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Vascular flora evolution in the major Mediterranean islands

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ABSTRACT Characteristics of Mediterranean island floras are analyzed with stress on endemic units. On these bases the main relationships between the major Mediterranean areas and the inland territories with the strongest floristic affinities are analyzed. Finally the role of aliens in Mediterranean island floras and threats are discussed.

KEY WORDS Biogeography; Mediterranean; endemism; alien flora.

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INTRODUCTION

The Mediterranean is among the richest regions in the world for wild and cultivated species. Circum-Mediterranean countries house about 25,000 species, almost one tenth of the world's vascular flora, the 63% of which are endemic (Greuter, 1991; Medail & Quezel, 1999).

A peculiarity of this area is the high amount of species with a narrow range, many of which are local endemics. In some sectors endemics are more than 20%. Among these there is Sicily and the other major Mediterranean islands and island groups: Baleares, Corse, Sardinia, Kriti, Cyprus with their mountain areas. The main reason for this high endemism can be searched in the pronounced habitat fragmentation that characterises the Mediterranean area as a whole.

CHARACTERISTICS OF MEDITERRANEAN ISLAND FLORAS

Mediterranean island flora is relatively well known although each year new species, sometimes completely unknown, are described (e.g. *Ptilostemon greuteri* Raimondo et Domina. Fig.1). Traditionally the floras of large Mediterranean islands are considered ancient, relatively poor in species, rich in endemic taxa and particularly vulnerable (Greuter, 1995).

Permanence in situ and prolonged evolutionary standstill are salient characteristics of Mediterranean island floras (Greuter, 1979). These have a relictual nature and are at least ancient as the islands themselves; for Cyprus, Crete and the Baleares about 5-6 milion years, dating back to the post-Messinian transgression (Greuter, 1995). According to the equilibrium theory of island biogeography (MacArthur & Wilson, 1967) the number of species on an island is in a state of dynamic equilibrium; diversity eventually stabilizes but turnover remains high as species continuously colonize and go extinct. The flora of the Mediterranean was subject to an impoverishment due to the climatic fluctuation during Pliocene and a subsequent enrichment due to immigration by long range dispersal (Quézel & Médail, 2003). This is more manifest in the islands where original species pool seems to become considerably impoverished before immigration could balance extinction.

Indeed the open sea is a more impermeable barrier for all kinds of land plants than is solid ground, even when inhospitable. On the sea there is no chance for small, ephemerous populations to get established, no resting places for pollen-carrying insects. Salt water will kill offmost swimming propagules in a matter of hours or days, and those that might survive will be deposited in saline habitats hostile to most non-littoral species. Germination loss after some days of saltwater exposure was verified for some Mediterranenan plants e.g. *Lotus cytisoides* L. (Fabaceae) and *Plantago weldenii* Rchb. (Plantaginaceae) (Potthoff, 1989), on the contrary to different Anfiatlantic plants that have a high resistance to saltwater (eg. *Portulaca* gr. *oleracea* L.) (Danin et al., 1978).

Comparing island floras with the mainland ones the ratio "species number/area size" does not give particular difference. But Mediterranean island floras are usually poor in endemics when compared with the relevant mainland areas (Greuter, 2001).

Figure 1. *Ptilostemon greuteri* in its natural habitat recently found in the Inici Mt. around Castellammare del Golfo (Trapani) few kilometres from the built-up area.

ENDEMISM

Number and rates of endemics in a given territory depend on the territory's size and is not related to its insularity. On the major Mediterranenan island systems, around 10% of the species are endemic and sometimes confined to a single island. This rate is lower also than in Oceanic islands (Table 1). In addition, in continental islands species are often quite localized and have a small number of individuals, e.g. *Abies nebrodensis* (Lojac.) Mattei in Sicily.

Adaptive radiation (Darwin, 1854) in which natural selection drives divergence of an ancestral species into descendants that are better able to exploit ecological opportunity (Dobzhansky, 1948) has no applicability in Mediterranean islands. Whenever you look closely at examples of variable, polymorphic groups you are likely to find mosaic patterns of geographical vicariance rather than sympatric niche differentiation concomitant with speciation, as is thought to be characteristic of genuine adaptive radiation. An example of is the vicarious distribution of *Anchusella variegata* (L.) Bigazzi, E.Nardi et Selvi in Italy and Northern Greece and *Anchusella cretica* (Mill.) Bigazzi, E.Nardi et Selvi in the Peloponnesus. Geographic vicariance is clear also within the apomictic/sexual complex of *Limonium*. This phenomenon started around 6 mya, at the same time as one of the most dramatic changes that affected the Mediterranean basin. The number of species of *Limonium* in the major Islands varies according to a decresing gradient from west to east: 57 in the Baleares, 27 in Corse, 51 in Sardinia, 44 in Sicily, 19 in Kriti and 9 in Cyprus (Domina, 2011) (Fig. 2). Therefore the West Mediterranean is being identified among the main centres of differentiation of the genus.

