THE EXOTIC FLORA OF GIBRALTAR

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Introduction

The native* flora of Gibraltar has been the subject of a number of listings (Cortés 1994a) reflecting the interest shown in it, due variously to its botanical isolation, geographical position, geological composition, accessibility or convenient unit size. Up to now, however, no real botanical interest has been shown in Gibraltar's exotic flora. Reference to introduced species has been made in a number of the more traditional floras, but no attempt has been made in the past to list these. The arrival of foreign, or exotic species into any part of the world today is easy and regular. Apart from individual arrivals in the luggage of travellers, commercial plant nurseries are responsible for a great deal of largely unco-ordinated international movement of plants. This was not always so, and in past centuries it is likely that the movement of plants followed established sea routes. It will often have been deliberate and, except of course for expeditions specifically procuring botanical specimens, will have involved the more spectacular or attractive plants and those that would survive an often long sea journey in one or other stage of its life cycle. The survival of an exotic plant in a naturalised or near naturalised state will depend on a number of factors. The most important is the similarity of the new environment to the original, or that within the range of tolerance of the introduced species. This will be largely in terms of climate and soil type, although other factors will clearly come into play. There is evidence that in many occasions introductions are all descended from one or a very few individual plants, in which case the particular requirements of a variety or even individual plant, not necessarily representative of the species, could be important. Such accidental factors could also determine other aspects of an introduced plant's biology. For example, species that mainly reproduce sexually in the wild may not do so at all in an introduced locality if they are self-sterile and the introduced strain is all descended from a single plant or clone.

***It is difficult to define "native" flora especially in an area as small and with a floristic history like Gibraltar (Cortes 1994b), where "new" species arrive or are recorded with some frequency while others are lost. In our case, plants native in the area which arrive naturally are not included as exotic, while plants not native in the area which may themselves have arrived by natural means at Gibraltar from naturalised populations in the region are considered as exotic.**

