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SPARTINA VERSICOLOR FABRE IN COASTAL AREAS OF TUSCANY (ITALY)

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Abstract: This paper aims to present an overview of *Spartina versicolor* Fabre populations in the coastal areas of Tuscany (Italy), in relation to its ecology and phytosociology. Geobotanical surveys were carried out on the sedimentary coasts along the whole region. Data show that the species grows in embryo dunes, retrodunal sandy lowlands and surrounding wet areas that are moderately saline. In all cases observed, the species exhibited also a high sterility and clonal spread. Phytosociological data show different associative behaviours of *S. versicolor* in different environment types. In particular it is possible to identify three different phytocoenoses strictly related to the environmental typologies (dunal, interdunal/retrodunal or wet) and also to soil salinity. In addition, the observations led us to describe a new subassociation.

Key words: dune, vegetation, plant chorology, salt marshes

Introduction

The grass genus *Spartina* represents a monophyletic lineage in subfamily *Chloridoideae* (Poaceae); it is composed of 14 (excluding hybrids) perennial species, with C4-photosynthesis, which tolerate a wide range of climatic conditions [1]. Most species originate from the New World, are salt-tolerant and colonize dunal habitats and coastal or inland salt marshes [42]. The species usually have high dispersal ability as shown by their successful introductions around the world. *Spartina* is distributed on the Atlantic and Pacific coastlines and inland America [5] and along the Atlantic and Mediterranean coasts of Europe and Africa, where it may have been introduced [3].

The ability of these grasses to colonize new territories is well known, and is not limited to the individual species of this genus, as is demonstrated by its frequent hybrids. Within the genus *Spartina*, some species often act as invaders and show a high capacity for transforming the habitat (see e.g. *Spartina alterniflora* or *S. densiflora*).

The most comprehensive taxonomic studies of the genus *Spartina* date back more than 50 years ago and in spite of the limited number of recognized species, a number of taxonomic problems definitely need further exploration with modern approaches. In his book Mobberley [38] delineated three complexes of species on the basis of morphology.

Spartina versicolor, on which our investigations were focused, is reported as belonging to Mobberley's third group, comprising species that display hard culms and spreading spikes with closely imbricate spikelets, such as *S. bakeri* (morphologically similar to *S. versicolor*), *S. densiflora*, *S. pectinata*, *S. cynusoroides* and *S. gracilis.*

To date, there is not much clarity in the systematics and above all in the nomenclature of the plants classified as *S. versicolor*; in particular, the main issues affecting the taxonomic

distinction between *S. versicolor* and the species classified and named as *S. patens.* Until the beginning of the 20th century, these two taxa have been considered to be separate species [18,21,16] and only towards the middle of the same century taxonomists begin to speak of a single "*patens*" complex to which should belong *S. versicolor*. Later, some researchers cite them as the same single species [30] probably introduced from America to the Mediterranean area. Nevertheless, even more recently, the citations about the taxonomy and above all the chorology of this species of *Spartina*, are different and controversial. This is particularly evident for the populations of the Mediterranean coast of which the origin and identify have often been questioned [40, 26]. In some cases, *S. versicolor* has been considered a native taxon, even if under different names (*Spartina versicolor, S. patens* and also *S. juncea*) [29,51,24,11,55,22,20], indicating good conservation status of the habitat; in others it has been cited as a geographical amphi-Atlantic variety [47,36] or as a non-native and invasive species of North American origin [19,13,43], thus to be controlled and eventually removed.

Moreover, according to Tutin [51] *S. versicolor* is one of two native Mediterranean species (together with *S. maritima*) of European coasts, where it is possible to find other non-native *Spartina* species such as *S. alterniflora* and *S. densiflora* or the hybrid *S. x townsendii*, while, according to others, such as Goulletquer et al. [27], it has a North American Atlantic origin.

A remarkable contribution to these issues comes recently, from gene expression analysis of ITS sequences studies confirming that *S. patens* and *S. versicolor* can be considered to be the same species [41].

In agreement with this interpretation and accepting the taxon under the name of *Spartina versicolor* Fabre, the main distribution area can be identified on the Atlantic and Pacific coasts of North America and Canada [34], on the Atlantic coasts of Europe (England, France, Spain and Portugal, Azores, Canary Islands), and also in Algeria, Tunisia, Spanish and the French Mediterranean coast, Italy [30,4,51,40] and China [2].

