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Some remarks on the flora and land use in North-Western Sardinia

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Some notes on the flora of Sassarese (North-Western Sardinia) and its modifications in the last century in connection with changes in land use are here discussed. Although the study area was heavily urbanised, especially in the last few decades, and had a long history of agricultural and pastoral use, its flora is still very diversified and rich and this, somehow, is strictly related to the land use. However the disappearance of some taxa, especially from wet habitats (springs, watercourses, temporary wet areas, etc.) as Hydrophyte and Helophyte, is pointed out. Other taxa are strongly threatened because of habitat fragmentation or heavy changes in land use.

Introduction

The flora of Miocene calcareous region of North-western Sardinia was recently investigated by Bagella & Urbani (2006). Many previous contributions, from which it was possible to detect floristic information on this area, are often specifically limited to small or marginal sub-areas (Nicotra 1895a, 1895b, 1895c, 1896, 1897; Béguinot 1922a; Nannetti 1914; Desole 1947a, 1955, 1956; Atzei & Draschich-Campazzi 1988). Even in the oldest Sardinian floristic checklists, as Mola (1818-19), Moris (1837-59), Macchiati (1882) and Barbey (1884-85), it is possible to find specific references to taxa collected in this territory. From systematic or ecological works, often dealing with a single taxon, it was also possible to get information on the present or past presence of entities, some of them previously given commonly growing in the study area and, recently, not detected any more. Among them are: Nicotra (1898), Béguinot (1922b), Desole (1954, 1959), Chiappini (1962, 1964), Steinberg (1971), Atzei & Picci (1975, 1977, 1981, 1982), Arrigoni & al. (1976-1991), Valsecchi (1976, 1977, 1979), Atzei (1980), Camarda (1983, 1984, 1998a, 2003), Corrias & al. (1991), Valsecchi & Filigheddu (1991), Filigheddu & Urbani (1994). Vegetational, phytoclimatic and biogeographic studies also contributed to the floristic knowledge of this territory (Herzog 1909; Terraciano 1909; Béguinot 1922c; Desole, 1947b; Moliner & Moliner 1955; Giacomini 1967; Arrigoni 1968; Biondi & al. 1988, 1989, 1990, 2001, 2002; Filigheddu & al. 1999, 2003; Bacchetta & al. 2003, 2004). Information on man-introduced species was also gathered from Viegi (1993) and Camarda (1998b).

Although the study area was heavily urbanised especially in the last decades and had a long story of agricultural and pastoral use and, somehow, in strict relation to this, its flora is still very diversified and rich. Many taxa present in the area are related in different ways to the presence of edges, drystone walls or other constructions, like water mills, residuals from traditional land use, still present, even if very often abandoned.

The object of this note is to examine some of the floristic changes in this territory undergone through the last century. The hypothesis of the shift in the floristic component correlated with the changes in the land use, the least causing the modification, or even the disappearance, of entire habitats, is discussed. This taking into account that change of destination in land use is actually considered one of the main causes of lost of biodiversity in Mediterranean biomes (Sala & al. 2000).

Study area

Calcareous outcrops in North-Western Sardinia cover a large area bordering in the West the Nurra, in the South and South-East the Logudoro and to the East the Anglona regions (Fig. 1). The area called "Sassarese" is one of the largest territories of the island (Mori

Fig. 1. Geographic location of the study area.

1966). The main urban settlement, Sassari, is characterised by the presence of a large olive grove belt, the "Sassari countryside", where small residential settlements and wide abandoned areas, used in the past for agricultural exploitation and now partly covered by new residential and commercial buildings, are present. Although the area is strongly urbanised and marked by a long time agricultural and pastoral use, some sectors of high natural and landscape relevance are present, especially close to the large valleys and calcareous rocky slopes characterising this territory. The presence of structures from the traditional agricultural activities is also relevant. They include drystone walls and terraces still standing in spite of the progressive, irreversible, run wild of the country. They characterise some aspects of the landscape and often contribute to preserve plant and animal biodiversity, together with other elements of the agrarian landscape, i.e. hedges (Forman & Godron 1986; Farina 1996).

The lithologic substratum of Sassarese is mainly composed of marine and continental deposits of middle lower Miocene. They lay on volcanic rocks from andesite to rhyolite of the calcareous-alkaline Oligo-Miocene volcanic cycle, composed of rhyolite, rhyodacite and dacite of upper Oligocene-middle lower Miocene and andesite and basalt andesite of upper Oligocene-lower Miocene (Barca & al. 1996; Carmignani & al. 2001).