The islands split off from the mainland (chersogenous ones), like all Mediterranean ones of an appreciable size, already carried their own, fully adapted and diversified flora when they became insular. They are conservative systems. Ideally, the flora of each island can be considered to be a reflection, perhaps impoverished but otherwise little

Island or Archipelago	Area Km^2	No. of species	species/ Area	No. of endemics	endemics/ Area	% of endemics
OCEANIC						
Juan Ferdinandez Island, Chile	93	147	1.58	118	1.27	80
Galapagos Islands, Ecuador	7844	543	0.07	229	0.03	42
Mauritius	1865	800	0.43	280	0.15	35
Rodrigues, Mauritius	104	145	1.39	48	0.46	33
Madeira, Portugal	769	750	0.98	129	0.17	17
Canary Islands, Spain	7273	2000	0.27	569	0.08	28
Ascension, UK	94	25	0.27	11	0.12	44
Soqotra, Yemen	3799	825	0.22	307	0.08	37
MEDITERRANEAN						
Baleares, Spain	4996	1500	0.30	121	0.02	8
Corse, France	8748	2781	0.32	240	0.03	9
Sardinia, Italy	24090	2407	0.10	238	0.01	10
Sicily, Italy	25708	2939	0.11	407	0.02	14
Kriti	8258	1971	0.24	189	0.02	10
Cyprus	9253	1940	0.21	121	0.01	6

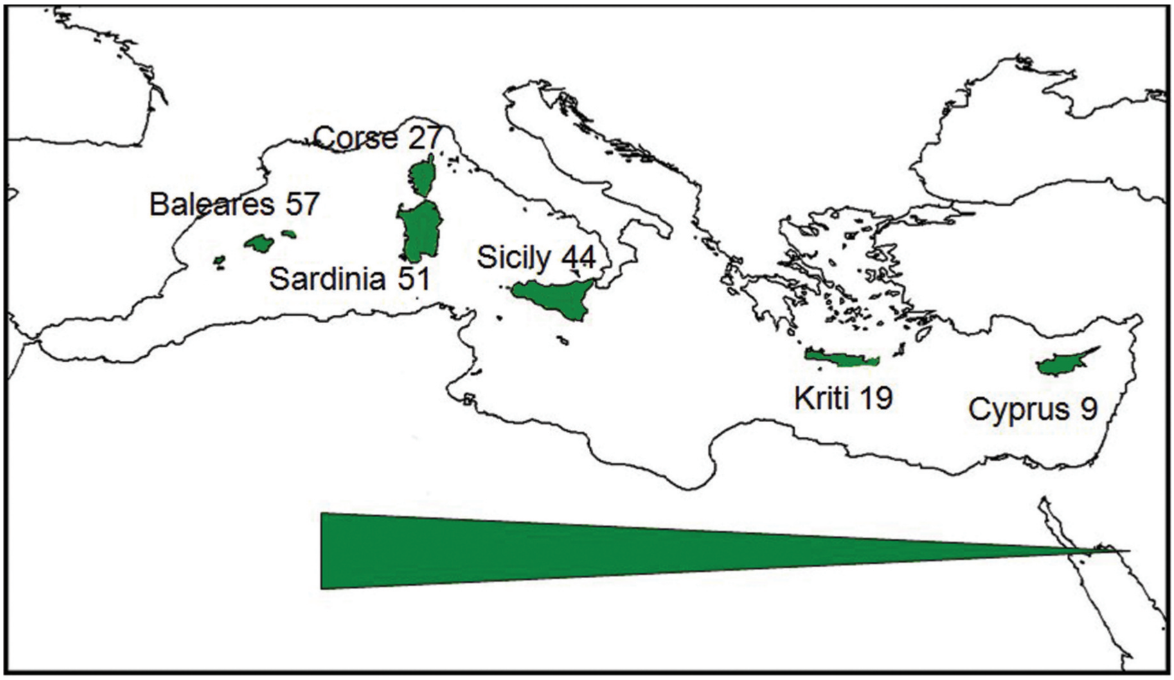
Table 1. Comparison between Oceanic islands and the main Mediterranean islands in number of species and endemics in relation with their area.