In Italy *S. versicolor* has been identified from almost the whole peninsula and also for the islands [54, 40] and in some cases it was indicated as species that is rare or at higher risk of local extinction [15, 48]. In the Tuscany region it was first reported by Bertacchi and Lombardi [6] from the dunes of San Rossore (Pisa) on a stretch of beach between the mouths of the Arno and Morto Rivers.

This paper reports the results of geobotanical investigations conducted on *S. versicolor* communities from some stations of the Tuscany region of Central Italy. The studies were carried out in order to improve the knowledge on the current distribution of the species in this region and on some aspects of its ecology and phytosociology.

Material and Methods

The individuals collected and analyzed for our study were determined and classified following Pignatti [40] and Conti et al. [14], as *Spartina versicolor* Fabre (= *Spartina juncea* (Michx.) Willd., *Spartina patens* (Aiton.) Muhl, *S. duriaei* Parl.), a perennial and caespitose geophyte that flowers from October to February.

Geobotanical surveys were carried out between 2010 and 2014, on the sandy shore and surrounding wet areas, along the whole Tuscany coast. In this paper we have reported the elaborated data of the relevés conducted, according to the Braun-Blanquet method, on *Spartina*

communities growing at the stations of Marina di Vecchiano (MV), San Rossore (SR), Tirrenia-Calambrone (TC), Spiagge Bianche Vada (SBV) (Fig. 1A).

On 100 samples, measurements of morphological features (culms per tiller, flowering culms per tiller, flowers per racemes, seeds per flowering racemes) were made to evaluate the fertility rates of the species.

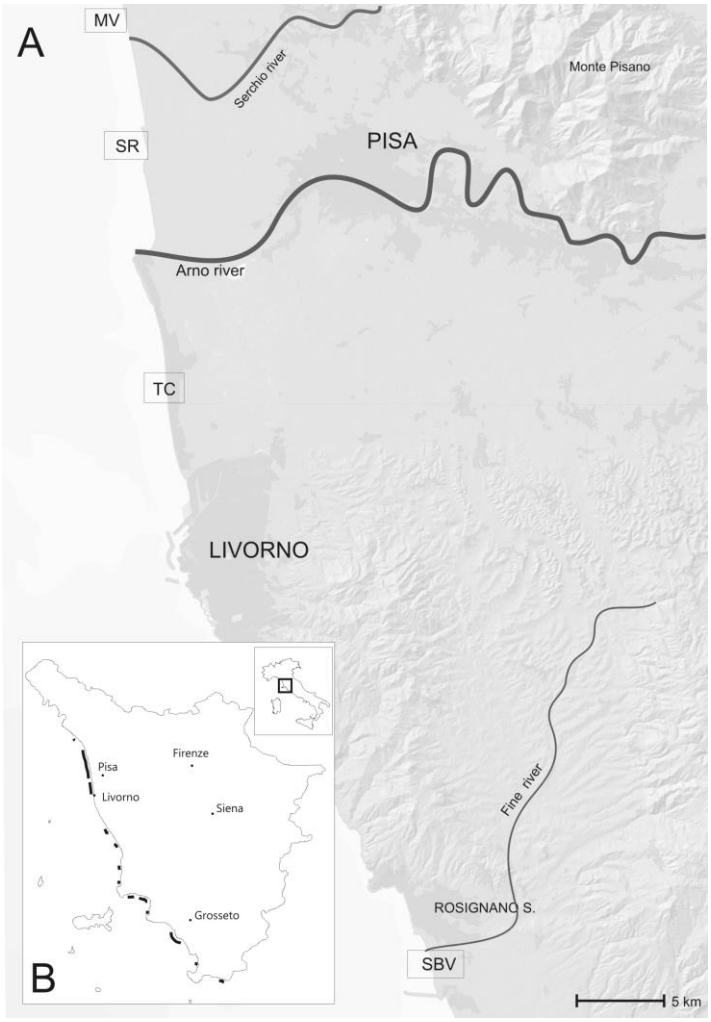

Fig. 1: A-Places of phytosociological relevés; B-Distribution (bold lines) of *S. versicolor* communities along the Tuscany coasts

Results

Distribution, ecology and morphology

The observations carried out in Tuscany revealed a distribution of *S. versicolor* all along the coastal sedimentary sectors, above all close to the mouths of major rivers (Arno, Serchio and Ombrone) (Fig. 1B).