Calcareous tablelands in Sassarese, prevalently inclined westwards to the South of the town of Sassari, are divided by several valleys, sometimes a few hundreds meters wide, with steep slopes and flat bottom, occasionally crossed by modest streams.

According to the bioclimatic classification by Rivas-Martínez (1996) and Rivas-Martínez & al. (1999), this area is characterised by an oceanic pluviseasonal Mediterranean bioclimate, upper mesomediterranean thermotype, and upper humid ombrotype.

Land use

Traditionally land use was agriculture in the most fertile areas and pasture in the marginal areas; the latter characterised by less deep soils and often by stony outcrops, strongly affecting plant covering and landscape structure. However, as a result of reduction of cultivated surfaces and of progressive urbanisation of the country, variations in the flora can become evident.

La Marmora (1860) wrote: "The more suitable yield of Sassarese soil is the oil, and it can be said that the land around the town, at a distance of four or five miles, is completely covered by olive trees… I think that olive trees were cultivated since Carthaginian and Roman age…" and Nicotra (1897): "Olive trees form a very extended and thick groves surrounding Sassari with an immense belt of ashen-green colour barely interrupted Northwestwards, where carriage roads and a railway to Porto Torres are planned".

Le Lannou clearly described in 1941 the special cultivation of Sassarese: "The Sassari countryside has one third of the olive trees of the island (one million of plants out of three). It is a forest covering over 7000 ha and extends around the main town, partially on its territory and partially on the ones of Sorso, Sennori, Tissi, Usini and Ossi on the tablelands of Miocene limestone and facing South side. Lower parts, devoted to vegetable cultivation, are the only clear patches in this tree landscape forming an uninterrupted block. The olive

grove of Sassarese includes two concentric areas. Inside, there is the pure olive grove and outside, olive trees are growing among rows of vines. Along the perimeter, vineyards without olive trees, form a third discontinuous belt, very marked in the West and Northwest, in the direction of Porto Torres….Vegetable gardens of Sassari cover almost 500 ha… They look like long and narrow corridors along the valleys, which meet near the town" (Brigaglia 1979).

Olive groves, often terraced and with their age-long plants, represent therefore a dominant element of Sassari countryside landscape. However, productive activities of this cultivation are decreasing due to high costs of manual harvest of olives, excessive breaking up of landed property and indiscriminate building, in the last decades. In many cases they are not cultivated, often totally abandoned, lacking of any preservation cure and so destined to disappear in few decades (Pietracaprina 1989). On the contrary, viticulture is still rather in use, especially in the Sorso and Sennori countryside. Vegetable cultivation is almost completely disappeared due to the growth of the towns in peripheral areas, previously devoted to vegetable gardens. Finally, fodder and cereal plants are grown North of the town of Sassari, up to the coast.

Water sources were numerous in the past, but today most of them are dried up or have extremely reduced flows. The past presence of sources is also confirmed by the still in use place-names, such as Eba Giara, Funtana Niedda, Fonte Barca, Funtana Fritta, Funtana di Lu Colbu, etc., historical evidences and several tanks and drinking troughs, today totally disused, but scattered all over. Fara (1835), in a posthumous edition of a work written towards the end of the 19th-century, counted the presence of about 400 sources in the surroundings of Sassari. La Marmora (1860) also reported "the high number of sources in the area of Sassari affects the nature of the soil, which is very rich".

Flora

The floristic list reported for the area including ancient reports consists up to now 840 infrageneric taxa of 419 genera divided into 107 families. Among them, 18 are to be considered cultivated (*cultae*), 11 are to be excluded from the area (*excludendae*) and 81 are in various ways to be confirmed (*inquirendae*). This latter group includes many taxa reported in the past by different authors, but not in recent studies or whose actual presence is not sufficiently proven. Some of them, as a matter of fact, should be considered as extinct in the area. Therefore the flora likely consists of 730 infrageneric taxa, divided into 385 genera of 98 families (Bagella & Urbani 2006).

The floristic list was checked in order to recognize taxa or cluster of taxa supposed to be affected in their presence or spread around by change in land use. Particularly, taxa checked in the past in the study area, but not confirmed through bibliographic references and/or herbarium specimens, during the last half century, and taxa critical for the conservation in the area were considered. The herbaria checked were SS, SASSA, FI and CAG. The main bibliographic references are reported above.

The biological spectrum of the 81 taxa not confirmed was made and compared with that of the flora really nowadays present in the area (Fig. 2 & 3).

