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Extinctions in Mediterranean Areas

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SUMMARY

Thirty-one species and two subspecies of vascular plants of the Mediterranean area are presumed extinct. This would correspond to an extinction rate of 0.11% of the native Mediterranean flora, which compares with rates of 0.3% for vascular plant species of the Cape floristic province of S. Africa, 0.4% for higher plant taxa of California, and 0.66% for those of Western Australia. Percentages of threatened plant taxa are between 25 and 125 times as high as extinction rates. Records of plant extinctions are both incomplete and error-prone, as shown by examples, but even with improving knowledge the rates of species loss are unlikely to change significantly. They are lowest for the Mediterranean area, in which human implantation is most ancient, and for which large-scale undocumented early extinction is assumed, and highest for the most recently colonized area, south-western Australia, where extinction may now be at its peak. At least for the Mediterranean, aiming at the rescue of each and every species in danger is a realistic if ambitious goal.

1. INTRODUCTION

The Mediterranean area is known as a region of high floristic diversity. When one delimits the area, as done for the purposes of *Med-Checklist* (Greuter *et al.* 1984–1989), to comprise all countries bordering the Mediterranean Sea plus Portugal, Bulgaria, the Crimea and Jordan, its wild flora of *ca.* 24000 species comes close to one tenth of the quarter of a million known vascular plant species of the globe (Greuter 1991). Jointly, the five areas of the world with a Mediterranean-type climate (the Mediterranean itself, California, central Chile, the Cape region, and south-western Australia) 'total some 70,000 or more species and represent a major part of the higher plant diversity of the world, exceeding the combined floras of tropical Africa and Asia' (Heywood 1993).

As I have recently demonstrated for the Mediterranean area (Greuter 1991), this richness is not caused by high local species density (on average the species numbers in small areas are not higher than in Central Europe), but by small mean distributional ranges, reflected by a remarkable number of narrow endemics. Many of these are extremely rare, occurring in low numbers and limited to a single or few localities. It is reasonable to assume that they are threatened, and the question of whether and to what extent their vulnerability has already resulted in extinction is certainly appropriate.

2. RECORDED EXTINCTIONS IN THE MEDITERRANEAN AREA

For the purpose of this survey, the Mediterranean area will be equated with the area covered by *Med-Checklist* (see above). Phytogeographically, this is at best a rough approximation, as that range extends beyond the Mediterranean summer drought domain to the north and south, but not covering it totally towards the east. Yet for practical purposes, accepting the *Med-Checklist* limits makes sense because within them complete, updated figures are available for those higher plants already treated, i.e. for *ca.* 45% of the total vascular flora. I shall restrict this analysis to vascular plant taxa in the ranks of species and subspecies; I will not consider partial extinctions, concerning only a portion of a taxon's range, but only total extinction.

Information concerning extinctions is in need of constant updating. The general inventories of threatened and endemic plants of the area (Anonymous (1983) for its European part; Lucas (1980) for south-west Asia and North Africa) are already badly out of date, and so is my own partial survey of extinct taxa (Greuter 1991) for the families so far treated in *Med-Checklist*. Several country red data books (or floristic inventories including red data categories) have been forthcoming in recent years, in which the field-based knowledge of local botanists has been incorporated: Conti *et al.* (1992) for Italy, Ekim *et al.* (1989) for Turkey, Gamisans & Jeanmonod (1993) for Corsica, Gómez-Campo (1987) for Spain and the Balearic Islands, Hadidi *et al.* (1992) for Egypt, Lanfranco (1989) for Malta, Velčev *et al.* (1984) for Bulgaria, and Wraber & Skoberne (1989) for Slovenia. All these and a few other sources have been used to rewrite the inventory of known Mediterranean plant extinctions as here given in table 1.