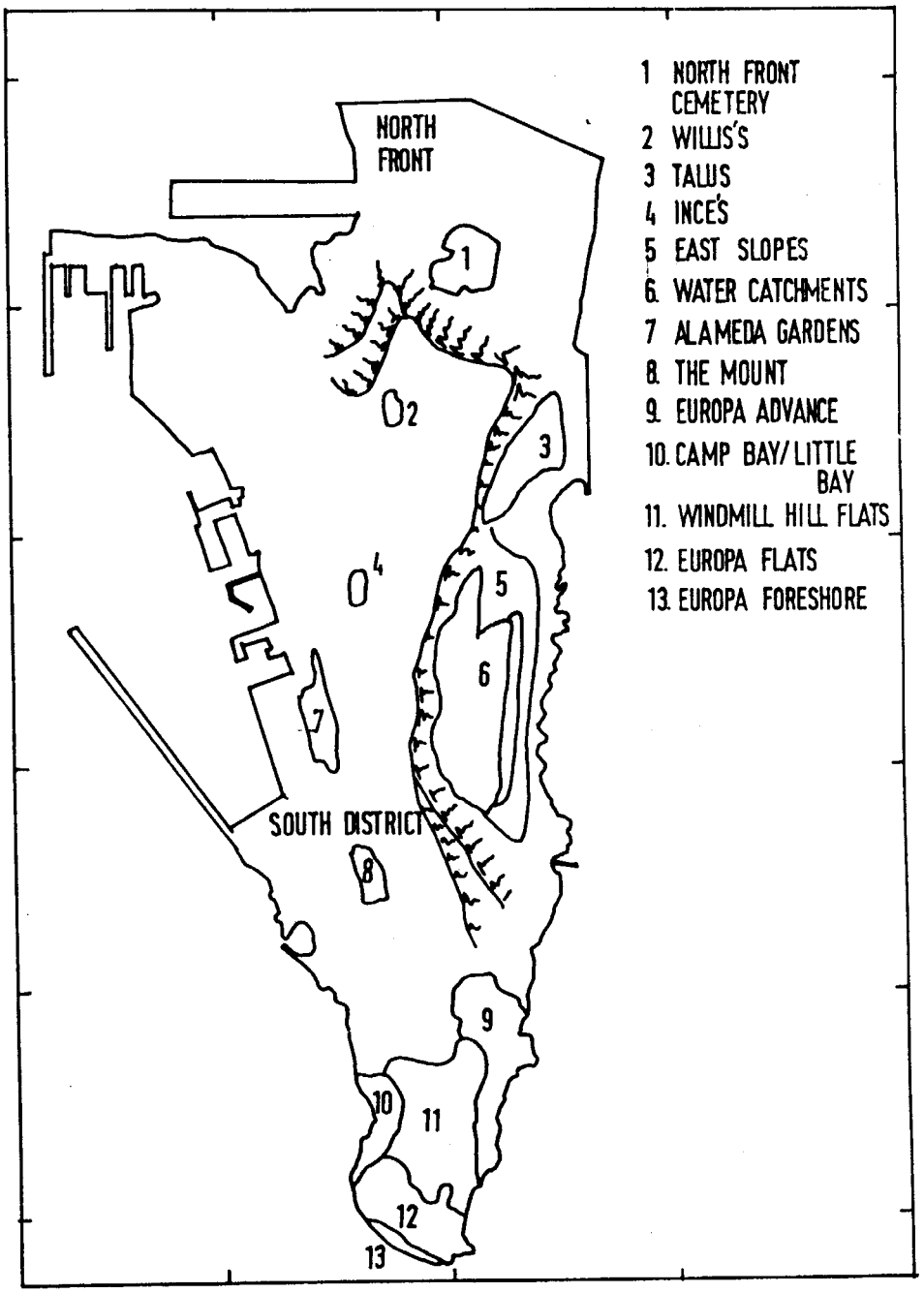


Figure 1. Sites mentioned in the text.

There will be cases too where a plant seems to do better in its new location than in the wild. Again any number of factors could be the cause of this. A study of introduced plants can therefore shed considerable light on the biology both of the species and its native habitat, and of the new habitat, as well as of the man-made history of the region in question.

This summary does not intend to delve deeply into all these factors. The intention is to present an annotated list of exotic plants that can be considered naturalised or semi-naturalised in Gibraltar, arranged in families and with their region or country of origin given. Many of these plants or groups of plants are good candidates for future individual study (see Lamb, 1994, Cortes 1994c).

Geographical limits and physical conditions.

The geographical limits of the study area are given as the territory of Gibraltar, latitude 36°7'N, 5°21'W, between the land frontier with Spain on the isthmus to the north and the shore at Europa Point to the south.

The soil in Gibraltar is generally basic as it lies on Jurassic limestone and there are número us outcrops of bedrock and loose rocks and screes on the surface. There are also outcrops of shale and areas covered with consolidated windblown sand (the east sand slopes). The climate is Mediterranean, with hot dry summers and cool wet winters.

Criteria.

