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FLORISTIC AND ECOLOGICAL REMARKS ON THE ISLET FORMICA DI BURANO (TUSCAN ARCHIPELAGO, TYRRHENIAN SEA)

Abstract - An up-to-date check-list of the vascular plants of Formica di Burano Islet is given. Species richness, turnover rate and floristic change trend through Grime's C-S-R strategies theory are briefly discussed.

Key words - Tuscan Archipelago, islets, flora, turnover, life-strategies.

Riassunto - *Note floristiche ed ecologiche sull'isolotto «Formica di Burano» (Arcipelago Toscano, Mare Tirreno)*. Viene presentata una lista aggiornata della flora vascolare dell'isolotto Formica di Burano. Vengono inoltre discussi gli aspetti inerenti la ricchezza di specie, il tasso di avvicendamento floristico ed il suo andamento utilizzando la teoria delle strategie C-S-R di Grime.

Parole chiave - Arcipelago Toscano, isolotti, flora, turnover, strategie primarie di Grime.

Introduction

Botanists have recently payed a remarkable attention to the islets of the Tuscan Archipelago (De Dominicis *et al*., 1988; Baldini, 1990, 1991, 2001; Foggi *et al*., 2000, 2009), in order to delineate both their biological importance and an appropriate conservation assessment for their simplified ecosystems. Some of these islets have been investigated since the end of the XIX century, thus the floristic inventories represent valuable databases for an evaluation of eventual changes affecting the structure of their plant communities elapsed during the last century. It may be particularly relevant for the islets prone to direct or indirect human disturbance, such as those where the massive increase of seagull populations seems to have induced strong modifications in the floristic and vegetational assemblages (see Foggi *et al*., 2000, 2009).
Formica di Burano (sometimes also named as «Formica di Ansedonia») is one of the smallest islets of the Tuscan Archipelago and represents an interesting field lab for comparing historical and recent data and monitoring the dynamic of these processes across time. In fact, due to its importance for nesting and wintering marine birds, this site has been included among those assigned to the SPA IT51A0035 («Isolotti grossetani dell'Arcipelago Toscano») of the Nature 2000 network.
The *Flora Italica* of Bertoloni reports *Lavatera arborea* L. «*ex insula delle Formiche prope Cosam a Prof. Giulio*» (Bertoloni, 1847: 268), which represents the first botanical information concerning this islet. Sommier (1902) quotes this latter and adds that of *Obione portulacoides* Moq. from the plant material collected by the marquis G. Doria in June 1901. In a further contribution, Sommier (1903) reports the full list of these *exsiccata*, which consist of nine species. One century later, the results of preliminary surveys of the islet's vegetation are given by Foggi *et al*. (2000), while Foggi *et al*. (2009) provide a list of five species collected during the period 1998-2000 on this islet. Unfortunately, this paper does not include the review of the previous records concerning Formica di Burano.
During a recent visit to the islet, one of us (PLC) had the opportunity to collect new data, which allow to update the knowledge on its floristic assemblage. Even if this islet harbours a very poor plant community, the comparison between previous and new records offers a chance to briefly discuss its ecological features.

Study area

Formica di Burano (42°22'49.5"N - 11°18'35.2"E) is located in southern Tuscany, to the east of Monte Argentario and to the south-east of the Ansedonia headland, 2.75 km off the continental coast. The surface is about 7,200 m^2 and the maximum elevation is 5 m a.s.l. The lithological substrate consists entirely of limestone, while thin and scarcely-developed soil occurs just in the rocky crevices of the flat top (Fig. 1). Following the classification of Thornthwaite & Mather, the climatic type was defined as B'2b'4C1W2 by Foggi *et al*. (2009), on the basis of the meteorological data available for Monte Argentario. The islet harbours 25-50 nesting pairs of seagulls (Foggi *et al*., 2009; P. Sposimo, pers. comm.), and it represents also an important winter dormitory for *Phalacrocorax carbo* L. (up to 1,000 individuals estimated: N. Baccetti, pers. comm.).