Several taxa had to be added to those listed as extinct in previous overviews, but others could be omitted for a variety of reasons. Some have been found to still survive, others are 'ghost species' that

Table 1. *Mediterranean species and subspecies of vascular plants presumed to be extinct in the wild*

(An asterisk denotes taxa still extant in cultivation and/or seed banks; a question mark indicates doubt as to actual extinction. References: 1, Anonymous (1983); 2, Ekim *et al.* (1989); 3, Gómez-Campo (1987); 4, Gómez-Campo (1990); 5, Greuter (1991); 6, Hadidi *et al.* (1992); 7, Lesouef & Olivier (1989); 8, Lucas (1980); 9, Velčev *et al.* (1984).)

taxon	country	family	references
? *Allium rouyi* Gaut.	Spain	Liliaceae	1,3
Astragalus pseudocylindraceus Bornm.	Anatolia	Leguminosae	2
Avenula hackelii (Henriq.) Holub	Portugal	Gramineae	1
Campanula oligosperma Damboldt	Anatolia	Campanulaceae	2
Cephalaria kesrouanica Mouterde	Lebanon	Dipsacaceae	5
**Coincya pseuderucastrum* subsp. *puberula* (Pau) Valdés	Spain	Cruciferae	5
Cynoglossum foliosum (Paine) Greuter & Burdet	Jordan	Boraginaceae	5
Dianthus multinervis Vis.	Yugoslavia	Caryophyllaceae	5
**Diplotaxis siettiana* Maire	Spain	Cruciferae	3,4,5
Fagonia taeckholmiana Hadidi	Egypt	Zygophyllaceae	6,8
Fibigia heterophylla Rech. f.	Syria	Cruciferae	5
? *Geocaryum bornmuelleri* (H. Wolff) Engstrand	Greece	Umbelliferae	1
? *Geocaryum divaricatum* (Boiss. & Orph.) Engstrand	Greece	Umbelliferae	1
? *Hypericum setiferum* Stef.	Bulgaria	Guttiferae	9
Limonium dubyi (Gren. & Godr.) Kuntze	France	Plumbaginaceae	7
**Lysimachia minoricensis* Rodr.	Balearic Isl.	Primulaceae	1,3,5
Morina subinermis Boiss.	Anatolia	Morinaceae	5
Onosma affinis Riedl	Anatolia	Boraginaceae	2
Onosma discedens Bornm.	Anatolia	Boraginaceae	2
Salvia peyronii Post	Lebanon	Labiatae	5
Sedum polystriatum R. T. Clausen	Anatolia	Crassulaceae	2
Silene oligotricha Hub.-Mor.	Anatolia	Caryophyllaceae	2
Silene rothmaleri P. Silva	Portugal	Caryophyllaceae	5
Silene tomentosa Otth	Gibraltar	Caryophyllaceae	5
Tephrosia kassasii Boulos	Egypt	Leguminosae	8
Teucrium leucophyllum Benth.	Anatolia	Labiatae	2
Thalictrum simplex subsp. *gallicum* (Rouy & Foucaud) Tutin	France	Ranunculaceae	7
Thymus oehmianus Ronniger & Soska	Yugoslavia	Labiatae	1
Trifolium acutiflorum Murb.	Morocco	Leguminosae	5
* *Tulipa sprengeri* Baker	Anatolia	Liliaceae	2
Verbascum calycosum Hausskn. & Murb.	Anatolia	Scrophulariaceae	2
? *Veronica euxina* Turrill	Bulgaria	Scrophulariaceae	1,9
Viola cryana Gillot	France	Violaceae	1,7

have never existed or have been sunk into synonymy, and a few were likely the product of occasional hybridization. There is also one (mainly Central European) category of plants that I decided not to consider: semi-domesticated weeds of arable fields, for several of which it is impossible to be sure whether and where they still exist in the wild, whereas most if not all are kept alive in germplasm collections. Three brome-grass species, as well as *Filago neglecta*, *Lolium remotum*, and *Silene linicola*, belong to this category.

The total number of Mediterranean higher plants presumed to be extinct is thus 33, of which 31 were species and two subspecies. This compares to a total of *ca.* 23 300 native Mediterranean plant species, or 29 000 taxa (species plus subspecies). The present Mediterranean extinction rate for vascular plants is therefore 0.13% at species level, or a mere 0.11% of the taxa.