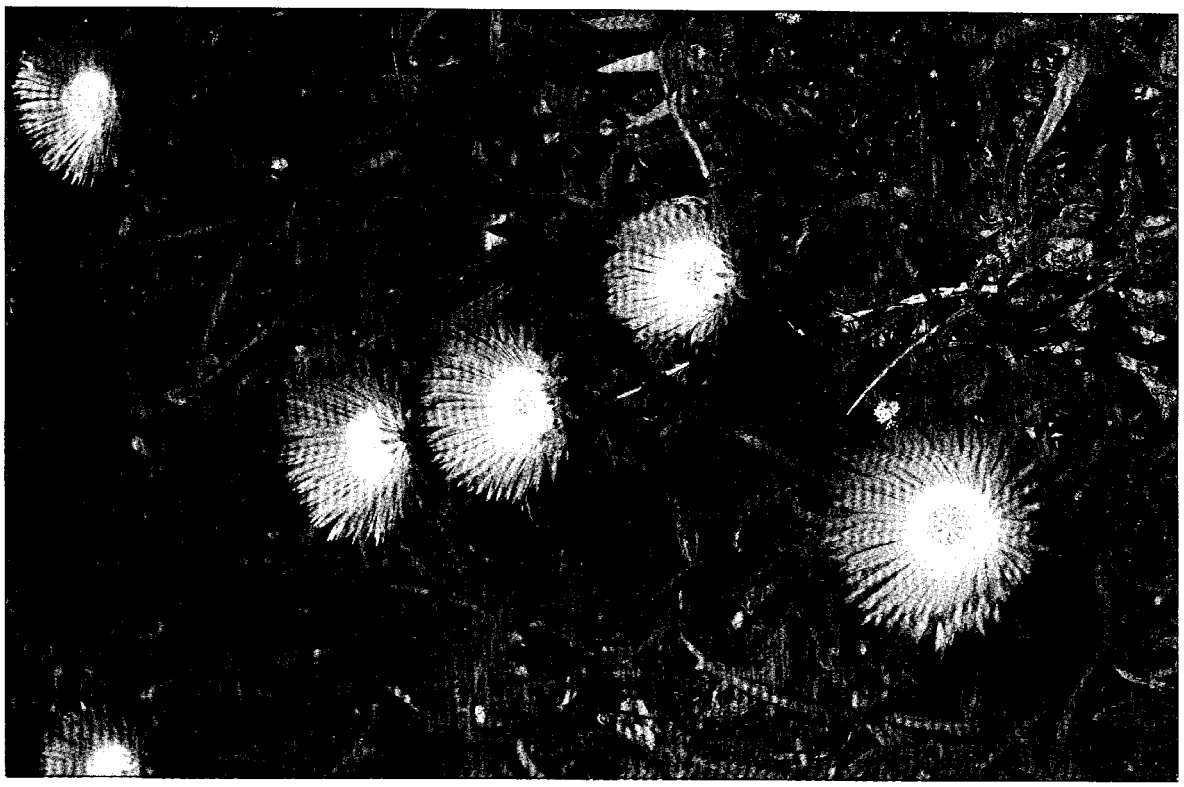
It is not easy to select criteria for the inclusion or exclusion of plant species in such a list as this. Naturalised plants in the context of this paper are considered to be plants that have a self-maintaining population in Gibraltar. Propagation will be natural by either sexual means or vegetatively. This catergory will include most of the well established species. In the case of species that propagate asexually, they may be unable to colonise new areas but may have proved able to expand the size of established stands. All non-native species included in Linares (1993) fall into these categories. Other species may be well established but show no sign of reproductive activity Other species still may actively propagate, even by means of seeds, within gardens with either enriched soil, irrigation or both, but fail to establish themselves in the wild due possibly either to soil conditions or to lack of water. Where these species are either common or prominent within the garden landscape, they are included for the sake of completeness. Species and cultivars that exclusively grow within gardens and show no signs of becoming established are excluded. Common garden annuals (petunias, pansies, etc.) are similarly excluded. A list of the introduced species discussed is at Appendix I. The sites mentioned in the text are identified in Figure 1.

