp. *triumfettii*	2	.	.	.	4	1	2	.	+	.	1	1	.	.
Rumex sanguineus	1	.	.	.	2	1	2	.	.	.	1	1	.	.
Pulicaria dysenterica	.	.	.	.	+	+	.	2	.	2	.	.	.	.
Torilis arvensis	.	.	2	.	+	.	+	+	1	.	3	3	.	.
Verbena officinalis	+	1	.	.	+	.	.	.	.	.	+	1	1	1
Cynodon dactylon	2	1	.	.	.	.	.	.	.	1	2	1	.	.
Centaurium erythraea	.	1	.	.	.	.	.	.	.	1	.	.	1	+
Trifolium squamosum	.	.	+	.	.	.	.	.	.	1	1	2	.	.
Daucus carota	.	.	.	.	+	1	.	.	.	.	+	1	.	.
Daucus broteroi	.	.	.	.	.	.	.	.	.	.	+	1	.	+

Blackstonia perfoliata	.	.	.	.	.	.	.	.	+	1	.	.	+	.
Odontites vernus subsp. *serotinus*	.	.	.	.	.	.	.	.	1	.	.	.	+	.
Melissa officinalis subsp. *altissima*	.	.	.	.	+	.	.	+	.	.	.	.	.	.
Atriplex prostrata	.	.	.	.	1	+	.	.	.	.	.	.	.	.
Rorippa palustris	.	.	3	2	.	.	.	.	.	.	.	.	.	.
Ranunculus sardous	.	1	+	.	.	.	.	.	.	.	.	.	.	.
Lolium perenne	2	2	.	.	.	.	.	.	.	.	.	.	.	.
Cichorium intybus	1	1	.	.	.	.	.	.	.	.	.	.	.	.

Other species: *Schoenoplectus tabernaemontani* and *Bunias erucago* +, *Anthemis arvensis* subsp. *incrassata*, *Cladanthus mixtum*, *Crepis setosa*, *Sonchus asper*, *Bromus hordeaceus* and *Medicago lupulina* 1 in 1; *Cyperus eragrostis* + in 2; *Erigeron bonariensis* +, *Juncus articulatus* and *Rumex maritimus* 1 in 3; *Rumex maritimus*, *Xanthium italicum* 1 in 4; *Althaea officinalis*, *Dipsacus fullonum*, *Bidens tripartita* and *Urtica dioica* + in 5; *Sonchus asper* and *Epilobium hirsutum* +, *Alisma plantago-aquatica* 1 in 6; *Phragmites australis*, *Cynanchum acutum* + in 7; *Bellardia trixago* + in 8; *Rubus ulmifolius* +, *Cyperus badius* 1, *Trifolium angustifolium* 2 in 10; *Trifolium pratense* 1 in 11; *Lathyrus hirsutus* +, *Allium polyanthum*, *Helminthotheca echioides* and *Rumex crispus* 1 in 12; *Erigeron bonariensis* and *Rubus ulmifolius* + in 13; *Erigeron bonariensis*, *Cynanchum acutum* and *Briza minor* + in 14.
Localities: 1,2: Gambarella, 02.07.2009; 3,4: Casa Scarola, 03.07.2009; 5: Parco di Rende, 03.07.2009; 6,7: Mandra dell'Avena, 03.07.2009; 8,9: Pellizzari, 10.09.2010; 10,11: Macchia d'Acci, 02.07.2009; 12-14: Mandra dell'Avena, 03.07.2009.

Typho angustifoliae-Schoenoplectetum tabernaemontani Br.-Bl. & Bolòs 1957 (Table 5, rel. 6, 7). Marsh vegetation dominated by *Schoenoplectus tabernaemontani* growing together with *Typha angustifolia*. In the study area, it is very rare and localized on silty-clayey substrates, in mesotrophic water, especially at the edge of marshes. This association is known for the Italian territory (Biondi *et al.*, 2004; Biondi & Vagge, 2004) and has also been found in Calabria (Maiorca *et al.*, 2007).

Typhetum latifoliae Nowiński 1930 (Table 5, rel. 8–10). Marsh vegetation dominated by *Typha latifolia* occurring in mesotrophic to eutrophic waters. Differently, from *Typhetum angustifoliae*, this association is rare in the study area, locating into habitats characterized by the accumulation of organic sediments, for example on the right bank of the lake. It can be said that *Typha latifolia* and *T. angustifolia* are often found together in marshes and ponds but, due to their competitive interaction, the communities with *T. latifolia* are restricted to less deep waters (Grace & Wetzel, 1981).

Sparganium neglectum community (Table 5, rel. 11). In the study area, this vegetation has been found in the very grazed marshy areas, for example, near the Tarsia's cemetery, as already observed at the mouth of the Crati river (Maiorca *et al.*, 2007). *Sparganium neglectum* forms well-defined associations only in conditions of high naturalness, on muddy substrates rich in organic matter and in eutrophic waters (Venanzoni & Gigante, 2000; Landucci *et al.*, 2013); otherwise, in disturbed environments, it is very difficult to typify it.

Helosciadietum nodiflori Maire 1924 (Table 5, rel. 12–15). Amphibious vegetation linked to fresh oligotrophic or mesotrophic, slow-flowing, and well-oxygenated waters (Landucci *et al.*, 2013), occurring on the shores of the lake close to small tributaries waterways. This association is characterized by the constant occurrence of *Helosciadium nodiflorum*, which is associated with several hydrophytes, especially *Veronica anagallis-aquatica*.

Damp meadows vegetation

Loto tenuis-Paspaletum paspaloidis Biondi, Casavecchia & Radetic 2002 (Table 6, rel. 1–4). This association describes a dense and species-rich meadow dominated by the neophyte *Paspalum paspaloides* developing in summer. It was described for central Italy (Marche) (Biondi *et al*., 2002) and was later found in other wetlands of southern Italy, including Calabria (Maiorca *et al*., 2005; 2007). Due to its hygrophily, in the study area, this association was exclusively found on moist soils along the banks of the lake.

Galio elongati-Juncetum inflexi Minissale & Spampinato 1985 (Table 6, rel. 5–7). Herbaceous vegetation dominated by *Juncus inflexus* and *Galium elongatum*, described for north-eastern Sicily (Minissale & Spampinato, 1987) and currently not reported for Calabria. It is a thermophilous, sub-hygrophilous, and sub-nitrophilous association, which prefers clayey-loam soils subjected to a short period of submersion and a drying up in the summer. Due to overgrazing, the *Galio elongati-Juncetum inflexi* shows a less number of characteristic species, a higher number of reptant hemicryptophytes (*Trifolium fragiferum*, *T. resupinatum*, etc.) and a more presence of *Cirsium creticum* subsp. *triumphettii*, which is not appreciated by cattle.