3. EXTINCTION RECORDS IN OTHER AREAS WITH A MEDITERRANEAN CLIMATE

No relevant information has been found for the Mediterranean-type portion of Chile, nor indeed for that whole country, but there are careful recent synopses with comparable data on the extinct and threatened higher plants for the three other summer-drought areas.

The Cape floristic region of South Africa, or fynbos biome, is the South African counterpart of the Mediterranean domain. It is famous for its floristic richness, with no less than 8580 native vascular plant species growing in a relatively small area (Bond & Goldblatt 1984). Of these, 26 are presumed to be extinct, twice as many as for the whole remainder of southern Africa (Hall & Veldhuis 1985), which corresponds to an extinction rate of 0.3%. For southern Africa as a whole, that rate is considerably lower (0.19%).

The state of California is not quite coextensive with the Mediterranean domain in North America, which extends beyond its border both in a northerly and southerly direction, but it certainly represents its core. It has a native flora of 5867 species or 7036 taxa (species, subspecies and varieties) according to Hickman (1993). Among these, 34 are presumed extinct in California, of which six survive outside that state, the genuine extinctions adding up to 24 species, three subspecies, and one variety (Smith & York 1984). The

Table 2. *Extinction and threat rates in Mediterranean-type floras (native vascular plant taxa)*
(Sources and specifications are given in the text.)

area	native flora (number of taxa)	extinct taxa	extinction rate (‰)	threatened taxa	threat rate (%)
Mediterranean (Med-Checklist)	29 000	33	1.1	4251	14.7
Cape Province (fynbos biome)	8580	26	3.0	1300	15.2
California	7036	28	4.0	718	10.2
Western Australia	8300	55	6.6	1451	17.5

extinction rate is thus 0.41% for species, or 0.4% for taxa, which is exactly the same as that calculated by Ayensu & DeFilipps (1978) for the whole of the United States of America.

The Mediterranean climate area of Australia is not easy to define. A summer drought régime extends right across the southern part of the continent, yet the floristically rich area that one considers as typically Mediterranean coincides with the south-western floristic province of Western Australia. The state of Western Australia has a vascular flora of 7465 native species (8300 taxa, excluding formae) of which 54 (55 taxa) are presumed extinct, roughly two thirds of the 82 (83) recorded extinctions of the whole continent (Leigh & Briggs 1992). The species extinction rate of 0.72% (0.66% for taxa) is the highest mentioned so far, but when only the south-western province is considered it may rise as high as 1% (50 species out of an estimated total of 5000). Species extinction rate for the Australian continent with its 17 590 native species (Hnatiuk 1990) is 0.47%.

4. EXTINCTION AGAINST THREAT: A DISQUIETING PERSPECTIVE

When one thinks of the alarming figures about ongoing global mass extinction that one reads in the newspapers, one may feel pleasantly surprised or at least relieved at the low rates of recorded extinctions in the floristically rich Mediterranean-climate areas. However, actual loss is one thing, impending threat of loss another.

Let us for once set aside the questions of how real are the threats faced by surviving plant species, how reliable the assessments of these threats, and how comparable the assessment criteria in various parts of the world; let us just compare the figures found in the literature (table 2). Those for the Mediterranean itself are put together from three independent sources (Lucas 1980; Anonymous 1983; Ekim *et al.* 1989), and relate to species and subspecies; those for the Cape floristic region (fynbos biome), from Hall & Veldhuis (1985), concern species alone; and those for California and Western Australia (Smith & York 1984; Leigh & Briggs 1992) encompass species, subspecies and varieties.

This survey shows that the percentage threats are not significantly different between these four widely distant areas, ranging from 10.2% to 17.5% (which tends to demonstrate that threat assessment has at least used comparable criteria). It also shows that, if the published figures are basically realistic, the impending threat is far worse than what has been put on record in matters of extinction. Threat rate and extinction rate differ by a factor varying between about 25 (Western Australia) and 125 (the Mediterranean).

In other words, if the present losses are still felt to be tolerable, future extinctions threaten to happen on a cataclysmic scale.

5. HOW RELIABLE ARE OUR DATA?

Apart from a few exceptional, fully documented cases, extinctions are surrounded by considerable uncertainty. Many of those that have been put on record may in fact not have happened yet, and instead many may already have taken place unnoticed.

