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MONOGRAPH

Taxonomy and conservation in Higher Plants and Bryophytes in the Mediterranean Area

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ABSTRACT The Mediterranean Region is among the areas of the world richest in wild and cultivated taxa. Extinctions in the Mediterranean area are bound to have occurred in historical times but they are not documented. The probable and documented cases of plant extinction in specific areas within the Mediterranean are equivalent to 0.25% of total species-by-area records. Species with a large range are more prone to local population size fluctuations and eventual extinction than species with a reduced population. Small islands floras are more prone to extinction than those on large islands and on the mainland. Reliability of our data on Mediterranean plant extinctions is poor. New emphasis on floristic research is needed to boost our deficient knowledge of the Mediterranean flora. A closer collaboration between scholars and amateurs can increase floristic knowledge and also help unravel taxonomic problems.

KEY WORDS vascular plants; mosses; extinctions; nomenclature.

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INTRODUCTION

The Mediterranean Region is among the areas of the world richest in wild and cultivated taxa. The vascular flora comprises about 25.000 species. 50% of the Flora (about 12.500 species) are endemic (Médail & Quézel, 1999). This richness is not due to high local species density but to small mean distributional areas reflected in a remarkable number of narrow endemics (Greuter, 1991; 2001). In spite of this high biodiversity, not all Mediterranean countries have their own Red List of endangered plants as yet; it is therefore quite difficult to make between-country comparisons. An overview was offered by Leon et al. (1985), who summarised the risk status of endemics in Mediterranean countries. More recently new lists were prepared for single countries. The red list of the flora of Greece (Phitos et al., 2009) is an outstanding example. Global summaries for Europe have been presented by Sharrock & Jones (2009), Bilz et al. (2011), and Heywood (2012), but for the extra-European parts of the Mediterranean they are still wanting.

MEDITERRANEAN VASCULAR PLANT EXTINCTIONS

Extinctions in the Mediterranean area are bound to have occurred in historical times, with the advent of agriculture and the profound transformation of the biota it entailed; but they are not documented. Even the alleged extinction of the famous "silphium" is not proven with certainty. The plant, probably a *Ferula* or other giant umbellifer, was used in classical antiquity in medicine and was also

fed to sheep and cattle. It was an essential item of trade with the ancient North African city of Cyrene (Fig. 1). By the first century A.C. the species, due to overgrazing and over-collection, was considered extinct in nature (Applebaum, 1979). However, from extant written documents and paintings it is not possible to name the plant with certainty. Its identity with several species has been suggested in lively and long-lasting debates, but it is still not possible to know for certain whether or not the plant is indeed extinct (Parejko, 2003).

The probable and documented cases of plant extinction in specific areas within the Mediterranean, as recorded in Med-Checklist volumes 1, 3, and 4 (Greuter et al., 1984-1989), are 116, equivalent to 0.25% of 47,298 total species-by-area records (Greuter, 1991). The reported cases of total extinctions of taxa are 22 (0.17 % of 12,886 taxa), of which: 7 are "mystery cases", 5 are cases of possible or actual rescue, and 10 are genuine cases of (presumed) extinction (Greuter, 1991). Since 1991, continuing field research has resulted in even more reassuring figures: the 7 "mystery cases" remain the same, 4 cases of possible or actual rescue were added (*Coincya monensis* subsp. *pubérula*, *Salvia peyronii*, *Silene rothmaleri*, *Silene tomentosa*), bringing the total to 9; and of the genuine cases of (presumed) extinction, only 6 remain.

The 7 "mystery cases" are: 1) *Alyssum paniculatum* Desf. (Cruciferae), based on a painting by Aubriet, allegedly representing a Cretan plant found by Tournefort in 1700 that matches no species known to grow in that area. 2) *Armeria arcuata* Boiss. et Reuter (Plumbaginaceae), once collected by Welwitsch in Portugal and never again found; according to Nieto Feliner (1987) it may well have been an occasional intersectional hybrid. 3) *Campanula pyrenaica* A. DC. (Campanulaceae), based on two specimens, one allegedly from the Balearic islands, the other from the Pyrenees. It has recently been considered a synonym of *Campanula scheuchzeri* Vill. (Castroviejo et al., 2010). 4) *Genista melia* Boiss. (Leguminosae), described from Milos (Cyclades, Greece) and once doubtfully reported from the Troad (Anatolia). The origin of the type, which may well belong to the W Mediterranean *Genista scorpius* complex, is in doubt. 5) *Lathyrus allardii* Batt. (Leguminosae), described from near Alger (Algeria) in 1879 and never seen since then. Its native status has already been doubted by its author. Perhaps it is only a form of *Lathyrus gorgoni* Parl., native further east and occasionally introduced. 6) *Quercus sicula* Lojac. (Fagaceae), described from a tree cultivated in the Botanical Garden of Palermo of unknown, probably not Sicilian origin. An altogether doubtful taxon, perhaps a mere variant of the *Quercus pubescens* complex. 7) *Silene vulgaris* subsp. *aetnensis* (Strobl) Pignatti (Caryophyllaceae), described in 1885, at varietal rank, from a single spot on Mt. Etna (Sicily). Considered an enigmatic plant not recently seen (Giardina et al., 2007).