Holoschoenetum vulgaris Maire 1924 (Tab. 6, Rel. 8–14). Herbaceous phytocoenosis dominated by *Scirpoides holoschoenus* (= *Holoschoenus vulgaris*) spread in the south-western Mediterranean area (Rivas-Martinez *et al*., 1980); in Italy, it is particularly widespread in the central-southern regions (Lastrucci *et al.*, 2017). Amongst its turfs, several Mediterranean hygrophytes are typical, such as *Pulicaria dysenterica* and several *Mentha sp. pl*.; moreover, some taxa resistant to trampling (as *Agrostis*

stolonifera and *Juncus inflexus*) are also frequent and characterize the variant with *Juncus inflexus* (Tab. 6, Rel. 8, 9). The *Holoschoenetum vulgaris* prefers the base-rich soils (García *et al.*, 2016) and tolerates temporary periods of dryness since demanding less water than other *Holoschoenetalia* plant communities.

Table 7. Riparian thickets and woods. *Tamarix africana* comm. (rel. 1-3) (*Tamaricion africanae*, *Tamaricetalia africanae*, *Nerio oleandri-Tamaricetea africanae*); *Salix alba and Populus alba* comm. (rel. 4-5) (*Populion albae*, *Populetalia albae*, *Salici purpureae-Populetea nigrae*); *Salicetum albo-brutiae* Brullo & Spampinato 1997 (rel. 6) (*Salicion albae*, *Salicetalia purpureae*, *Salicetea purpureae*)

Altitude (m asl)	55	55	55	55	55	60
Plot size (m^2)	50	50	50	100	100	100
Tree cover (%)	-	-	-	80	80	100
Shrub cover (%)	100	100	100	20	20	50
Herb cover (%)	45	45	35	80	80	60
Species N.	14	9	8	18	17	17
Relevé N.	1	2	3	4	5	6
Characteristics						
Tamarix africana	5	5	4	.	1	+
Vitex agnus-castus	+	.	2	.	.	.
Salix brutia	.	.	.	.	.	2
Salix alba	.	.	.	4	4	5
Populus alba	.	.	.	2	3	.
Populus nigra	.	.	.	2	.	1
Salix alba (shrubs)	.	1	1	.	.	.
Salix purpurea	.	.	.	.	.	2
Equisetum telmateia	.	.	.	4	4	.
Clematis vitalba	.	.	.	.	1	3
Carex pendula	.	.	.	+	1	.
Hypericum hircinum subsp. *majus*	.	.	.	+	+	.
Angelica sylvestris	.	.	.	+	1	.
Rumex sanguineus	.	.	.	.	.	+
Vitis vinifera	.	.	.	.	.	1
Eupatorium cannabinum	.	.	.	1	1	.
Mentha aquatica	.	.	.	1	+	.
Other species						
Rubus ulmifolius	2	3	3	.	.	2
Brachypodium sylvaticum	2	.	.	.	.	3
Equisetum ramosissimum	1	.	.	.	.	1
Phragmites australis	.	1	.	.	.	1
Holcus lanatus	.	.	.	2	1	.
Prunella vulgaris	.	.	.	1	1	.
Samolus valerandi	.	.	.	1	1	.
Doronicum orientale	.	.	.	+	1	.
Clinopodium vulgare subsp. *arundanum*	.	.	.	+	+	.
Potentilla reptans	.	.	.	+	1	.
Torilis arvensis	.	1	1	.	.	.
Scirpoides holoschoenus	1	.	1	.	.	.
Cynodon dactylon	1	1	.	.	.	.

Other species: *Cytisus villosus*, *Euphorbia hirsuta*, *Melica arrecta* and *Melissa officinalis* subsp. *altissima* +, *Crataegus monogyna*, *Euphorbia characias* and *Oloptum miliaceum* 1 in 1; *Carex hirta*, *Galium palustre* subsp. *elongatum* and *Mentha longifolia* 1 in 2; *Asparagus acutifolius* +, *Rosa sempervirens* 2 in 3; *Trifolium pratense* +, *Lythrum junceum* and *Epilobium hirsutum* 1 in 4; *Tussilago farfara* + in 5; *Arum italicum* and *Rubia peregrina* +, *Convolvulus sylvaticus* and *Chaerophyllum temulum* 1, *Polypogon viridis* 2 in 6.

Localities: 1: Gambarella, 02.07.2009; 2,3: Case Gualdo, 03.07.2009; 4,5: Case Gualdo, 30.04.2012; 6: Tarsia Lake, Brullo & Spampinato, 1997.

Riparian thickets and woods

Tamarix africana community (Table 7, rel. 1-3). A shrubby community with *Tamarix africana*, *Vitex agnus-castus* floristically very poor. It is mainly found in several creeks of Tarsia Lake on alluvial deposits with a fine loamy-sandy texture. This plant community shows similarities with the *Tamarix africanae-Viticetum agnicasti*, widespread along with the halophilous coastal environments of Calabria (Brullo & Spampinato, 1997; Maiorca *et al*., 2007).

Salix alba-Populus alba community (Table 7, rel. 4, 5). A riparian plant community dominated by *Salix alba* and *Populus alba*. In the undergrowth, several hygrophilous species of the *Populetalia albae* order occur. In the study area, riparian woods are rare and occur only in the narrow gorges crossed by short streams flowing in the western side of the lake. This pioneer forest community is subjected to periodical and destructive flooding, but it is able to recolonize alluvial sediments quickly.

Salicetum albo-brutiae Brullo e Spampinato 1997 (Table 7, rel. 6). A shrubby or arborescent plant community dominated by *Salix alba* and other willows, such as *Salix brutia* and *Salix purpurea* (Brullo & Spampinato, 1997). The herbaceous layer consists of a few typical species of open swamp habitats. The *Salicetun albo-brutiae* occurs on floods with a fine silty-sandy texture along the banks of the Crati River before it enters the Tarsia Lake.

Syndinamism

The phytocoenoses around the Tarsia Lake, although subjected to a considerable anthropogenic disturbance, are well floristically and ecologically characterized. Their presence depends on the degree of edaphic humidity linked to filling and emptying the lake through the opening and closing of the dam.