The biological spectrum of the taxa that are presumed actually lacking in the area (Fig. 2)

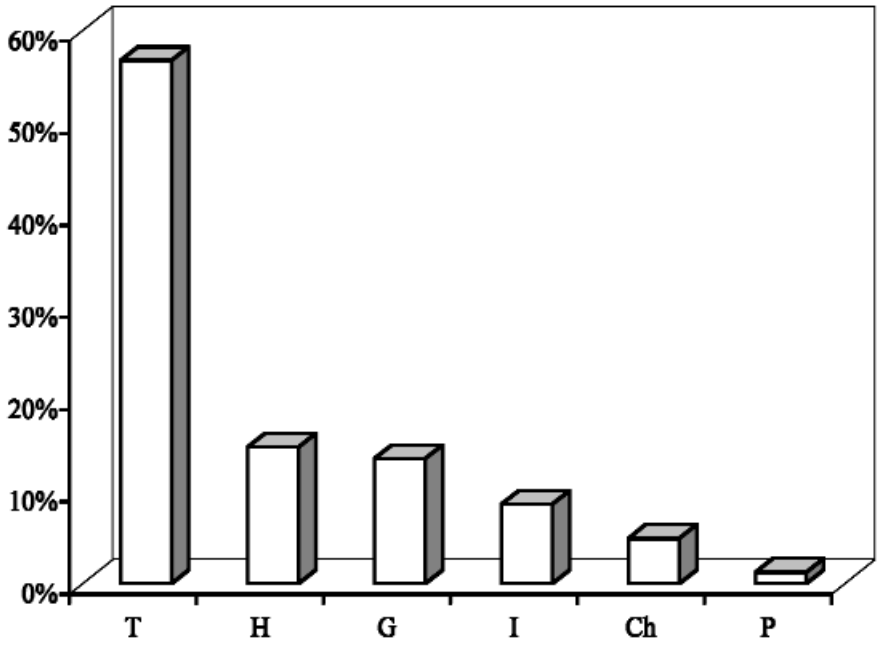

Fig. 2. Biological spectrum of the taxa reported for the study area in the past, but missing in recent surveys.

indicates Therophytes (58%) prevailing on the other biological forms. Many of them are considered weeds of the cultures, as: *Adonis annua* L. subsp. *annua* (Steinberg 1971); *Papaver argemone* L. (Nicotra 1896); *Ranunculus arvensis* L (many specimens in SASSA!); *Adonis microcarpa* DC. (Steinberg 1971); *Amaranthus graecizans* L. sub *A. sylvestris* (one specimen in SASSA!); *Digitaria sanguinalis* (L.) Scop. (Nicotra 1895a 1897); *Galium tricornutum* Dandy (Nannetti 1914); *Legousia hybrida* (L.) Delarbre sub *Specularia hybrida* (L.) A. DC. (Nannetti 1914); *Kickxia elatine* (L.) Dumort. sub *Linaria prestandreae* Tin. (Nicotra 1896); *Myagrum perfoliatum* L. (Barbey 1884-85); *Scandix australis* L. (Nannetti 1914); *Setaria pumila* (Poiret) Schultes sub *S. glauca* (Nicotra 1896); *Trisetaria parviflora* (Desf.) Maire sub *T. parviflorum* Desf (Nicotra 1897). Other Therophytes, that characterise temporary wet habitats, as *Cyperus fuscus* L. or *Isolepis cernua* (Vahl) R. & S. sub *Scirpus savii* S. & M. (Nicotra 1896, 1897) are also missing from the actual flora.

Among the Hemicryptophytes significant is the missing of *Carex panormitana* Guss., a rare endemic to Sicily and Sardinia. For this taxon only one specimen, collected in the study area, is reported: Sassari a Scala di Giocca, 5.V.1895, Martelli in FI (!). Other Hemicryptophytes of wet habitats missing are *Scrophularia auriculata* L. sub *S. aquatica* (one specimen in FI!) and *Carex remota* L. (Nicotra 1895a).

In the last decades of the 20th century many Hydrophytes disappeared from this territory. They represent 9% of the total of the missing taxa. Some of them were recorded in the beginning of the 19th century, (Mola 1818-1819) and never reported later: *Myriophyllum*

spicatum L., *Potamogeton lucens* L., *Potamogeton pectinatus* L. and *Ranunculus aquatilis* L. Other Hydrophytes given in Mola (1818-1819) were still reported at the end of the same century. Among them *Sparganium erectum* L. sub *S. ramosum* L. and *Zannichellia palustris* L. (Nicotra 1895a). In the same period *Spirodela polyrhiza* (L.) Schleiden was also reported (Nicotra 1895a).