The species

AGAVACEAE

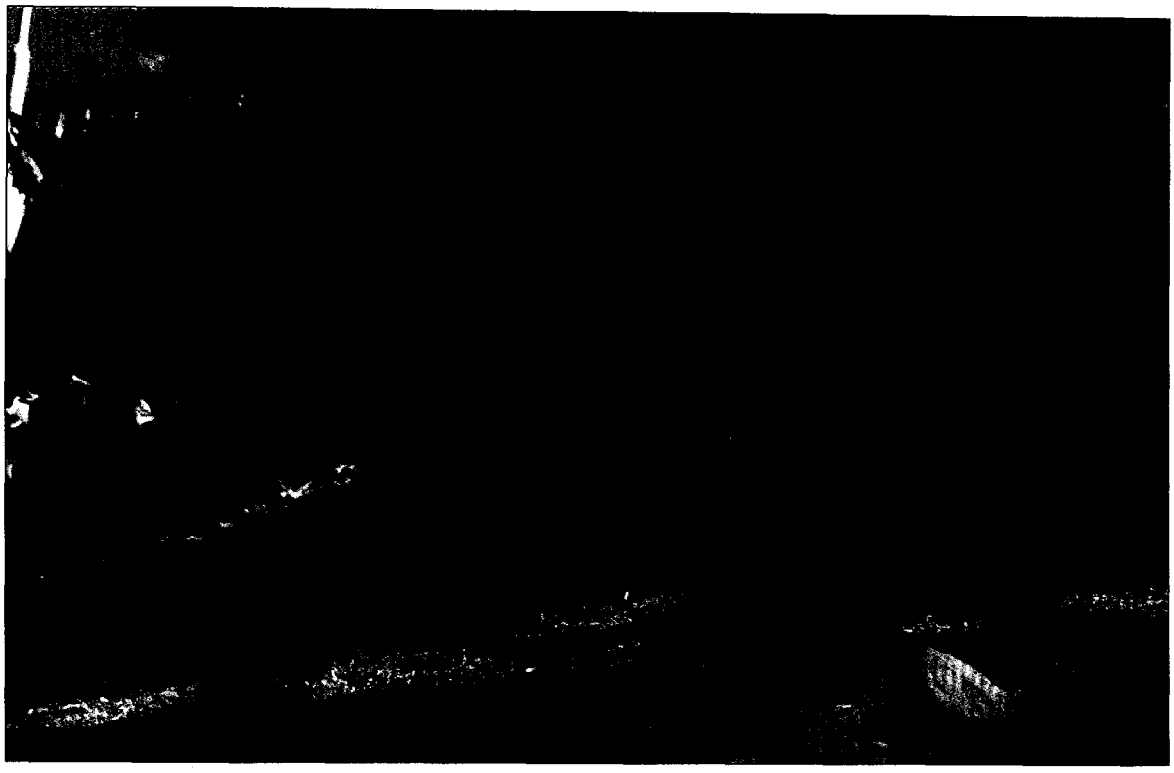
Agave americana Mexico.

Naturalised and reproducing by means of plantlets developing on flower spikes. A feature of open ground in Gibraltar, as elsewhere in the region. Isolated individuals grow on the Upper Rock, but the main localities outside cultivation are various locations on the east side of Gibraltar and Europa Point Foreshore



Carpobrotus edulis

Antholyza aethiopica on a firebreak on the Upper Rock.