Spring vegetation of temporary ponds and muds geosigmetum. This vegetation occurs in winter or spring on muddy sediments when the lake is empty (Figure 4). The *Rumici maritimi-Ranunculetum scelerati* grows on the water-saturated muds and it is the most widespread plant community from winter to spring. The *Filaginello uliginosae-Veronicetum peregrinae* develops in the driest muds. In the pools with water, the *Charetum vulgaris* algal community is found; on the contrary, the *Helosciadietum nodiflori* is presenting on the muds submerged by a few centimeters of water. All these plant communities form a mosaic with the thallophytic communities on silty soils (*Riccia glauca* community; *Botrydietum granulati*) or with *Limosella aquatica* communities on sandy soil.

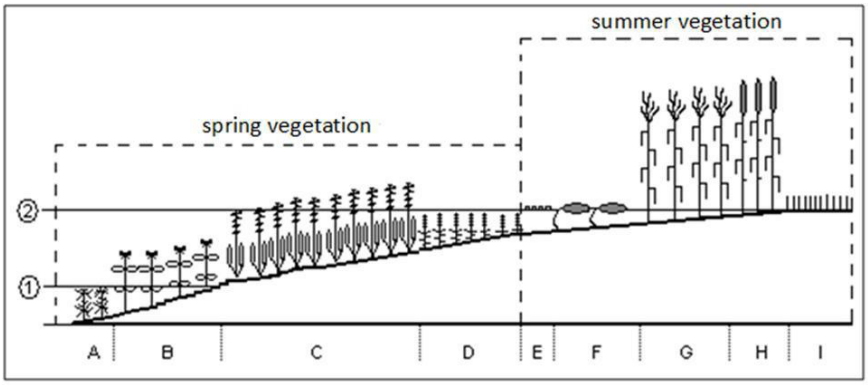

Figure 4. Transect of the main aquatic and marsh communities related to the water level during spring (1) and summer (2). A, *Charetum vulgaris*; B, *Helosciadietum nodiflori*; C, *Rumici maritimi-Ranunculetum scelerati*; D, *Filaginello uliginosae-Veronicetum peregrinae*; E, *Lemnetum gibbae*; F, *Potamogetonetum nodosi* and/or *Ceratophylletum demersi*; G, *Polygono salicifolii-Phragmitetum communis*; H – *Typha sp.pl.* associations; I, *Bidenti tripartitae-Polygonetum mitis* and damp meadows of the *Molinio-Arrhenatheretea* class.

Summer aquatic and marsh vegetation geosigmetum. Due to lake filling during the summer, the muddy communities disappear. On the other hand, this allows for a greater development of aquatic vegetation (Figure 4). On the lake's surface, we can see the *Lemnetum gibbae* free-floating aquatic vegetation, whereas in the waters, the rooted-floating vegetation, such as the *Ceratophylletum demersi* and *Potamogetonetum nodosi*, occurs. Over the river banks, the marsh plant communities characterised by helophytes are widespread (*Polygono salicifolii-Phragmitetum comunis*, *Typhetum angustifoliae*, *Typhetum latifoliae*). They are replaced by damp meadows on the humid ground (*Loto tenuis-Paspaletum paspaloidis; Galio elongati-Juncetum inflexi*, *Holoschoenetum vulgaris*). On muddy sediments rich in nutrients and dry in the summer, the associations of the *Bidentetea tripartiti* class occur, such as the *Bidenti tripartitae-Polygonetum mitis*.

Riparian woods and thickets geosigmentum. The riverbank vegetation on alluvial soils along the banks of the Crati River, next Tarsia Lake, is formed by a pioneer willow shrub vegetation of the *Salicetum albo-brutiae*. However, the proximity of the watercourse to

crops or pastures does not allow the development of a large hygrophilous riparian forest community. Along short streams flowing in narrow gorges before entering the lake, sometimes dry in the summer, the hygrophilous riparian woods of the *Populetalia albae* are present. Instead, *Tamarix africana* thickets occur on alluvial and sandy sediments located at the mouth of these small streams.

Conclusions

The vegetation study is fundamental in the management and planning of natural resources for the identification and assessment of habitats and to ensure and support the effectiveness of conservation activities. Our study highlighted and characterized many plant communities referable to natural or semi-natural habitats, according to the European Directive 92/43/EEC (Biondi *et al.*, 2009, 2012; Zivkovic *et al.*, 2017) (Table 8). Among those habitats, the most important for biodiversity conservation are "3170*, Mediterranean temporary ponds" and "3130 - Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*", both typical of temporarily flooded pools. Significant areas are occupied by habitats "3150, Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation" widespread on most of the lake's waters and "6420, Mediterranean tall humid herb grasslands of the *Molinio-Holoschoenion*".

On the whole, the marsh vegetation of Tarsia Lake presents a high spatial heterogeneity and brings together a complex mosaic of phytocoenoses according to changes in the water regime and to water availability. Some detected phytocoenoses are of particular interest because they are located at the border of the distribution range, such as *Limosella aquatica* and *Botrydietum granulati* communities, which are common in the temperate European territories, while becoming rare in the Mediterranean environment. The peculiar mesoclimatic conditions characterizing the study area probably favor the presence of these phytocoenoses as well as *Filaginello uliginosae-Veronicetum peregrinae* and *Rumici maritimi-Ranunculetum scelerati* associations.

The importance of Tarsia Lake wetlands has been recognized at Community level with the establishment of the SCI "Lago di Tarsia - IT9310055" and at the local level with the Regional Nature Reserve "Lago di Tarsia", aimed at protecting the habitats of the marshlands for the conservation of very rare plant and animal species in southern Italy.

Wetlands in Mediterranean are recognized as an important part of biodiversity, often subjected to threats and destruction, and reduced to a few areas strongly threatened by anthropogenic actions. In Italy, Calabria does not escape this situation, because about 90% of wetlands have disappeared over the last century (Spampinato *et al.*, 2007). Our study confirms that artificial lakes can be crucial in order to increase humid habitats and to partially compensate for the loss of natural wetlands. The Tarsia Lake preserves flora and vegetation of considerable naturalistic interest, which the predisposition of an adequate program of monitoring and protection is required.

Table 8. Habitats of Community Interest according to European Directive 92/43/EEC.