In Mediterranean-type areas, few species are so well studied and so closely monitored that one may confidently expect their disappearance to be noted and recorded as soon as it happens. Many species have not been recollected since they were first discovered, perhaps over a century ago, for the simple good reason that the place where they grow has never again been visited by a botanist, or if someone did visit it, it may have been in the wrong season when only seeds or underground storage organs were present. Quite frequently the collecting localities are not exactly known, or have been misstated. It would therefore be unreasonable to assume extinction for a taxon that has not been collected recently unless there are other facts to support that assumption, such as a thorough but vain search of the known localities, or obvious disturbance or destruction of the areas and habitats of former occurrence.

One must thus accept that there are an unknown number of unrecorded extinctions, especially for areas with a disproportionately low avowed extinction rate. Think of the Maghreb countries of North Africa with their high number of endemics, of which but a single one, *Trifolium acutiflorum* Murb. from Morocco, is presumed extinct.

Conversely – as is indicated by the qualification of recorded extinctions as 'presumed' – botanists have learnt to be cautious when asserting that a species has died out. The number of presumed extinctions recorded for the California flora has decreased from 44 to 34 within four years: the rediscovery of 11 taxa and the dismissal of three that had in fact never existed having more than outweighed the four newly recorded losses. As Smith & York (1984) have clearly demonstrated, 'a number of List 1A [presumed extinct] plants do not stay there for long once special attention is drawn to them and renewed efforts are made to rediscover them'.

For Greece alone, no less than three species reported missing have been rediscovered in the last few years. *Adonis cyllenea* Boiss. *et al.*, not found again on Mount Killini since 1854, was collected exactly 130 years later on nearby Mount Parnias, where a few small populations survive (Strid 1986, 1992*a*). It has now been brought into cultivation, and is said to show promise as an ornamental garden plant. The fate of *Helichrysum taenari* Rothm., discovered in south Peloponnisos by Rothmaler in 1942, was uncertain for many years. No specimens existed: they were all burnt in the Berlin fire of 1943, and Rothmaler's (1944) original description was based on his memory and field-book notes. A number of experienced field botanists searched for it in vain. Yet Strid (1986, 1992*b*) found it growing safely in its single locality in 1984, and in a second nearby one in 1991, and he succeeded in growing it as an attractive, if not fully hardy, plant for the rockery. Finally, there is the case of *Onobrychis aliacmonia* Rech. f., as certain an extinction as one might think of as its only locality and its surroundings were flooded in about 1975, together with large parts of the Aliakmon valley, due to the construction of a dam. Yet it was rediscovered in 1985 in a completely different environment and at a distance of 400 km, in a Peloponnisos locality (Greuter 1987), where meanwhile its population has again dramatically declined due to human action (G. Iatrou, personal communication). Is it due to disappear for a second time and, if so, may we hope for yet another rediscovery elsewhere?

Let me stop here and conclude: reliability of our data on Mediterranean plant extinctions is poor. We can hope to improve it in the long run by undertaking a thorough field inventory of the whole flora, and by monitoring closely all threatened endemic taxa, but for the time being we are mostly left to guess. Yet, although the contents of extinction lists are bound to undergo considerable change in the future, I contend that, by and large, their present size will stay. Pending a new qualitative analysis, our quantitative assumptions on plant extinctions in Mediterranean areas are reasonably sound.

6. WHERE DO WE STAND?

Loss of one species in a thousand, as we believe has happened in the Mediterranean area, is not really excessive. Perhaps it is not even significantly more than the natural extinction rate (although one must bear in mind that it happened within little more than a century, which is the average 'age' of Mediterranean species as scientifically described and named taxa). Does this mean that the situation is under control, and that our flora is safe? And, if so, what are the implications of the distinctly higher, yet perhaps not dramatic, rates of loss in the other Mediterranean-type floras? The following thoughts are largely hypothetical, yet they may perhaps help us understand the situation we face.