In the first 60 km from the north, the species was found only at a single station. This is probably caused by a diffuse and excessive unsustainable use of the dunal environments of this coastal stretch, such as permanent bathing establishments.

In the following coastal sector, coinciding with the alluvial basin of the Serchio and Arno Rivers, the relevés showed a considerable and widespread presence of the species.

Proceeding south, *S. versicolor* was found sporadically along all the sandy coasts with higher occurence and cover near the mouth of the Ombrone River.

S. versicolor was not observed in any of the islands of the Tuscan archipelago (Fig. 1B).

In the geographical contexts analyzed, it was observed that *S. versicolor* development is linked to embryo dunes, retrodunal sandy lowlands and surrounding wet areas but with wider extensions in the swampy areas near river mouths. Similar to what was observed in previous studies on plant communities of brackish areas of the S. Rossore [9], we observed a preferential growth of *S. versicolor* on substrates with low salinity levels (around 5‰). When lime-clay component prevails or when the substrate is permanently flooded or the salinity becomes too high (over 12‰), the species is replaced by others that are more hygrophilous (e.g. *Phragmites australis*) and/or more halotolerant (e.g. *Salicornia patula* and *Juncus acutus*).

The measurements carried out on the 100 samples collected in the field, corresponding overall to about 3600 culms, show a high sterility of the species: in front of a production of flowering culms *c.* 8% of the total, a markedly low seed production (92 seeds, equal to 0.13% of the total of the flowers of the entire sample) was observed. It is also clear that all the populations are developed mainly vegetatively ("phalanx growth") (Table 1, Photo 1).

Table 1: Vegetative and reproductive features of *S. versicolor* populations growing in San Rossore (Pisa – Tuscany) (100 tiller, 3600 total culms, 295 total flowering culms, 92 total seeds)

Culms /tiller (N ± SE)	Flowering culms/tiller (N ± SE)	Flowers/raceme (N ± SE)	Seeds/flowering culms (N ± SE)
36±8.7	2.9±0.8	230±9.5	0.31±0.7

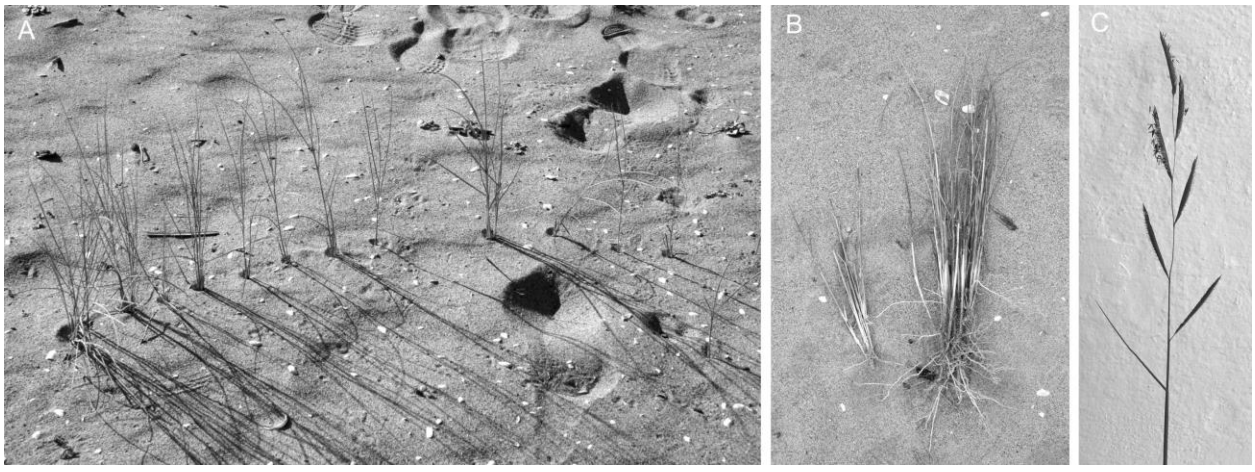

Photo 1: A- Example of *S. versicolor* "phalanx growth"; B – Tillers; C- Flowering raceme

Phytosociology

In our study, the relevés carried out in the four different locations along the Tuscany coast described in Fig. 1A, showed associative behaviour of *S. versicolor*, diversified for environments. In particular it is possible to identify three environmental typologies: dunal, interdunal/retrodunal and wet.