Natura 2000 Habitat Syntaxon
3150 Natural euthrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation
Ceratophylletum demersi
Lemnetum gibbae
Callitrichetum palustris
Potamogetonetum nodosi
Callitrichetum palustris
3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*
Filaginello uliginosae-Veronicetum peregrinae
Limosella aquatica community
3170 Mediterranean temporary ponds (priority habitat)
Isoëtetum duriei
3270 Rivers with muddy banks with *Chenopodion rubri* p.p. and *Bidention* p.p. vegetation
Bidenti tripartitae-Polygonetum mitis
Rumici maritimi-Ranunculetum scelerati
Polygono lapathifolii-Xanthietum italici
6420 Mediterranean tall humid herb grasslands of the *Molinio-Holoschoenion*
Holoschoenetum vulgaris
Loto tenuis-Paspaletum paspaloidis
Galio elongati-Juncetum inflexi
92A0 *Salix alba* and *Populus alba* galleries
Salicetum albo-brutiae
Salix alba and *Populus alba* community
92D0 Southern riparian galleries and thickets (*Nerio-Tamaricetea* and *Securinegion tinctoriae*)
Tamarix africana community

Syntaxonomical scheme

Charetea fragilis F. Fukarek ex Krausch 1964
Charetalia hispidae Sauer ex Krausch 1964
Charion vulgaris (Krause ex Krause & Lang 1977) Krause 1981
Charetum vulgaris Corillion 1957
Lemnetea minoris Tüxen ex O. Bolòs & Masclans 1955
Lemnetalia minoris Tüxen ex O. Bolòs & Masclans 1955
Lemnion minoris Tüxen ex O. Bolòs & Masclans 1955
Lemnetum gibbae Miyawaki et J. Tüxen 1960
Potamogetonetea pectinati Klika in Klika & Novák 1941
Potamogetonetalia pectinati Koch 1926
Potamogetonion pectinati Libbert 1931
Ceratophylletum demersi Hild 1956
Potamogetonetum nodosi (Soó 1960) Segal 1964
Callitricho hamulatae-Ranunculetalia aquatilis Passarge ex Theurillat in Theurillat et al. 2015
Ranunculion aquatilis Passarge ex Theurillat in Theurillat et al. 2015
Callitrichetum palustris (Dihoru 1975 n.n.) Burescu 1999
Cladonio digitatae-Lepidozietea reptantis Ježek et Vondráček 1962
Diplophylletalia albicantis Philippi 1963
Physcomitrellion patentis Hübschmann 1957
Riccia glauca community
Botrydietum granulati Hübschmann 1957
Isoëto-Nanojuncetea Br.-Bl. et Tx. in Br.-Bl. et al. 1952
Isoëtetalia durieui Br.-Bl. 1936
Isoëtion durieui Br.-Bl. 1936
Isoëtetum duriei Br.-Bl. 1935
Nanocyperetalia flavescentis Klika 1935
Nanocyperion flavescentis Koch 1926
Filaginello uliginosae-Veronicetum peregrinae Molero Brion. & Romo 1988
Eleocharition soloniensis Philippi 1968
Limosella aquatica community
Bidentetea tripartitae Tüxen, Lohmeyer & Preising ex Von Rochow 1951
Bidentetalia tripartitae Br.-Bl. & Tüxen ex Klika in Klika & Hadac 1944
Bidention tripartitae Nordhagen ex Klika et Hadác 1944
Bidenti tripartitae-Polygonetum mitis (Roch. 1951) T.Tüxen 1979
var. with *Bidens frondosa*
Rumici maritimi-Ranunculetum scelerati Oberdorfer 1957
Chenopodion rubri (Tüxen 1960) Hilbig & Jage 1972
Polygono lapathifolii-Xanthietum italici Pirola & Rossetti 1974
Phragmito australis-Magnocaricetea elatae Klika in Klika & Novák 1941
Phragmitetalia australis Koch 1926
Phragmition communis Koch 1926
Polygono salicifolii-Phragmitetum comunis Barbagallo, Brullo & Furnari 1979
Typhetum angustifoliae (Allorge 1921) Pignatti 1953
Typho angustifoliae-Schoenoplectetum tabernaemontani Br.-Bl. & Bolòs 1957
Typhetum latifoliae Nowiński 1930
Nasturtio officinalis-Glyceretalia fluitantis Pignatti 1953
Glycerio fluitantis-Sparganion neglecti Br.-Bl. & Sissingh in Boer 1942
Sparganium neglectum community
Apion nodiflori Segal in Westhoff et Den Held 1969
Helosciadietum nodiflori Maire 1924
Molinio-Arrhenatheretea Tüxen 1937
Holoschoenetalia vulgaris Br.-Bl. ex Tchou 1948
Paspalo distichi-Agrostion semiverticillatae Br.-Bl. in Br.-Bl., Roussine & Nègre 1952
Loto tenuis-Paspaletum paspaloidis Biondi, Casavecchia & Radetic 2002
Agrostio stoloniferae-Scirpoidion holoschoeni De Foucault 2012
Galio elongati-Juncetum inflexi Minissale & Spampinato 1985
Holoschoenetum vulgaris Maire 1924
Nerio oleandri-Tamaricetea africanae Br.-Bl. & O. Bolòs 1958
Tamaricetalia africanae Br.-Bl. & O. Bolòs 1958 em. Izco, Fernández-González & A. Molina 1984

Tamaricion africanae Br.-Bl. & O. Bolòs 1958
Tamarix africana community
Salici purpureae-Populetea nigrae Rivas-Martínez & Cantó ex Rivas-Martínez, Báscones, T.E. Díaz, Fernández-González & Loidi 2001
Populetalia albae Br.-Bl. xx Tchou 1948
Populion albae Br.-Bl. ex Tchou 1948
Salix alba and *Populus alba* community
Salicetalia purpureae Moor 1958
Salicion albae Soó 1930
Salicetum albo-brutiae Brullo & Spampinato 1997

References

Aleffi, M. 1992. Associazioni di briofite ed alghe dei laghi artificiali di Campotosto e Barrea (Abruzzo, Italia centrale). Doc. Phytosoc. n.s. 14: 91–96.

Ali, M.M. & Rhazi, L. 2010. Limosella aquatica. The IUCN Red List of Threatened Species. http://www.iucnredlist.org/.

Barbagallo, C., Brullo, S. & Furnari, F. 1979. Osservazioni fitosociologiche sulla vegetazione del Fiume Ciane (Sicilia orientale). Pubbl. Ist. Bot. Univ. Catania. 13 p.

Bartolucci, F., Peruzzi, L., Galasso, G., Albano, A., Alessandrini, A., Ardenghi, N.M.G., Astuti, G., Bacchetta, G., Ballelli, S., Banfi, E., Barberis, G., Bernardo, L., Bouvet, D., Bovio, M., Cecchi, L., Di Pietro, R., Domina, G., Fascetti, S., Fenu, G., Festi, F., Foggi, B., Gallo, L., Gottschlich, G., Gubellini, L., Iamonico, D., Iberite, M., Jiménez-Mejías, P., Lattanzi, E., Marchetti, D., Martinetto, E., Masin, R.R., Medagli, P., Passalacqua, N.G., Peccenini, S., Pennesi, R., Pierini, B., Poldini, L., Prosser, F., Raimondo, F.M., Roma-Marzio, F., Rosati, L., Santangelo, A., Scoppola, A., Scortegagna, S., Selvaggi, A., Selvi, F., Soldano, A., Stinca, A., Wagensommer, R.P., Wilhalm, T. & Conti, F. 2018. An updated checklist of the vascular flora native to Italy. Plant Biosyst. 152(2): 179–303. doi: 10.1080/11263504.2017.1419996

Beccarisi, L., Ernandes, P., Medagli, P. & Zuccarello, V. 2006. "Stagni temporanei mediterranei" nella Puglia centro-meridionale. Inform. Bot. Ital. 38(1): 184–185.