Island or archipelago	% Aliens in the flora	Area Km^2	Altitudinal range	No. Total taxa / area
CORSE	16.4	8748	2710	0.318
SARDINIA	6.4	24090	1834	0.100
CYPRUS	10.5	9253	1953	0.230
SICILY	8.4	25708	3323	0.125
KRITI	7.3	8258	2456	0.239
BALEARES	15.1	4996	1450	0.346

Table 2. Comparison between the percentage of aliens in the flora and geographical features of the major Mediterranean islands.

changed, of the plant cover it was bearing at the time when it became insular (Greuter, 2001).

For the same reason the endemics shared among the floras of the main Mediterranean islands are very poor. Sicily shares 65% of its flora with Sardinia and Corsica but only few endemics, e.g. *Carex panormitana* Guss., *Dianthus arrostii* C. Presl and *Genista aetnensis* (Raf. ex Biv.) DC.



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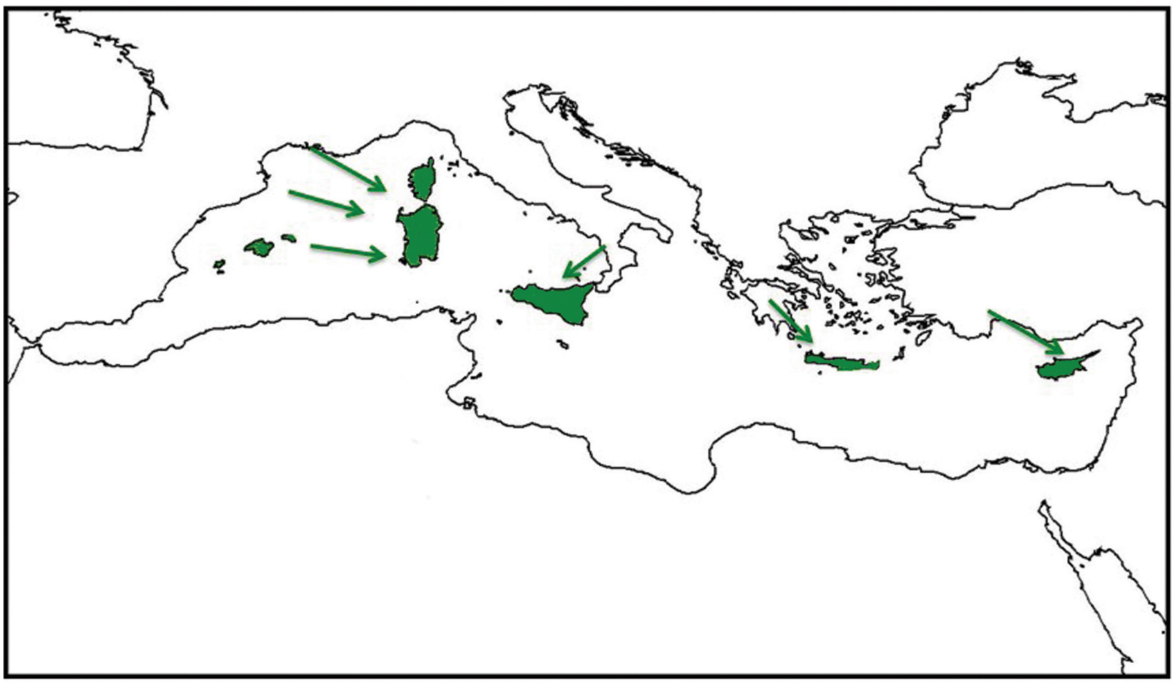

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Figure 2. Occurrence of *Limonium* species in the major islands of the Mediterranean, it is evident a decreasing gradient from west to east. Figure 3. Floristic affinities between the major Mediterranean islands and the relevant inland territories.

The Sardinian flora is better represented in Corsica, where 84% of its flora occurs (Bocchieri et al., 2006); strong similarities with the Balearic Islands, as well as with coastal Spain and France (Fig. 3) are also clear. This pattern is expected because the islands have a similar geological history and they, particularly Sardinia, were closer to the Balearic Islands and the Pyrenees in the Miocene, e.g. *Soleirolia soleirolii* (Req.) Dandy, Urticaceae.

Corsica shows the strongest floristic affinity with Sardinia, when we compared endemics shared between W Mediterranean islands. A particularly conspicuous affinity also exists with the adjacent mainland of France (incl. Massif Central), NE Spain and W Italy (e.g. *Bupleurum stellatum* L. Apiaceae). Crete shows the strongest floristic affinity with Greece (e.g. *Potentilla speciosa* Willd. Rosaceae) but few similarities with Anatolia and E Mediterranean.

Cyprus shows the strongest floristic affinity with Anatolia (e.g. *Onosma mite* Boiss. et Heldr., Boraginaceae) and few similarities with East Mediterranean and North African territories.