A relevant loss is represented by the endemic *Arenaria balearica* L. It was known in the study area from the calcareous slopes in a narrow valley contiguous to the city of Sassari (Sassari a Scala du Pintore, 2.VI.1895, U. Martelli, FI!), but, recently, the entire habitat was destroyed by the construction of a huge residential building.

The biological spectrum of the flora, i.e. the compendium of current flora and the taxa not found recently (Fig. 3), shows a high deficit in Hydrophytes and Helophytes. Specifically, 10 are the Hydrophytes and Helophytes together in the present flora, and 7 are the ones not found recently, presumably lost.

Other taxa not yet disappeared, but strongly threatened, are *Borago pygmaea* (DC.) Chater & Greuter, found only once, near a spring and *Viola arborescens* L. confined in few residual stations completely included or heavily endangered by the town growth.

Conclusions

The bibliographic and historical survey allowed interesting observations on the deep changes of the territory and its flora in the last two centuries. One of the possible main rea-

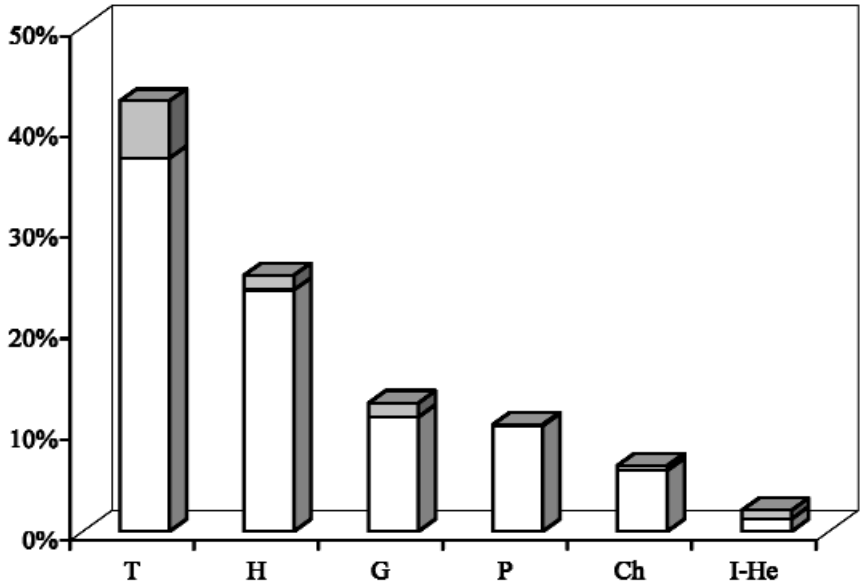

Fig. 3. Biological spectrum of the flora of the study area: current flora (white) and taxa missing in recent surveys (grey).

sons for the disappearance of some Therophytes, strictly related to the culture practices, is the shift in land use, especially in agriculture practises.

Very evident is the loss of biodiversity among taxa related to wet habitats (springs, water courses, temporary wet areas, etc.). Among them, *Carex panormitana* Guss. and *Borago pygmaea* (DC.) Chater & Greuter are the most relevant. The first, included in the II Habitat Directive (European Commission 1992) and in the Italian Red Book (Conti & al. 1992) as Vulnerable, is now very likely to be considered extinct in the North Sardinia and the second, included in the Italian Red Book (Conti & al. 1992) as Rare, is to be considered with a high risk of extinction in this area.

Arenaria balearica L. could also be considered lost in the area because the narrow valley from where it was known, have been included into the city of Sassari.

Other taxa present in the study area are of great interest. Among them, there are four endemics whose *locus classicus* lies in the Sassarese: *Ophrys sphegodes* subsp. *praecox* Corrias, endemic to Sardinia and Corse, and the Sardinian endemics *Centaurea corensis* Valsecchi & Filigheddu, *Limonium racemosum* (Lojac.) Diana and *Scrophularia morisii* Valsecchi. These last three taxa are known exclusively for the Sassarese.

The high anthropic impact, the habitat disruption, the agricultural practices and the shift towards different land uses, have in various ways contribute to the changes in the floristic richness, and to the deletion or rarefaction of several taxa in this area. A possible conservation of the residual species and habitat biodiversity could be favoured by a suitable management and, possibly interconnection of the habitats hosting, or that used to host these entities.

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