Dunal environment (Table 2) - *S. versicolor* is included in the association *Elymo farcti-Spartinetum junceae* Vagge e Biondi, 1999 typical of the embryo dune. However, at least in some of our surveys (e.g. rel. 1, 2 and 10), this association appears to mix with *Echinophoro*

spinosae-Ammophiletum arundinaceae Gehu, Rivas-Martınez et R.Tuxen 1972 typical of the fixed dune. In these cases, most probably, it is an *Ammophila arenaria* (L.) Link subsp. *australis* (Mabille) Laınz *facies* of the association *Elymo farcti-Spartinetum junceae* Vagge et Biondi, 1999 (Photo 2).

Table 2: *Elymo farcti* - *Spartinetum junceae* Vagge e Biondi, 1999 (*Ammophila arenaria* (L.) Link subsp. *australis* (Mabille) Laınz *facies* – Rel. n° 1, 2, 10*)*

Relevé	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Coverage (%)	**60**	**50**	**80**	**100**	**80**	**50**	**30**	**50**	**30**	**60**	**50**	**30**
Surface (m²)	**20**	**25**	**15**	**15**	**20**	**20**	**20**	**10**	**40**	**50**	**20**	**20**
Charact. of association												
Spartina versicolor Fabre	**2**	**2**	**3**	**4**	**3**	**2**	**1**	**+**	**+**	**+**	**1**	**+**
Elymus farctus (Viv.) Runemark ex Melderis	**+**	**.**	**1**	**1**	**1**	**2**	**1**	**3**	**.**	**+**	**1**	**+**
Charact. of higher units												
Echinophora spinosa L.	**.**	**.**	**r**	**.**	**.**	**+**	**+**	**.**	**.**	**1**	**.**	**1**
Ammophila arenaria (L.) Link *subsp. australis* (Mabille) Lainz	**2**	**1**	**+**	**+**	**.**	**.**	**.**	**.**	**.**	**2**	**.**	**+**
Othantus maritimus (L.) Hoffmgg. et link	**.**	**.**	**+**	**.**	**.**	**r**	**+**	**.**	**.**	**.**	**.**	**.**
Eryngium maritimum L.	**.**	**+**	**.**	**+**	**.**	**.**	**.**	**.**	**1**	**r**	**.**	
Polygonum maritimum L.	**+**	**.**	**.**	**.**	**.**	**.**	**r**	**.**	**.**	**.**	**.**	**.**
Solidago litoralis Savi	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**+**	**.**	**1**	**.**	**+**
Pancratium maritimum L.	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**+**	**.**	**+**	**.**
Euphorbia paralias L.	**+**	**1**	**+**	**+**	**.**	**1**	**+**	**1**	**.**	**.**	**.**	**+**
Calystegia soldanella (L.) R.Br.	**+**	**.**	**.**	**.**	**.**	**r**	**.**	**1**	**+**	**+**	**.**	**+**
Medicago litoralis Rohde	**.**	**.**	**r**	**.**	**.**	**.**	**.**	**+**	**.**	**+**	**.**	**.**
Euphorbia peplis L.	**+**	**+**	**+**	**.**	**.**	**.**	**r**	**.**	**.**	**2**	**.**	**.**
Helichrysum stoechas (L.) Moench.	**.**	**.**	**+**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**+**
Trasgr. *Cakiletea*												
Cakile maritima L.	**.**	**.**	**+**	**.**	**.**	**+**	**.**	**+**	**+**	**.**	**.**	**.**
Other species												
Bromus madritensis L.	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**r**	**+**	**.**	**+**	**+**
Silene colorata Poir.	**.**	**r**	**.**	**.**	**.**	**.**	**r**	**.**	**+**	**.**	**.**	**+**
Inula viscosa L.	**.**	**.**	**.**	**.**	**r**	**.**	**.**	**.**	**.**	**.**	**.**	**.**

Places of relevés: Rel. 1, 2 SBV sud - Rel. 3 SBV nord – Rel. 4, 5, 6, 7 SR – Rel. 8, 9, 10 TC – Rel. 11, 12 MV