The 9 cases of possible or actual rescue are: 1) *Coincya monensis* subsp. *puberula* (Pau) Leadlay (Brassicaceae), described in 1902 from Saniján in Galicia (Spain) but looked for unsuccessfully in its locus classicus by Castroviejo (1982), was reported from 4 localities in 1995 (Vioque & Pastor, 1995). 2) *Diplotaxis siettiana* Maire (Brassicaceae), an endemic of Alborán island (Spain) where its only population has recently been destroyed. It survives in cultivation and seed banks, and reintroduction into its native habitat looks promising (Pérez Latorre & al., 2013). 3) *Erodium astragaloides* Boiss. et Reuter (Geraniaceae), described from Sierra Nevada (Spain) where it has always been rare and was not again found in this century, was recently rediscovered in the Sierra de Cazorla (Gómez-Campo, 1987). 4) *Lysimachia minoricensis* Rodr. (Primulaceae), an endemic of Menorca (Balearic Islands, Spain) that has disappeared from its natural habitat but survives in cultivation. Reintroduction into its original habitat has been attempted (see Gómez-Campo, 1987) but so far has not been successful, although attempts continue (Galicia Herbada & Fraga Arquimbau, 2011). 5) *Onobrychis aliacmonia* Rech. f. (Leguminosae), described from Greek Macedonia, had its single locality, on the banks of Aliakmon River, flooded by an artificial lake in c. 1975. A very similar plant, discovered in Laconia (Peloponnesus), was first identified with it but later described as a distinct subspecies then species, *O. peloponnesiaca* (Iatroú et Kit Tan) Iatroú et Kit Tan. The genuine *O. aliacmonia* was rediscovered in 1985 close to its classical locality, where it managed to colonise new habitats (Greuter, 1987). 6) *Limonium dufourii* (Girard) Kuntze (Plumbaginaceae), an endemic of the Albufera de Valencia (Spain), first described in 1842, last seen in 1972, was considered a victim of

Fig. 1. Sylver Coin of Cyrene dating back late 6th-early 5th centuries BC. depicting the silphium © Trustees of the British Museum (Reproduced by kind permission of the British Museum of London) on the left and *Ferula communis* on the right.

reclamation of its native wetland areas. At present, 6 small populations are known to have survived (Laguna et al., 1994). 7) *Salvia peyronii* Post (Lamiaceae), discovered in 1883 on cliffs near Feitroun (Lebanon) and never seen until recently, although it is showy and had been looked for repeatedly, was found again in the same area (Jabal Moussa) in 2011 (Tohmé & Tohmé, 2011). 8) *Silene rothmaleri* Pinto da Silva (Caryophyllaceae), described in 1945 from Cabo S. Vicente (Algarve, Portugal) and not seen since in spite of a thorough search by Jeanmonod (Greuter & Raus, 1984), was rediscovered in 2000 (Dinter & Greuter, 2004). 9) Of *Silene tomentosa* Otth (Caryophyllaceae) a few 19th-Century specimens were known, all from the E side of the Gibraltar rock (Spain), but until 1984 none had been collected in the 20th Century (Jeanmonod, 1984). In 1994 the species was rediscovered growing in the wild and is since cultivated in the Alameda Botanical Gardens (Linares, 1998).

The 6 remaining cases of (presumed) extinction are: 1) *Cephalaria kesruanica* Mouterde (Dipsacaceae), discovered in 1939 in Lebanon. Its type locality was probably destroyed; a record from a further locality requires confirmation (Mouterde, 1980). 2) *Trachelanthus foliosus* (Paine) Tristram (Boraginaceae), discovered in Jordan in 1973 and found in a second locality in 1886. It has not been seen again (Feinbrun, 1978). 3) *Dianthus multinervis* Vis. (Caryophyllaceae) discovered by Botteri on the isolated islet of Jabuka (Pomo, Croatia) where it was not collected again and has probably disappeared (Greuter, 1995). 4) *Fibigia heterophylla* Rech. f. (Brassicaceae), discovered in 1911 between Homs and Palmyra in Syria and never again collected (Mouterde, 1970). 5) *Morina subinermis* Boiss. (Dipsacaceae), described from plants collected in Bithynia (Anatolia) without exact locality and never seen since, although it is a showy species. 6) *Trifolium acutiflorum* Murb. (Leguminosae). Described from Murbeck's own gathering made at Marrakesh (Morocco), but never collected again in spite of thorough searches (Fennane & Ibn Tattou, 1998).