Beccarisi, L., Medagli, P., Mele, C., Ernandes, P. & Marchiori, S. 2007. Precisazione sulla distribuzione di alcune specie rare degli ambienti umidi della Puglia meridionale (Italia). Inform. Bot. Ital. 39(1): 87–98.

Bernardo, L., Passalacqua, N.G. & Gargano, D. 2002. Analisi fitosociologica degli ambienti umidi e palustri del Piano della Lacina (Serre Calabre). Congresso Società Italiana di Fitosociologia, Perugia.

Bernardo, L., Bartolucci, F., Cancellieri, L., Costalonga, S., Galasso, G., Galesi, R., Gargano, D., Iberite, M., Iocchi, M., Lattanzi, E., Lavezzo, P., Magrini, S., Peccenini, S., Sciandrello, S., Scoppola, A., Signorino, G., Tilia, A. & Spampinato, G. 2012. Contributo alla conoscenza floristica della Calabria: resoconto dell'escursione del Gruppo di Floristica (S.B.I.) nel 2008 nella Presila Catanzarese. Inform. Bot. Ital. 44(1): 125–151.

Biondi, E. & Vagge, I. 2004. The vegetal landscape of the Republic of San Marino. Fitosociologia 41(1 suppl. 1): 53–78.

Biondi, E., Casavecchia, S. & Radetic, Z. 2002. La vegetazione dei "guazzi" e il paesaggio vegetale della pianura alluvionale del tratto terminale del Fiume Musone (Italia centrale). Fitosociologia 39(1): 45–70.

Biondi, E., Vagge, I., Baldoni, M. & Taffetani, F. 2004. Biodiversità fitocenotica e paesaggistica dei fiumi dell'Italia centro-settentrionale: aspetti fitosociologici e sinfitosociologici. Stud. Trent. Sci. Nat. Acta Biol. 80: 13–21.

Biondi, E., Blasi, C., Burrasco, S., Casavecchia, S., Copiz, R., Del Vico, E., Galdenzi, D., Gigante, D., Lasen, C., Spampinato, G., Venanzoni, R. & Zivkovic, L. 2009. Manuale Italiano di interpretazione degli habitat della Direttiva 92/43/CEE. Soc. Bot. Ital. Min. Amb. Tut. Terr. Mar., Roma.

Biondi, E., Burrascano, S., Casavecchia, S., Copiz, R., Del Vico, E., Galdenzi, D., Gigante, D., Lasen, C., Spampinato, G., Venanzoni, R., Zivkovic, L. & Blasi, C. 2012. Diagnosis and syntaxonomic interpretation of Annex I Habitats (Dir. 92/43/ EEC) in Italy at the alliance level. Plant Sociol. 49(1): 5–37. doi: 10.7338/pls2012491/01

Biondi, E., Blasi, C., Allegrezza, M., Anzellotti, I., Azzella, M.M., Carli, E., Casavecchia, S., Copiz, R., Del Vico, E., Facioni, L., Galdenzi, D., Gasparri, R., Lasen, C., Pesaresi, S., Poldini, L., Sburlino, G., Taffetani, F., Vagge, I., Zitti, S. & Zivkovic, L. 2014. Plant communities of Italy: The vegetation Prodrome. Plant Biosyst. 8(4): 728–814. doi: 10.1080/11263504.2014.948527

Braun-Blanquet, J. 1964, Pflanzensoziologie. Grundzuge der Vegetationskunde. Springer Verlag, Wien.

Brullo, S. & Furnari, F. 1976. Le associazioni vegetali degli ambienti palustri costieri della Sicilia. Not. Fitosoc. 11: 1–43.

Brullo, S. & Minissale, P. 1998. Considerazioni sintassonomiche sulla Classe Isoeto-Nanojuncetea. Itinera Geobot. 11: 263–290.

Brullo, S. & Sciandrello, S. 2006. La vegetazione del bacino lacustre "Biviere di Gela" (Sicilia meridionale). Fitosociologia 43(2): 21–40.

Brullo, S. & Spampinato, G. 1990. La vegetazione dei corsi d'acqua della Sicilia. Boll. Acc. Gioenia Sci. Nat. 23(336): 119–252.

Brullo, S. & Spampinato, G. 1997. Indagine fitosociologica sulle ripisilve della Calabria (Italia meridionale). Lazaroa 18: 105–151.

Brullo, S. & Spampinato, G. 1999. Syntaxonomy of hygrophilous woods of the Alno-Quercion roboris. Ann. Bot. (Roma) 57: 133–146.

Brullo, S., Minissale, P. & Spampinato, G. 1994. Studio fitosociologico della vegetazione lacustre dei Monti Nebrodi (Sicilia settentrionale). Fitosociologia 27: 5–50.

Brullo, S., Scelsi, F. & Spampinato, G. 2001. La Vegetazione dell'Aspromonte. Studio fitosociologico. Laruffa Ed., Reggio Calabria.

Brullo, S., Gangale, C. & Uzunov, D. 2003. Aspetti vegetazionali degli ambienti umidi della Sila (Calabria). 98° Congr. Naz. Soc. Bot. Ital., Catania.

Brullo, S., Guarino, R., Minissale, P., Siracusa, G. & Spampinato, G. 1999. Syntaxonomical analysis of the beech forests from Sicily. Ann. Bot. (Roma) 57: 121–132.

Cameriere, P., Crisafulli, A., Maiorca, G., Signorino, G. & Spampinato, G. 2008. Contributo alla conoscenza della vegetazione degli stagni temporanei della Calabria meridionale. Atti 103° Congr. Soc. Bot. Ital., Reggio Calabria.

Cano, E., Musarella, C.M., Cano-Ortiz, A., Piñar, J.C., Pinto Gomes, C.J., Rodríguez Torres, A. & Spampinato, G. 2017. A phytosociological review of siliceous sedges in C-W Spain and their state of conservation based on diversity indices. Plant Sociol. 54(2) Suppl. 1: 5–14. doi: 10.7338/pls2017542S1/01.