Syntaxonomical scheme

AMMOPHILETEA Br.-Bl. & Tüxen ex Westhoff, Dijk & Passchier 1946
Ammophiletalia australis Br.-Bl. 1933
Ammophilion australis Br.-Bl. 1921 corr. Rivas Mart., M.J.Costa & Izco in Rivas Mart., Lousã, T.E.Diáz, Fern.-Gonz. & J.C.Costa 1990
Sporobolo arenarii-Elytrigenion junceae Géhu 1988 corr Géhu 1996
Elymo farcti- Spartinetum junceae Vagge e Biondi, 1999
MOLINIO-ARRHENATHERETEA Tüxen 1937
Holoschoenetalia vulgaris Br.-Bl. ex Tchou 1948
Imperato cylindricae-Erianthion ravennae Br.-Bl. & O. Bolòs 1958
Schoeno nigricantis- Erianthetum ravennae Pignatti 1953
spartinetosum versicoloris subass. nova

JUNCETEA MARITIMI Br.-Bl. in Br.-Bl., Roussine & Nègre 1952
Juncetalia maritimi Br.-Bl. ex Horvatić 1934
Juncion maritimi Br.-Bl. ex Horvatić 1934
Spartino-Juncetum maritimi O. Bolòs 1962

Photo 2: *Elymo farcti-Spartinetum Junceum* Vagge e Biondi, 1999 (Embryonal dune)

Interdunal/retrodunal environment (Table 3) - In sandy and wet interdunal and retrodunal environments, but without waterlogging, *S. versicolor* is often present with almost monophytic populations in which it is accompanied by characteristic species of *Holoschoenetalia* such as *Erianthus ravennae* and *Schoenus nigricans*. This type of population, has never been described for other contexts of the Italian peninsula, is instead rather widespread on the coast north and south of the Arno River. This has led us to describe, within the *Schoeno nigricantis-Erianthetum ravennae* Pignatti 1953, the new sub-association *spartinetosum versicoloris* (holotype relevè n° 6) (Photo 3).

Wet environment (Table 4) - In areas permanently flooded characterized by the most silty substrate and slightly salty water (5 ‰), *S. versicolor* grows in large communities where it is always associated with *Juncus maritimus* and other species of weakly brackish coastal environments, giving rise to the association *Spartino-Juncetum maritimi* O. Bolos 1962 (rel. 1, 2, 3, 4, 5, 6) (Photo 4). However, in adjacent areas which in summer dry up and have higher levels of salinity (about 12 ‰), the reduction of *Spartina* coverage is accompanied by the emergence of more salt-tolerant species such as *Aeluropus littoralis* (in these cases always present) and *Aster tripolium* or true halophytes such as *Crypsis aculeata, Salicornia patula* and *Limonium narbonense* (rel. 8, 9, 10). In this case the plant community identified can be interpreted as an *edaphic variant* of *Aeluropus littoralis* of the *Spartino-Juncetum maritimi* O. Bolos 1962 association.

Table 3: *Schoeno nigricantis - Erianthetum ravennae* Pignatti 1953 (subass. *spartinetosum versicoloris* - holotipe rel. n° 6*)*

Relevé	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Coverage (%)	**100**	**100**	**80**	**100**	**80**	**100**	**60**
Surface (m²)	**50**	**50**	**50**	**100**	**50**	**100**	**50**
Charact. of association							
Erianthus ravennae (L.) Beauv.	+	+	**1**	+	+	**1**	**1**
Schoenus nigricans L.	+	.	+	.	+	+	+
Diff. of subassociation							
Spartina versicolor Fabre	**4**	**4**	**3**	**5**	**3**	**4**	**2**
Trasgr. *Phragmito-magnocaricetea*							
Phragmites australis (Cav.) Trin.	+	.	.	+	**1**	.	.
Other species							
Bolboschoenus maritimum (L.) Palla	.	.	.	.	.	.	**1**
Euphorbia paralias L.	+	+	+	.	.	.	.
Euphorbia peplis L.	+	+	.	.	.	.	.
Polygonum maritimum L.	+	.	.	.	.	.	.
Inula viscosa L.	.	.	+	.	.	.	.
Rubus ulmifolius Schott	.	.	+	.	.	.	+