The above figures do not refer to the entire Mediterranean vascular flora but only to that part (ca. 45 %) covered by the first three published volumes of Med-Checklist (Greuter et al., 1984-1989). An attempt has subsequently been made by Greuter (1994) to produce a similar list for the entire Mediterranean flora, using various other sources. The result was a table with 33 names, not taking into account the "mystery cases" and redeemed species. Of the taxa in this second list 21 are additional to the first, of which 12 were included bit not

considered extinct in Med-Checklist and 9 have not yet been treated in that work. Focusing on the former, we find that not all are worthy additions to the extinct (Ex) category. One represents an interspecific hybrid (*Thalictrum simplex* subsp. *gallicum* (Rouy et Fouc.) Tutin = *T.*×*timeroyi* Jord., see Hand 2001). *Limonium dubyi* (Gren. et Godr.) Kuntze, described from France, is currently included in the synonymy of *L. bellidifolium* (Gouan) Dumort. *T ephrosia kassasii* Boulos, from the borders of the Nile in Egypt, is not considered as extinct in that country's recent floristic and conservational literature. *Thymus oehmianus* Ronniger et Soska obviously survives in its locus classicus in the Treska gorge, as its live portrait appears on a recent (2003) postage stamp of the FYR Makedonija. Of the 7 Turkish endemics listed on the faith of Ekim et al. (1989), 4 apparently survive according to recent assessments of that country's flora (Ekim et al., 2000, Eken et al., 2006): *Campanula oligosperma* Damboldt, *Onosma affinis* Riedl, *Sedum polystriatum* R.T. Clausen, and *Silene oligotricha* Hub.-Mor. This leaves us with a reduced number of 4 genuine, additional presumed extinctions: Local and Global extinctions

Species with a large range are more prone to local population size fluctuations and eventual extinction than species with a reduced population. *Neslia paniculata* (L.) Desv. (Brassicaceae) is an example of a species with large distribution that registered important local extinctions at the borders of its range (Fig. 2). *Spirodela polyrrhiza* (L.) Schleid. (Lemnaceae), a species distributed almost world-wide, was considered extinct in Catalonia but has been found in the lower course of the Ebro River and in the Vallvidrera reservoir (Curto et al., 2013). *Rhamphidium purpuratum* Mitt. (Bryophyta, Ditrichaceae), known to be widely distributed in Macaronesia and Crete, had its only mainland site, known since 1940, in the north of Portugal. The