Materials and methods

The present study is based on field notes and plant material collected during a visit at Formica di Burano Islet in early July 2009. Some species occurring with few or single individuals have been identified through detailed photos and/or plant parts, in order to reduce disturbance on the local community dynamics. The

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Fig. 1 - The NE sector of the flat top of the islet.

available *exsiccata* have been deposited in the Herbarium Mediterraneum of Palermo. Plant samples have been classified mainly following Pignatti (1982), Tutin *et al*. (1968-1980; 1993), and some updated reviews (Castroviejo, 1990; Arrigoni, 2006; el-Bakatouschi *et al*., 2007). Dicots and Monocots families' placements follow, respectively, Cronquist (1988) and Dahlgren *et al*. (1985). Nomenclature follows mainly Pignatti (1982), Tutin *et al*. (1968-1980; 1993), Greuter *et al*. (1984-1989) and Conti *et al*. (2005). For each taxon, life-form (Raunkiaer, 1934), chorotype (or xenophyte status, according to Richardson *et al*., 2000), primary life-strategy (Grime, 1977; 2001), pollination (Julve, 1998), and dispersal strategies (from personal observations and Molinier & Müller, 1938; Julve, 1998) have been indicated. The following abbreviations have been used in text: R, ruderal; S, stress tolerant; SR, stress tolerant/ruderal; ANE, anemogamy; AUT, autogamy; ENT, entomogamy; A, anemochory; B, barochory; EN, endozoochory; EP, epizoochory; HY, hydrochory. Species previously recorded but not confirmed are marked by the symbol «°».

List of taxa

Magnoliophyta-Dicotyledones

Amaranthaceae
Amaranthus cfr. *retroflexus* L. – T scap – Naturalized alien – R – ANE – EN – Very rare.

Apiaceae
Crithmum maritimum L. – Ch suffr – Mediterranean-Atlantic – S – ENT – AN/HY – Some individuals in the coastal belt. Previously recorded by Sommier (1903) and Foggi *et al*. (2009).
°*Daucus gingidium* L. – H scap – CW Mediterranean – S – ENT – EP – (Sommier, 1903).

Asteraceae
Erigeron bonariense (L.) Cronq. – T scap – Naturalized alien – R – ENT – AN – Very rare.
°*Senecio leucanthemifolius* Poir. s.l. – T scap – CW Mediterranean – R – ENT – AN – (Sommier, 1903).
Sonchus oleraceus L. – T scap – Boreal-Tethyan – R – ENT – AN/EP/BA – Only one individual observed.

Boraginaceae
Heliotropium europaeum L. – T scap – European-Mediterranean – R – ENT – BA – Few and scattered individuals in the inner plateau.

Caryophyllaceae
Spergularia salina J. et C. Presl – T scap – Holarctic – R – AUT – AN – In the rocky crevices, at the margins of the chenopod vegetation. Previously recorded by Sommier (1903, as *Lepigonum marinum* Wahlb.).

Chenopodiaceae
Atriplex portulacoides L. – Ch frut – Tethyan-European – SR – AUT – AN – Common, even if it seems less abundant than the latter species. Previously recorded by Sommier (1902; 1903, as *Obione portulacoides* Moq.) and Foggi *et al*. (2009).
Atriplex prostrata DC. – T scap – Holarctic – R – AUT – AN – Common and abundant. Previously recorded by Sommier (1903, as *Atriplex hastatum* L.) and Foggi *et al*. (2009, as *Atriplex hastata* L.).
Chenopodium album L. – T scap – Holarctic-Paleotropical – R – ANE – EN – Few plants, widely distributed.
°*Salsola soda* L. – T scap – Boreal-Tethyan – R – ANE – BA – Not observed, even if this species has been recently recorded by Foggi *et al*. (2009).
Sarcocornia perennis (Mill.) A.J. Scott – Ch succ – Holarctic – SR – ANE – HY – Rare and localized in some rocky substrates, it grows together with other chenopods. Previously recorded by Sommier (1903, as *Salicornia fruticosa* L.).
Suaeda maritima (L.) Dumort. – T scap – Cosmopolitan – R – ANE – BA – Common and abundant. Previously recorded by Sommier (1903).