Caridi, D., Maiorca, G., Spampinato, G., Cameriere, P. & Crisafulli, A. 2006. Analisi diacronica della vegetazione della riserva "Foce del Fiume Crati" (Calabria, Italia). Pp. 539–544. Atti 10° Conf. ASITA, Bolzano.

Caridi, D., Maiorca, G., Antonucci, I., Leuzzi, A., Spampinato, G., Cameriere, P. & Crisafulli, A. 2015. Sviluppi del progetto Phytos.I.S. in Calabria: la carta della biodiversità vegetale del lago di Tarsia. Pp. 225–230. Atti 19° Conf. ASITA, Lecco.

Anonymous. 1958–1962. Carta Geologica della Calabria Scala 1:25.000. Cassa per il Mezzogiorno. Serv. Geol. It., Ril. Geol. Comp. Aero-Ricerche (Dir. Ril. M.P. Marchetti), Roma.

Cesca, G. & Peruzzi, L. 2001. Isoëtes (Lycophytina, Isoetaceae) with terrestrial habitat in Calabria (Italy). New karyological and taxonomical data. Fl. Medit. 11: 303–309.

Chidichimo, G. 1991. Aspetti chimici delle acque del Crati. In: Club Trekking Val Calamo, Ambiente Crati '91. Pp. 111–114. Ed. Il Busento, Cosenza.

Cortini Pedrotti, C. 2001–2006. Flora dei Muschi d'Italia. Vol. 1–2. Antonio Delfino Editore, Roma.

Cortini Pedrotti, C. & Aleffi, M. 1990. Associazioni di briofite e di alghe dei laghi Idro e Terlago (Italia settentrionale). Doc. Phytosoc. n.s. 12: 265–272.

Crisafulli, A., Cannavò, S., Maiorca, G., Musarella, C.M., Signorino, G. & Spampinato, G. 2010. Aggiornamenti Floristici per la Calabria. Inf. Bot. Ital. 42(2): 431–442.

Di Pietro, R., Dibitonto, P., Garziano, G., Sciandrello, S., Wagensommer, R.P., Medagli, P. & Tomaselli, V. 2009. Preliminary results of floristic and vegetation surveys in three coastal humid areas in the Puglia region (southern Italy). Lazaroa 30: 99–107.

Ernandes, P., Beccarisi, L., Medagli, P. & Zuccarello, V. 2006. Note sulle conoscenze floristiche degli "stagni temporanei mediterranei" della Puglia centro-meridionale. Inf. Bot. Ital. 38(1): 185–186.

Ernandes, P., Beccarisi, L. & Zuccarello, V. 2007. L'habitat prioritario "stagni temporanei mediterranei" in Puglia: nuovi dati distributivi e segnalazioni di specie interessanti. Inform. Bot. Ital. 39(2): 271–279.

Ernandes, P., Beccarisi, L. & Zuccarello, V. 2008. I luoghi dell'acqua temporanea: "Laghi" e "Pozzelle", gli habitat effimeri del Salento. Atti Congr. "Spelaion" 2008, Nardò (Lecce).

Ernandes, P. & Marchiori, S. 2013. Mediterranean temporary ponds in Puglia (South Italy): a "joyau floristique" to protect. Bot. Let. 160(1): 53–64. doi: 10.1080/12538078.2013.773461.

Ernandes, P., Gigante, D., Beccarisi, L., Marchiori, S., Venanzoni, R. & Zuccarello, V. 2017. Isoeto-Nanojuncetea in Puglia (S-Italy): First phytosociological survey. Plant Sociol. 54(2): 23–36. doi: 10.7338/pls2017542/03

Ettl, H. 1978. Xanthophyceae. 1. Süsswasserflora von Mittel-Europa 3: 1–530.

Gafta, D. 1991. Zonation et dynamisme de la végétation dans quelques forêts riverines de l'Italie du sud. Coll. Phytosoc. 20: 233–240.

Galasso, G., Conti, F., Peruzzi, L., Ardenghi, N.M.G., Banfi, E., Celesti-Grapow, L., Albano, A., Alessandrini, A., Bacchetta, G., Ballelli, S., Bandini Mazzanti, M., Barberis, G., Bernardo, L., Blasi, C., Bouvet, D., Bovio, M., Cecchi, L., Del Guacchio, E., Domina, G., Fascetti, S., Gallo, L., Gubellini, L., Guiggi, A., Iamonico, D., Iberite, M., Jiménez-Mejías, P., Lattanzi, E., Marchetti, D., Martinetto, E., Masin, R.R., Medagli, P., Passalacqua, N.G., Peccenini, S., Pennesi, R., Pierini, B., Podda, L., Poldini, L., Prosser, F., Raimondo, F.M., Roma-Marzio, F., Rosati, L., Santangelo, A., Scoppola, A., Scortegagna, S., Selvaggi, A., Selvi, F., Soldano, A., Stinca, A., Wagensommer, R.P., Wilhalm, T. & Bartolucci, F. 2018. An updated checklist of the vascular flora alien to Italy. Plant Biosyst. 152(3): 556–592. doi: 10.1080/11263504.2018.1441197.

Gangale, C. & Uzunov, D. 2014. Le comunità terofitiche anfibie della Sila: peculiarità floristiche e problemi di conservazione. Boll. Acc. Gioenia Sci. Nat. 47: 79–84.

García, A.S., Rodríguez-Rojo, M.P., Cantó, P. & Molina, J.A. 2016. Diversity and classification of tall humid herb grasslands (Molinio-Holoschoenion) in Western Mediterranean Europe. Appl. Veg. Sci. 19(4): 736–749. doi: 10.1111/avsc.12249.

Gargano, D., Passalacqua, N.G. & Bernardo, L. 2007. Bogs and mires in Mediterranean areas: the vegetation of the marshlands of the Lacìna Plain (Calabria, S. Italy). Phyton (Horn, Austria) 47(1): 161–189.

Gigante, D., Landucci, F. & Venanzoni, R. 2014. The reed die-back syndrome and its implications for floristic and vegetational traits of Phragmitetum australis. Plant Sociology 50(1): 3–16. doi: 10.7338/pls2013501/01.

Grace, J.B. & Wetzel, R.G. 1981. Habitat partitioning and competitive displacement in cattails (Typha): experimental field studies. Am. Nat. 118: 463–474.

Guarino, R., Marcenò, C., Ilardi, V., Mannino, A.M. & Troia, A. 2019. One Chara does not make Charetea in the Mediterranean aquatic vegetation. Webbia 74(1): 139–147 139–147. doi: 10.1080/00837792.2019.1607142.

Guiry, M.D. & Guiry, G.M. 2018. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. http://www.algaebase.org.