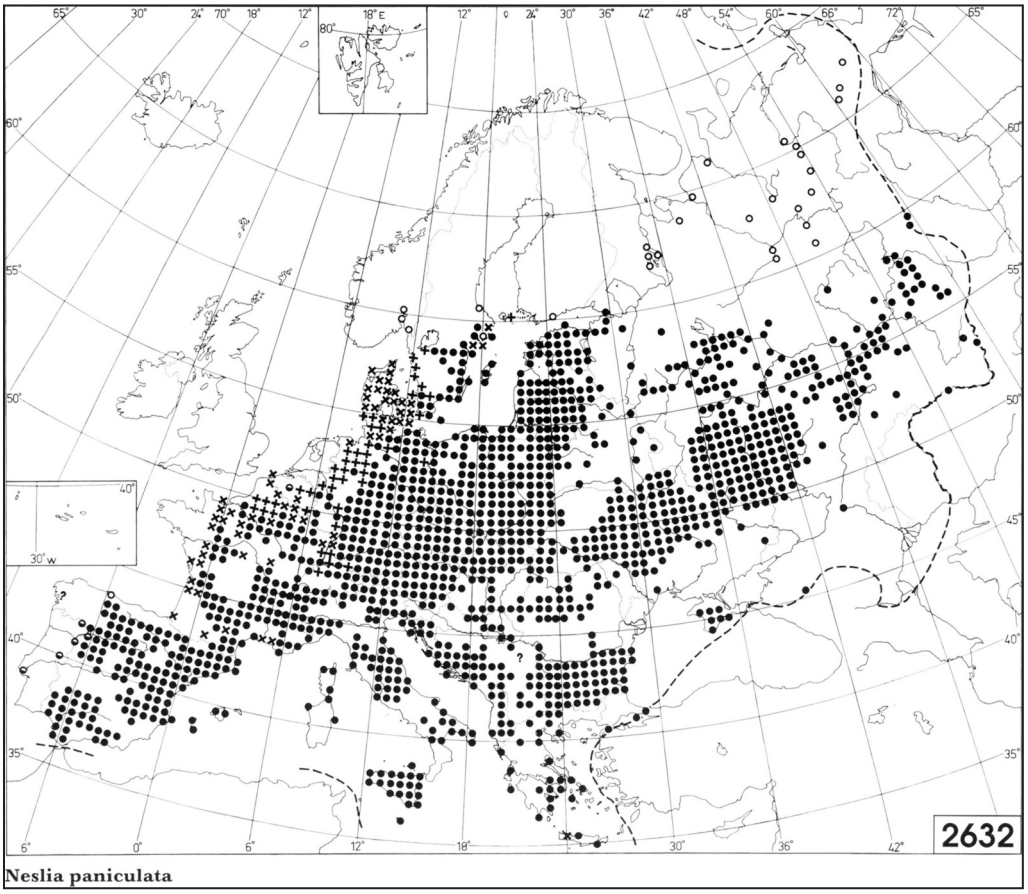

Fig. 2. Distribution of *Neslia paniculata* from Jalas et al. (1996). The crosses in the NW part of the distribution indicate the extinction of the plant in that area.

species was considered as vulnerable in the European Red List (www.bio.ntnu.no/ECCB/ RDB Taxon.php), and later considered extinct in Portugal by Sérgio et al. (1994, 2001). After more than 60 year it was found again in south-west Portugal near the Monchique mountains (Sérgio et al. 2011).

For taxa with a single locality destruction of the habitat implies its complete loss: *Adenostyles alpina* subsp. *nebrodensis* (Wagenitz et I. Müll.) Greuter (Asteraceae) is known from a single locality in a canyon of the Madonie Mountains (Sicily); the capture of a source, c. 50 years ago, has aridified the area and brought the taxon to the brink of extinction, with but a single individual still alive.

Limonium catanense (Lojac.) Brullo (Plumbaginaceae), at the beginning of the 20th century, was only known in an area that now belongs to the harbour of Catania.

Small islands floras are more prone to extinction than those on large islands and on the mainland (Greuter, 1995). This may be due to the greater fragility of island habitats due to their smaller surface and higher human pressure (Domina & Mazzola, 2011). The population of *Daucus rupestris* Guss. (Apiaceae) on Lampione is extremely depleted and faces imminent extinction due to high concentration of nitrogen from gull droppings, of which the plant is intolerant (Lo Cascio & Pasta, 2012). *Limonium intermedium* (Guss.) Brullo (Plumbaginaceae) was growing on Lampedusa in a salt marsh near the harbour, now converted to a soccer field (Fig. 3); at present only some individuals survive in the Botanical Garden of Catania, grown from seed sampled in the field about 40 years ago (Brullo, pers. comm.).

Cistus ×*skanbergii* Lojac. (Cistaceae) is the natural hybrid between *C. monspeliensis* and *C. parviflorum* and occurs in scattered localities in the Mediterranean, wherever the two parents meet. It was described from the island of Lampedusa (Italy), where today but a single individual is known and only one parent still occurs. Efforts to conserve that individual would be a futile exercise.

There are several cases of old, unconfirmed records, due perhaps to misidentification, and of taxa of uncertain taxonomic position, that must be taken into account in management and conservation plans for endangered species. *Orobanche aegyptiaca* Pers. (Orobanchaceae) was reported in error from Italy (Monte Gallo and Lampedusa). It was recorded in Scoppola & Spampinato (2005) as being

Fig. 3. The soccer field in Lampedusa on the place of the salt marsh near the harbour locus classicus et unicus of *Limonium intermedium*.

very rare and endangered. The study of specimens from both sites showed that they had been misidentified and belong to *O. mutelii* F.W. Schultz (Domina et al., 2011). *Euphrasia mendoncae* Samp. (Orobanchaceae) was described by Sampson in 1936 from specimens collected in 1932 by F. Mendonça and thought to be endemic to Bragança (Portugal). It was never found again despite extensive searches in 1990 and 1996. In Flora Iberica (Vitek, 2009) now it is treated as a synonym of *E. minima* Jacq. ex DC. The presence of such non-species in lists of plants requiring protection diverts attention from others that are really threatened.