Malvaceae
Malva veneta (Mill.) Soldano, Banfi et Galasso – H bienn – Mediterranean-Atlantic – R – ENT – HY/BA/EN – Few and scattered individuals in the inner plateau. Previously recorded by Bertoloni (1847), Sommier (1902; 1903) and Foggi *et al*. (2009), as *Lavatera arborea* L.

Plantaginaceae
Plantago major L. subsp. *intermedia* (Gilib.) Lange – H ros – Subcosmopolitan – R – ANE – BA – Extremely rare.

Portulacaceae
Portulaca oleracea L. subsp. *granulato-stellutata* (Poellen) Danin et H.G. Baker – T scap – Subcosmopolitan – R – AUT – BA/EN – Rare and isolated individuals.

Solanaceae
Solanum nigrum L. – H scap – Cosmopolitan – R – ENT – EN – Few and scattered individuals, mainly in the inner plateau.

Monocotyledones

Poaceae
Digitaria sanguinalis (L.) Scop. – T scap – Cosmopolitan – R – ANE – BA/EP –Extremely rare.

Discussion

A total of 19 taxa belonging to 11 families has been recorded for Formica di Burano Islet; however, only 16 were confirmed or newly recorded during the present survey. Chenopodiaceae, with 31.6% of the occurring species, result the richest family. Life-form spectrum shows a remarkable preponderance of therophytes (Fig. 2), which reach the highest percentage value (62%) so far recorded in the Tuscan islets (see Foggi *et al*., 2009). Entomogamy and anemogamy are the dominant reproductive types, both with a percentage value of 37.5%, while autogamy value is 25%. Long- and short-distance dispersal modes are quite uniformly represented within the islet flora, with a predominance of anemochory (36%) and barochory (29%), and 5 out of 16 species are characterized by mixed strategies. Surprisingly, endozoochory (16%) and epizoochory (6%) do not prevail in a context where seabirds seem to represent the main ecological constraint for floristic structure and dynamic. The vascular flora of the studied islet appears to be characterized by sharp differences in comparison to other micro-insular areas of the Tuscan Archipelago, mostly related to its physiography. Sharing the same flat morphology, the same geolithological substrate, and similar plant communities, Formica di Burano could resemble well to Formica Grande (the main islet of Formiche di Grosseto), where small depressions occupied by chenopod vegetation are alternate to bare rocky substrates that harbour lithophilous aerohaline communities (Foggi *et al*., 2000). However, the *Crithmo-Limonietea* formations of Formica Grande are dominated by *Limonium doriae* (Sommier) Pignatti, endemic of this islet (Baldini, 1990), while no *Limonium* species has never been recorded on Formica di Burano. The lack of species belonging to this genus, e.g. *Limonium multiforme* Pignatti, which is widely distributed on other nearby islets (Isolotto di Porto Ercole and Argentarola) as well as along the continental coast of Argentario (Baldini, 2001), could be explained with the habitat disturbance related to the high density of wintering and nesting seabirds on Formica di Burano.

In order to evaluate the ecological meaning of the floristic changements occurred on the islet, present species composition has been compared with the data collected in early XX century (Sommier, 1903). For each census, the prevalence score of each strategy (percentage weight of each strategy out of the total of the strategies of islet's vascular flora) in both periods has been calculated. The prevalence score (%) of each strategy was computed as a weighted sum of the prevalence scores, where the «pure» strategy (e.g. S or R) was considered by a factor 1, the «double» strategy (i.e. SR) by 0.5. For instance, prevalence of strategy R (%) is calculated as follows: $1 \times R + 0.5 \times SR$. The 1901 and 2009 scores were then placed in the centre of the space occupied by the censuses in the ordination (Fig. 3), and strategy patterns were drawn as contour maps.