Hrivnák, R., Otahelová, H., Kochjarová, J., Blanár, D. & Husák, S. 2005. Plant communities of the class Charetea fragilis Fukarek Ex Krausch 1964 in Slovakia: new information on their distribution and ecology. Thaiszia - J. Bot. Košice 15: 117–128.

Infusino, E., Callegari, G. & Cantasano, N. 2014. Il trofismo delle acque lentiche. Il caso dell'invaso di Tarsia sul fiume Crati (Calabria). Agriregionieuropa 37: 72–76.

Landucci, F., Gigante, D., Venanzoni, R. & Chytrý, M. 2013. Wetland vegetation of the class Phragmito-Magno-Caricetea in central Italy. Phytocoenologia 43: 67–100. doi: 10.1127/0340-269X/2013/0043-0545.

Lastrucci, L., Cerri, M., Coppi, A., Ferranti, F., Ferri, V., Foggi, B., Lazzaro, L., Reale, L., Venanzoni, R., Viciani, D. & Gigante, D. 2017. Understanding common reed die-back: a phytocoenotic approach to explore the decline of palustrine ecosystems. Plant Soc. 54(2): 15–28. doi: 10.7338/pls2017542S1/02

Lastrucci, L., Dell'Olmo, L., Foggi, B., Massi, L., Nuccio, C., Vicenti, C. & Viciani, D. 2017. Contribution to the knowledge of the vegetation of the Lake Massaciuccoli (northern Tuscany, Italy). Plant Soc. 54(1): 67–87. doi: 10.7338/pls2017541/03.

La Valva, V. & Astolfi, L. 1988. Secondo contributo alla conoscenza delle zone umide della Campania: la flora dei Variconi (Foce del Volturno - CE). Delpinoa 29–30: 77–106.

Liendo, D., Campos, J.A., Biurrun, I. & García-Mijangos, I. 2016. New contributions to the native and alien flora in riparian habitats of the Cantabrian watershed (Northern Spain). Lazaroa 37: 175–184. doi: 10.5209/LAZA.52852.

Maiorca, G., Spampinato, G. & Caprio, A. 2002. Flora e vegetazione dei laghi costieri La Vota (Calabria Centro-Occidentale). Fitosociologia 39(1): 84–105.

Maiorca, G., Spampinato, G., Cameriere, P., Crisafulli, A., Caridi, D., Paleologo, P. & Grasso, S. 2005. Carta della Vegetazione Reale della Foce del Fiume Crati (CS - Calabria). ARSSA, Prog. Phytos. I.S., vol. 2. Tip. De Rose, Cosenza.

Maiorca, G., Spampinato, G., Crisafulli, A. & Cameriere, P. 2007. Flora vascolare e vegetazione della Riserva Naturale Regionale "Foce del Fiume Crati" (Calabria, Italia meridionale). Webbia 62(2): 121–174.

Maiorca, G., Crisafulli, A., Puntillo, D., Spampinato, G., Signorino, G., Caridi, D. & Cameriere, P. 2013. Carta della biodiversità vegetale del Lago di Tarsia (CS-Calabria). ARSSA, Progetto Phytos.I.S. vol. 4. Pellegrini Ed., Cosenza.

Minissale, P. & Spampinato, G. 1987. Osservazioni fitosociologiche sul Lago Gurrida (Sicilia Nord-orientale). Giorn. Bot. Ital. 119(3–4): 197–225.

Minissale, P., Molina, J.A. & Sciandrello, S. 2017. Pilularia minuta Durieu (Marsileaceae) discovered in south-eastern-Sicily: new insights on its ecology, distribution and conservation status. Botany Lett. 164(3): 197–208. doi: 10.1080/23818107.2017.1357051.

Molero Briones, J. & Romo, A. 1988. Vegetación higronitrófila de los embalses del curso superior del Segre y de la Noguera Pallaresa (Prepirineos Centrales). Acta Bot. Barcinon. 37: 289–296.

Molina, J.A., Tahiri, H., Agostinelli, E., Ezzahra El Alaoui-Faris, F., Lumbreras, A.,C. Pardo, V. Silva, Pinto-Cruz, C., Castoldi, E. & Navarro Campoamor, J. 2009. Contribución al conocimiento de la flora y vegetación de los humedales temporales del NO de Marruecos. Lazaroa 30: 251–259.

Mucina, L., Bültmann, H., Dierßen, K., Theurillat, J.-P., Dengler, J., Carni, A., Šumberová, K., Raus, T., Di Pietro, R., Gavílan García, R., Chytrý, M., Iakushenko, D., Schaminée, J.H.J., Bergmeier, E., Santos Guerra, A., Daniëls, F.J.A., Ermakov, N., Valachovic, M., Pignatti, S., Rodwell, J.S., Pallas, J., Capelo, J., Weber, H.E., Lysenko, T., Solomesh, A., Dimopolous, P., Aguiar, C., Freitag, H., Hennekens, S.M. & Tichý, L. 2016. Vegetation of Europe: Hierarchical floristic classification system of plant, lichen, and algal communities. Appl. Veg. Sci. 19 (suppl. 1): 3–264. doi: 10.1111/avsc.12257.

Musarella, C.M., Laface, V.L.A., Morabito, A., Cano-Ortiz, A., Cannavò, S. & Spampinato, G. 2019. Aggiornamenti sulla flora alloctona calabrese: novità e conferme. Notiziario della Società Botanica Italiana, 3(1): 3.

Musarella, C.M., Stinca, A., Cano-Ortíz, A., Laface, V.L.A,. Petrilli, R., Esposito, A. & Spampinato, G. 2020. New data on the alien vascular flora of Calabria (southern Italy). Ann. Bot. (Roma), in press. doi:10.13133/2239-3129/14838.

Pavone, P., Spampinato, G., Minissale, P., Tomaselli, V., Sciandrello, S. & Ronsisvalle, F. 2007. Cartografia degli habitat della Direttiva CEE 92/43 nei biotopi della Provincia di Siracusa (Sicilia orientale). Fitosociologia 44(2) Suppl. 1: 183–193.

Pedrotti, F. 1988. La flora e la vegetazione del Lago di Loppio (Trentino). N. Giorn. Bot. Ital., n.s. 122(3–4): 105–147.

Pedrotti, F. & Gafta, D. 1992. Tipificazione di tre nuove associazioni forestali ripariali nell'Italia meridionale. Doc. Phytosoc. 14: 557–560.

Pesaresi, S., Galdenzi, D., Biondi, E. & Casavecchia, S. 2014. Bioclimate of Italy: application of the worldwide bioclimatic classification system. J. Maps 10(4): 538–553. doi: 10.1080/17445647.2014.891472.