When extinction rates are compared in the four domains with a Mediterranean climate for which such data exist, one immediately notes their correlation with the age and duration of large-scale human colonization. The rate is lowest for the Mediterranean itself, where agriculture and grazing have now lasted for between 8000 and 6000 years in most of its parts. It rises as the onset of European settling is delayed, through the 0.3% of the Cape region and the 0.4% of California to the perhaps 1% of the south-western province of Western Australia.

This is not unexpected. If it is assumed that species elimination peaks in the initial phases of dramatic change induced by human implantation, then much of it may have happened in the Mediterranean before the time when the first botanists appeared on the scene and started studying and describing the flora. In the Cape region, the time gap between settlement and exploration was much smaller; in California both may have been more or less concomitant; and in Western Australia the botanist often preceded the settler.

In all these areas the native plant cover disappeared from fertile lands suited for agriculture or grazing. The plants themselves either took to weediness or succumbed. Because whole vegetation units were eliminated, it is reasonable to assume that many of their component species shared their fate. Pre-botanical extinction must have been important in the countries bordering the Mediterranean Sea, and may be seen as the price paid for the present relative stability of their flora.

Perhaps one may take the difference between south-western Australia's 1% extinction and the much lower Mediterranean rate as indicative of the amount of unrecorded early extinction in the latter domain: but I rather doubt it. The trouble is not yet over for the Australian flora, nor may the present amount of loss be fully understood. Take the genus *Picris* as an example, the Australian representatives of which have just been revised in Berlin. Instead of a single naturalized alien, as was formerly believed, it turned out that Australia houses ten native species, all but one endemic, plus a couple of alien weeds (Holzapfel & Lack 1993). Of the native species, two or three are no longer extant, having been named and described *post mortem*, and they are all south-west Australian. They are typical examples of species confined to land suited for agriculture or grazing and showing no weedy colonizing aptitudes (S. Holzapfel, unpublished results). Many more such species doubtless exist or have existed.

Pre-botanical Mediterranean extinction, of which nothing definite is known, is thus likely to be of a similar order of magnitude as the present and foreseeable extinction caused by man in other Mediterranean-type regions.

7. WHERE DO WE GO?

I will limit considerations on the future to the Mediterranean area itself, which is the only region with which I am sufficiently familiar. It is an area in which the flora, no doubt somewhat impoverished but still remarkably rich, has learnt to cope with man and his destructive habits. Present loss rates are tolerably low and can, if one takes care, be further reduced.

This is not the kind of situation in which one asks for priorities among species to be saved: one can and must fight for every single species. The Mediterranean flora has been sufficiently bled even before the situation was realized. Losses are now dwindling, and they must be made to stop.

Considerable effort is certainly needed, but can mostly be confined to the levels of making inventories and monitoring the flora. Traditional human pressures on the natural environment are tolerable and perhaps even necessary, which may pose problems in the not infrequent cases in which land use regresses.

New threats and pressures do unfortunately emerge which the native biota are unprepared to face. Mass tourism affecting the shorelines is probably the worst, but skiing, which is becoming fashionable on some south European mountains, may come next and cause massive disturbance to hitherto unspoilt natural habitats. Urbanization, industrialization and consequent pollution are other threats that one must bear in mind. Road, rail and dam building may unpredictably affect the single populations of rare endemics unless and until an assessment of their impact is made mandatory before construction may start.

However, all these problems are not of a scale that would make them insoluble. Provided there is sufficient goodwill and concern within the countries concerned – and much progress has recently been made in this respect – plant extinction around the Mediterranean can be successfully checked. Botanical science must play a pivotal role in this process, which requires sound factual knowledge as its very basis.

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ADDENDUM

A recent inventory of the threatened plants of Greece (Phitos *et al.* 1993), published after the present manuscript had been finalized, adds four Greek endemics to the list of presumed extinct Mediterranean vascular plant species (table 1): *Alkanna sartoriana* Boiss. & Heldr., *Centaurea tuntasia* Halácsy, *Paronychia bornmuelleri* Chaudhri, and *Polygala subuniflora* Boiss. & Heldr. This results in an increase of 0.02% in the extinction rates quoted in the text for the Mediterranean area.

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