Absolute (S2: Herwitz *et al*., 1996) and relative (Rt: Diamond, 1969; Schoener, 1983; Morrison, 1997; 2003) turnover rates have been also calculated by using the following formulae:

$$S2 = (I + E) / 2t \text{ and } Rt = [(I + E)/t\ (S1901 + S2009)] \times 100,$$

where «t» is the time period between Sommier (1903) and our census (108 years), «E» stands for the species present only in 1901 (year of Doria's collection) and now extinct (2) and «I» for the «immigrant» species recorded during the 2009 visit (9). Hence, S2 = 0.051 and Rt = 264.81. Both values result quite low, even if the data could feel the effects of the very large time gap between the compared censuses.

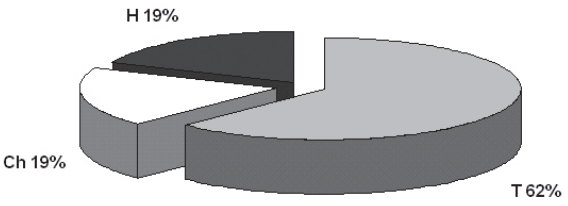

Fig. 2 - Raunkiaer's life-form percentages of the flora of Formica di Burano Islet.

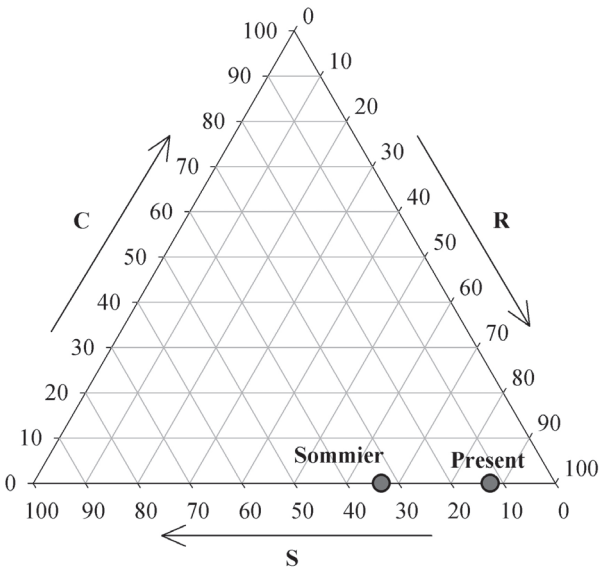

Fig. 3 - Comparison of Grime strategy of the whole flora: 1901 *vs*. present day.

Concerning the nine «new entries» (*Amaranthus* cfr. *retroflexus*, *Erigeron bonariense*, *Sonchus oleraceus*, *Heliotropium europaeum*, *Chenopodium album*, *Plantago major* subsp. *intermedia*, *Portulaca oleracea* subsp. *granulato-stellutata*, *Solanum nigrum* and *Digitaria sanguinalis*), all are typical to *Stellarietea mediae* R. Tx. Lohmeyer et Preising ex von Rochow 1951, that includes all the plant communities dominated by plenty of nitrophilous, ruderal and somewhat pioneer annual and perennial herbs characterizing cultivated and abandoned agricultural areas, wastelands, disturbed suburban areas, etc. On the other hand, the two species recorded by Sommier (1903) but not confirmed during the present study are typical to coastal rocky habitats: *Daucus gingidium* is characteristic of coastal subshrub lithophilous aerohaline communities (class *Crithmo-Limonietea* Br.-Bl. in Br.-Bl., Roussine et Nègre 1952), while *Senecio leucanthemifolius* behaves as a nitrophilous species and is rather common in *Crithmo-Limonietea* communities subject to seagull disturbance. This fact, jointly with the low occurrence of endo- and epizoochorous species, suggests that seabird activity (particularly gulls) should not be considered the main direct agent of floristic changements, but as indirect factor that mostly influences the vegetation structure and distribution. From this point of view, Formica di Burano seems to be exposed to pressure and disturbance level similar to those observed in several micro-insular Mediterranean contexts (Vidal *et al*., 2000; Snogerup & Snogerup, 2004), including other Tuscan islets (Foggi *et al*., 2009). Furthermore, the complex effect of its flat morphology and low elevation, which expose the islet to severe stress factors (solar radiation, wind, salt-spray, poor pedogenesis) and can favour seabird disturbance, could be regarded as the plausible cause of the very low local species richness.

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