Places of relevés: Rel. 1, 2, 3, 4 SR – Rel. 5 MV – Rel. 6, 7 TC

Photo 3: *Schoeno nigricantis-Erianthetum ravennae* Pignatti 1953 sub-association *spartinetosum versicoloris* (Interdunal/retrodunal environment)

Discussion

The ecology of *S. versicolor* in the Tuscany stations surveyed seems to be characterized by a wide range of coastal habitat and then very similar to that observed in other contexts, both in North America and Europe [46, 44, 4]. The observations showed that the species occupy large areas in the coastal bands disturbed by edaphic or morphological changes, showing a high degree of adaptation. However, *S. versicolor* forms communities that do not seem to replace the native vegetation. This, despite having accepted the allochthonous origin of *S. versicolor*, does not

justify, in our opinion, its inclusion among invasive species, in contrast to the position taken by some other European authors.

Table 4: ***Spartino - Juncetum maritimi*** **O. Bolòs 1962 (edaphic** ***variant*** **at** ***Aeluropus littoralis*** **- rel. n° 7 - 10*)***

Relevè	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Coverage (%)	**100**	**100**	**100**	**100**	**80**	**80**	**60**	**50**	**60**	**50**
Surface (m^2)	**20**	**50**	**100**	**50**	**50**	**50**	**20**	**50**	**50**	**100**
Charact. of association										
Spartina versicolor Fabre	**4**	**5**	**5**	**4**	**1**	**2**	**2**	**+**	**2**	**+**
Juncus maritimus Lam.	**+**	**1**	**+**	**1**	**1**	**+**	**+**	**1**	**2**	**+**
Charact. of higher units										
Juncus acutus L.	**.**	**.**	**r**	**.**	**3**	**+**	**.**	**+**	**.**	**+**
Aster tripolium L.	**.**	**r**	**.**	**.**	**.**	**+**	**r**	**.**	**+**	**.**
Limonium narbonense Mill.	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**+**	**.**	**+**
Inula chritmoides L.	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**+**	**+**	**.**
Trasgr. *Sarcocornietea*										
Aeluropus littoralis (Gouan) Parl.	**.**	**.**	**.**	**.**	**.**	**.**	**1**	**1**	**+**	**2**
Trasgr. *Thero-Salicornietea*										
Salicornia patula Duval -Jouve	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**1**	**.**	**+**
Trasgr. *Phragmito-magnocaricetea*										
Phragmites australis (Cav.) Trin.	**+**	**.**	**+**	**1**	**.**	**+**	**.**	**.**	**+**	**.**
Other species										
Carex otrubae Podp.	**+**	**.**	**.**	**+**	**.**	**.**	**.**	**.**	**.**	**.**
Carex divisa Hudson	**.**	**.**	**.**	**.**	**.**		**.**	**+**	**+**	**.**
Samolus valerandi L.	**.**	**r**	**.**	**.**	**.**	**.**	**+**	**.**	**.**	**.**
Cynodon dactylon (L.) Pers.	**.**	**.**	**.**	**.**	**+**	**.**	**.**	**.**	**.**	**.**
Crypsis aculeata (L.) Aiton.	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**+**	**+**	**+**
Polypogon monspeliensis (L.) Desf.	**.**	**.**	**.**	**.**	**.**	**.**	**+**	**.**	**+**	**.**
Bolboschoenus maritimus (L.) Palla	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**+**	**.**	**.**
Agrostis stolonifera subsp. *maritima* Mayer	**+**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**r**

Places of relevés: Rel. 1 - 5, 7 - 10 SR – Rel. 6 SVD, Mouth of the Fine River

The populations analyzed showed high sterility and vigorous clonal spread in agreement with what is reported for other European populations able to spread mainly vegetatively [13, 31]. This is in partial contrast to what occurs in North American species for which sexual reproduction and seed dispersal is reported, although with a wide range of seed bank production [45, 52]. This fact can be related to the different phenology of the populations growing in the different continents. While in North America the flowering period of *S. versicolor* occurs from May to November [33] or from May to September [17], in Tuscany, as well as in other Italian regions, it is only during autumn or early winter [40], when the climatic conditions (light and/or temperature) probably become unsuitable for subsequent reproductive stages.