Among the mosses there are also cases of taxa considered as extremely rare or extinct, only to be later included in other, widely distributed taxa. *Clasmatodon parvulus* (Hampe) Sull. (Brachytheciaceae) was believed to occur in North America and very rarely in Germany and Spain. Meinunger (1992) deemed it as extinct in Germany because it had not been found again since 1851, and it came to be known as one of the rarest mosses of the European continent (Frey et al., 1995; Düll, 1985), being so was included as endangered (EN) in the Red Data Book of European Bryophytes (Schumacker & Martiny, 1995). Heras et al. (2006) found that both the German and Spanish records were based on misidentified plants of *Pseudoleskeella tectorum* (Funck ex Brid.) Kindb. ex Broth. and must be excluded from the European and Mediterranean bryoflora. *Thamnium cossyrense* Bott. (Neckeraceae), described by Bottini (1907), was considered endemic to Pantelleria until 2001, when Mastracci

(2001) included it in *Scorpiurium sendtneri* (Schimp.) M. Fleisch., a species widely distributed in Mediterranea area. *Fissidens exiguus* Sull. (Fissidentaceae), considered rare in France and Greece (Schumacker & Martiny, 1995), is now synonymised with *F. bryoides* Hedw., a common taxon in Temperate areas (Pursell, 2007). Likewise, *Trichostomopsis aaronis* (Lorentz) S. Agnew & C. C. Towns (Pottiaceae), thought to be a rare taxon of Spain and Turkey (Schumacker & Martiny, 1995), has recently been synonymised with *Didymodon australasiae* (Hook. et Grev.) R. H. Zander, a common taxon throughout the Mediterranean area (Ros et al., 2013).

DELIMITATION OF TAXA

Different delimitation bear on the range and the conservation status of taxa (Lastrucci et al., 2014). A glaring example is *Thymus herba-barona* Loisel. that can either be considered to comprise a single taxon, occurring in the Balearic islands, Corsica and Sardinia (Molins et al., 2011), or split into different taxa based on chromosome number: the diploid *Thymus herba-barona* subsp. bivalens Mayol et al. (2n = 28), endemic to a single locality in Serra D'Aljabia (Mallorca) with only about 50 mature individuals; *Thymus herba-barona* subsp. *herba-barona*, tetraploid (2n = 56) growing in Corsica, and *T. catharinae* Camarda, hexaploid (2n = 84), restricted to Sardinia.

Arenaria bolosii (Cañig.) L. Sáez et Rosselló (Caryophyllaceae), a critically endangered taxon only known from a single site on the island of Mallorca (Bibiloni & Mus, 2006), was first described as a variety, *Arenaria grandiflora* var. *bolosii* Cañig., then considered a subspecies, *A. grandiflora* subsp. *bolosii* (Cañig.) Colom, eventually to be recognised a as a separate species.

Some taxonomists, called lumpers, tend to favour a broad taxon concept, whereas others, known as splitters, emphasize minute differences. These preferences depend in part on the size of the area on which a researcher is working. Those who study plants of a restricted territory will likely search for differences whereas botanists with a broad geographical interest may favour a synthetic approach. Several taxa considered to be narrow endemics can just as well be interpreted as local expressions of wide-ranging taxa. However, as long as there can be reasonable doubt it is better to maintain the local taxa rather than letting them disappear in synonymy. As an example, in *Pancratium maritimum* L., some populations may not deserve the status of separate species yet they possess a well-diversified genome that deserves being preserved (Giovino et al., 2015).

CONSIDERATIONS

New emphasis on floristic research is needed to boost our deficient knowledge of the Mediterranean flora. Amateurs, if well directed, can play an important role in this endeavour. Many academic scholars spend much of their time and efforts in the laboratory, to the detriment of field research, yet they may dispose of funds for networking that allow combining the efforts of amateurs over a wider geographical area than they might cover individually. A closer collaboration between scholars and amateurs can, by promoting field research by the latter, not only increase floristic knowledge but also help unravel taxonomic problems.

Lists of taxa that are part of laws or regulations and their annexes should be updated at regular intervals. In order to apply to the originally intended taxa they must use their currently correct names; but they should also, in addition, include synonyms to reflect historical usage and accommodate alternative taxonomic views. For higher plants, synonymic checklists now exist that are widely accepted by the scientific community, notably Euro+Med Plantbase (http://www.emplantbase.org/), resulting from a project funded within the V and VII Framework Programme of the European Community. Likewise, the checklists published by Ros et al. (2007, 2013) provide a sound basis for channeling conservation measures of Mediterranean hepatics, anthocerotes and mosses.

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