Pignatti, S. & Mengarda, F. 1962. Un nuovo procedimento per l'elaborazione delle tabelle fitosociologiche. Acc. Naz. dei Lincei, Rend. cl. Sc. fis. mat. nat., s. VIII 32: 215–222.
Pignatti, S. 2017–2018. Flora d'Italia, Vols. 1–3. Edagricole, Bologna.
Piñar Fuentes, J.C., Cano-Ortiz, A., Musarella, C.M., Pinto Gomes, C.J., Spampinato, G. & Cano, E. 2017. Rupicolous habitats of interest for conservation in the central-southern Iberian Peninsula. Plant Sociology 54(2) Suppl.1: 29–42. doi: 10.7338/pls2017542S1/03.
Podani, J. 2001. SYN-TAX 2000, computer program for multivariate analysis in ecology and taxonomy. Scientia Publ. Budapest.
Pott, R., 2011. Phytosociology: A modern geobotanical method. Plant Biosyst. 145 (Suppl.1): 9–18. doi: 10.1080/11263504.2011.602740
Puglisi, M., Minissale, P., Sciandrello, S. & Privitera, M. 2015. The bryophyte vegetation of the Mediterranean temporary ponds in Italy. Plant Sociology 52 (2): 69–78. doi: 10.7338/pls2015522/03.
Rivas-Martínez, S., 1996–2019. Global Bioclimatics (Clasificación Bioclimática de la Tierra) http://www.globalbioclimatics.org/book/publications.htm. Accessed on-line 26 Sep 2019.
Rivas-Martínez, S., Costa, M., Castroviejo, S. & Valdés- Bermejo, E. 1980. Vegetación de Doñana (Huelva, España). Lazaroa 2: 5–189.
Rodwell, J.S. 1995. British Plant Communities: Vol. 4, Aquatic Communities, Swamps and tall-herb fens. Cambridge University Press, Cambridge.
Sburlino, G., Tomasella, M., Oriolo, G. & Poldini, L. 2004. La vegetazione acquatica e palustre dell'Italia nord-orientale 1 - La classe Lemnetea Tüxen ex O. Bolòs et Masclans 1955. Fitosociologia 41(1), suppl. 1: 27–42.
Schotsman, H.-D. 1967. Les Callitriches: Espèces de France et taxa nouveaux d'Europe. Éditions Paul Lechevalier, Paris.
Sciandrello, S., Privitera, M., Puglisi, M. & Minissale, P. 2016. Diversity and spatial patterns of plant communities in volcanic temporary ponds of Sicily (Italy). Biologia 71(7): 793–803. doi: 10.1515/biolog-2016-0096.
Silva, J.P., Phillips, L., Jones, W., Eldridge, J. & O'Hara, E. 2007. LIFE and Europe's wetlands: Restoring a vital ecosystem. European Commission, Environment Directorate-General, Luxembourg.
Silva, V., Pinto-Cruz, C. & Espírito-Santo, M.D. 2009. Temporary ponds and hygrophilous grasslands plant communities in Monfurado Site of Community Importance. Lazaroa 30: 81–88.
Spampinato, G., Crisafulli, A. & Cameriere, P. 2007. Trasformazione delle zone costiere della Regione Calabria (Italia meridionale) e conseguenze sulla flora degli ambienti umidi. Fitosociologia 44(2): 119–128.
Spampinato, G., Crisarà, R., Cannavò, S. & Musarella, C.M. 2017. Phytotoponims of southern Calabria: A tool for the analysis of the landscape and its transformations. Atti Soc. Tosc. Sci. Nat., Mem., Serie B, 124: 61–72. doi: 10.2424/ASTSN.M.2017.06.
Spampinato, G., Musarella, C.M., Cano-Ortiz, A. & Signorino, G. 2018. Habitat, occurrence and conservation status of the Saharo-Macaronesian and Southern-Mediterranean element Fagonia cretica L. (Zygophyllaceae) in Italy. J. Arid Land 10(1): 140–151. doi: 10.1007/s40333-017-0076-5.
Spampinato, G., Sciandrello, S., Giusso del Galdo, G., Puglisi, M. Tomaselli, V., Cannavò, S. & Musarella, C.M. 2019. Contribution to Mediterranean wetland: the Aquila Lake vegetation (Calabria, Southern Italy). Plant Sociol. 56(2): 53–68.
Strumia, S. 2004. Contributo alla conoscenza delle cenosi forestali ripariali del fiume Volturno (Campania). Delpinoa n.s. 46: 63–70.
Šumberová, K. 2011a. VAA05 Lemnetum gibbae Miyawaki et J. Tüxen 1960. In: Chytrý M. (Ed.). Vegetace České republiky. 3. Vodní a mokřadní vegetace. Pp. 57–61. Academia, Praha.
Šumberová, K. 2011b. MBA01 Rumici maritimi-Ranunculetum scelerati Oberdorfer 1957. In: Chytrý M. (Ed.). Vegetace České republiky. 3. Vodní a mokřadní vegetace. Pp. 351–355. Academia, Praha.
Van der Maarel, E. 1979. Transformation of cover-abundance values in phytosociology and its effects on community similarity. Vegetatio 39: 97–114.
Venanzoni, R. & Gigante, D. 2000. Contributo alla conoscenza della vegetazione degli ambienti umidi dell'Umbria (Italia). Fitosociologia 37(2): 13–63.
Vila-Viçosa, C., Vázquez, F.M., Mendes, P., Del Rio, S., Musarella, C., Cano-Ortiz, A. & Meireles., C. 2015. Syntaxonomic update on the relict groves of Mirbeck's oak (Quercus canariensis Willd. and Q. marianica C.Vicioso) in southern Iberia. Plant Biosyst. 149(3): 512–526. doi: 10.1080/11263504.2015.1040484.
Weber, H.E., Moravec, J. & Theurillat, J.P. 2000. International Code of Phytosociological Nomenclature. 3r ed. J. Veg. Sci. 11: 739–768. doi: 10.2307/3236580
Zivkovic, L., Biondi, E., Pesaresi, S., Lasen, C., Spampinato, G. & Angelini, P. 2017. The third report on the conservation status of habitats (Directive 92/43/EEC) in Italy: processes, methodologies, results and comments. Plant Sociol. 54(2): 51–64. doi: 10.7338/pls2017542/06

Websites

Medwet 2018. Wetlands for a sustainable Mediterranean region. Available online at: https://medwet.org/
WetVegEurope 2018. European marsh vegetation: synthesis and formalized classification for nature conservation. Available online at: http://www.sci.muni.cz/botany/vegsci/wetveg/