HUMAN IMPACT

In the last centuries man has become the most important vector for newcomers surpassing the other animals, birds, drift and wind; in this way former isolation barriers were broken (Domina & Mazzola, 2011). By the trade of goods, plants and animals Man has, accidentally or purposely, introduced large quantities of alien propagules into suitably cleared, new manmade habitats, or at least into a degraded, unbalanced environment. This could have eliminated vulnerable old relic species. But if these losses did happen, it must have been long before reliable botanical records were made (Greuter, 2001). Looking at the damage that already occurred in a flora can be assessed its vulnerability. Rather than by new species introduction most damages to floras are to be imputed to habitat loss; recent examples are the endemics *Lysimachia minoricensis* J.J.Rodr. (Primulaceae) extinct from Menorca and *Adenostyles nebrodensis* (Wagenitz et I. Müll.) Greuter (Asteraceae) practically extinct from Sicily.

Vulnerability of a flora is evidenced by its opening to aliens. New introductions of plant diaspores is difficult in the Mediterranean because of niche pre-emption of a resident flora that has long been well adapted to existing habitat conditions (Runemark, 1969). This is overcome when habitats have been pre-cleaned by human activities. So since ancient times the Mediterranean islands have been affected by more intense human pressure, therefore they host higher percentage of alien than the mainland. The most important relations in large islands have been observed between aliens occurrence and floristic density. In fact the aliens occurrence in each island is related to extension and variety of habitats actually susceptible to invasions (Domina & Mazzola, 2011).

WHERE ARE WE GOING

Large Mediterranean islands conserve mid-Tertiary floras rich in endemics. These plants are well fitted to their natural environment and several of them, in spite of their rarity, continue to survive if their habitats are not manipulated. Touristic and urban development are seriously damaging unique biota and their plants. Research on Mediterranean plant diversity, biology, demography and distribution is to be intensified to better know how we can protect plant admitting a wise human development aware of natural resources. Awareness of conservation problems is arising throughout the Mediterranean, and if coordinated efforts are done, we are still in time to prevent heavy losses and to leave this rich and valuable plant heritage to future generations.

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REFERENCES

Bocchieri E., Mannini D. & Iiriti G., 2006. Endemic flora of Codula di Luna (Gulf of Orosei, Central Eastern Sardinia). Bocconea, 19: 233-242.

Danin A., Baker I. & Baker H.G., 1978. Cytogeography and taxonomy of the *Portulaca oleracea* L. polyploid complex. Israel Journal of Botany, 27: 177 211.

Darwin C., 1845. Journal of Researches into the Natural History and Geology of the Countries Visited During the Voyage of H.M.S. Beagle Round the World, under the Command of Capt. FitzRoy, R.N, 2nd ed. John Murray, London, 519 pp.

Dobzhansky T., 1948. Darwin's finches and evolution. Ecology, 29: 219-220.

Domina G., 2011. Plumbaginaceae. In: Euro+Med Plantbase - the information resource for Euro-Mediterranean plant diversity. Published on the Internet http://ww2.bgbm.org/EuroPlusMed/ [20/11/2012].

Domina G. & Mazzola P., 2011. Considerazioni biogeografiche sulla presenza di specie aliene nella flora vascolare del Mediterraneo. Biogeographia, 30: 269-276.

Greuter W., 1979. The origin and evolution of island floras as exemplified by the Aegean archipelago. In: Bramwell D. (ed.), Plants and island. London & New York, pp. 87-106.

Greuter W., 1991. Botanical diversity, endemism, rarity, and extinction in the Mediterranean area: an analysis based on the published volumes of Med-Checklist. Botanica Chronica, 10: 63-79.

Greuter W., 1995. Origin and peculiarities of Mediterranean island floras. Ecologia Mediterranea, 21: 1-10.

Greuter W., 2001. Diversity of Mediterranean island floras. Bocconea, 13: 55-64.

MacArthur R.H. & Wilson H.E., 1967. The theory of island biogeography. Princeton.

Médail F. & Quézel P., 1999. Biodiversity hotspots in the Mediterranean Basin: Setting global conservation priorities. Conservation Biology, 13: 1510-1513.

Potthoff S., 1989. Schwimmfähigkeit und Salztolleranz von Diasporen küstenbewohnender Pflanzen der Südostägais und ihre Möglichkeiten der Verbreitung durch Meeresströmungen. Diploma thesis, Free University, Berlin.

Quézel P. & Médail F., 2003. Ecologie et biogéographie des forêts du basin méditerranéen. Elsevier, Collection Environnement, Paris, 573 pp.

Runemark H., 1969. Reproductive drift, a neglected principle in reproductive biology. Botaniska Notiser, 122: 90-129.