Photo 4: *Spartino-Juncetum maritimi* O. Bolos 1962 (Wet environment)

As regards the vegetational aspects of *S. versicolor* populations, a similarity with what is described in European literature is detectable. On the contrary, a comparison, in phytosociological terms, with American communities is rather difficult. In the USA, in environments similar to those along the European and Mediterranean coasts, *S. versicolor* (cited as *Spartina patens*) is often reported in association with several North American species [32, 34, 35], mostly without being treated according to Braun-Blanquet phytosociological methodology and nomenclature. In these contexts the use of phytosociological nomenclature for this species seems to be rare. Among the few examples found in literature we can mention the description, for populations growing on the coasts of Maine, of the association named *Spartinetum patentis* with three related subassociations, [28].

In Europe *S. versicolor* is ascribed, as a characteristic species, to at least two specific associations: *Spartino versicolor-Juncetum maritimi* O. Bolòs, 1962 and *Elymo farcti-Spartinetum junceae* Vagge and Biondi, 1999 (= *Elymo farcti-Spartinetum patentis* [Baudiere et Simonneau 1971] Gehu et al. 1992).

In the first case (*Spartino versicolor-Juncetum maritimi* O. Bolòs, 1962), the association appears characteristic of brackish marshes, especially along the margins in contact with the dunal strips. Here *S. versicolor* tends to create a very dense sward and it is accompanied more frequently by *Juncus maritimus* and *Juncus acutus*. In this association *S. versicolor* prefers sandy soils, wet enough or exceptionally flooded. This association can be considered a catenal contact between the halo-hygrophyle associations of *Juncion maritimi* and the strictly psammophilous ones of *Ammophiletea* [39, 23, 10, 49].

In the second case (*Elymo farcti-Spartinetum junceae* Vagge and Biondi, 1999) the association is found in the pioneer vegetation of embryo dunes, where *Spartina* is accompanied by *Elymus farctus* and *Euphorbia paralias* [25, 53].

In other cases *S. versicolor* is described as a companion species in different and significantly more psammophilous associations [8, 7] or, when the cover is high, under the generic term “community of *S. versicolor”* [50, 37].

The relevés conducted on the *S. versicolor* phytocenotic communities in Tuscany do not differ much from what is reported for other European or Italian coastal areas. In some cases, however, it is possible to detect, in addition to facies or edaphic variants, also an associative behaviour that gives different and repetitive results, and allows us to identify the new subassociation *spartinetosum versicoloris* (see Table 3) not described in other Italian continental contexts. The presence of this subassociation seems to be linked to particular ecological conditions (wet sands close by the most salty inland areas behind) that occur in some stations such as those close to the mouth of Arno and Serchio Rivers. In these areas the soil features favour the development of grasslands typical of the retrodunal depressions, moderately hygrophile and physionomically dominated by *Erianthus ravennae,* a large caespitose hemicryptophyte that with *Schoenus nigricans* forms the association *Schoeno nigricantis-Erianthetum ravennae* Pignatti 1953 belonging to class *Molinio-Arrhenatheretea* Tüxen 1937. This association in many contexts is considered to be of great environmental value and therefore worthy of protection and control [37].

Such associative behaviour of *S. versicolor* observed in some coastal areas of Tuscany reveals a great plasticity of the species and prompts us to plan further and more detailed investigations. This is in order to better define the phytosociology and the ecophysiological features of *Spartina,* and in particular its environmental requirements and optimal growth conditions, also for its potential use in an applied context.

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SPARTINA VERSICOLOR FABRE ÎN REGIUNILE DE COASTĂ ALE TOSCANEI (ITALIA)

(Rezumat)

Articolul prezintă informaţii despre ecologia şi fitosociologia populaţiilor de *Spartina versicolor* Fabre din zonele de costă ale Toscanei (Italia). Studiile geobotanice au fost făcute pe coastele sedimentare din întreaga regiune. Datele colectate arată faptul că specia creşte pe nisipurile din dunele embrionare, în locurile joase dintre dune şi în zonele umede moderat sărate din jur. În toate situaţiile studiate, specia a prezentat un grad ridicat de sterilitate şi înmulţire clonală. Datele fitosociologice arată comportamente de asociere diferite pentru *S. versicolor* în medii de viaţă diferite. A fost posibilă identificarea a trei tipuri diferite de fitocenoze legate strict de tipologia mediului (pe dune, între dune sau umede) şi de salinitatea solului. În plus, a fost posibilă şi descrierea unei noi subasociaţii.

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