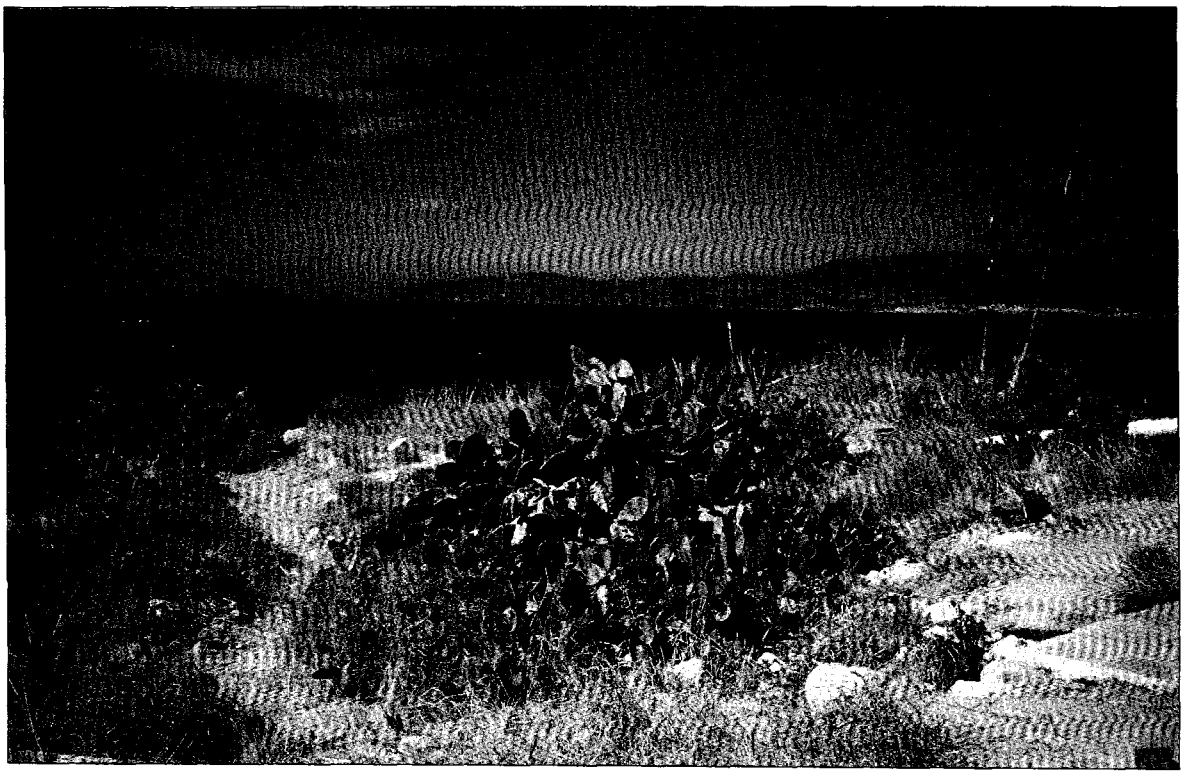


Amaryllis belladonna at the Gibraltar Botanic Gardens.

Agave ghiesbreghtii Mexico
Naturalised and reproducing like *A. americana,* but only on a few sites on the east side of the Rock.

AIZOACEAE
Carpobrotus edulis S. Africa.
Planted as a sand and scree stabiliser on the North Front, east sand slopes, Europa Advance Road, Europa Point and cliffs on the south west of the Rock. Also a garden escape on various locations in the Upper Rock. Where it grows it clearly replaces the native vegetation and excludes wild plants. It is having a particularly adverse effect on parts of the east sand slopes and on cliffs on the south west littoral. Kelaart (1846) does not mention this species, but Debeaux & Dautez (1888) do, stating that it was planted in gardens and to cover taluses and screes, and sometimes escaped, while Wolley Dod (1914) states that it was becoming naturalised. In Gibraltar it does not set seed. Propagation is local by means of runners. The magenta form is the most common. Yellow flowers are found on Europa Point Foreshore.

Disphyma crassifolium S. Africa.
Planted as *Carpobrotus edulis* at one site on Europa Advance Road. It was mentioned by Wolley Dod (1914) as being "quite naturalised" at its present location, near the lighthouse.



Opuntia Ficus-indica and *Agave americana* at Europa Point.

AMARANTHACEAE

Amaranthus blitoides Americas

Widely naturalised in the area as elsewhere in C & S. Europe, NW Africa & Macaronesia

Amaranthus muricatus S. America

Widely naturalised in the area as in the rest of the W. Mediterranean & Macaronesia.

AMARYLLADACEAE

Narcissus tazetta Mediterranean/Asia

Naturalised in several areas, always close to cultivation and gardens, especially North Front Cemetery and Alameda Gardens. Possibly the *Narcissus polyanthus* attributed by Wolley Dod (1914) to Clusius (1601), although this may have instead been *N. papyraceus,* a common native plant.

Amaryllis belladonna S. Africa

Naturalised within the Alameda Gardens and some other gardens where is sets seed readily. However, not found in truly wild locations.

Leucojum autumnale W. Mediterranean
Native in the region, but apparently not in Gibraltar, as Wolley Dod (1914) admits to having introduced it in 1883 on the Upper Rock at Willis's (where it is still found), and Ince's, where it has not been seen recently. It is found on the lower slopes below Ince's, and it is not clear whether these plants are descended from the introduced ones or were there originally.

APOCYNACEAE
Nerium oleander Mediterranean
A common plant in cultivation in gardens and roadside flowerbeds. It is native in the surrounding region where it grows along and inside river courses, and although it sets seed in Gibraltar, germination has only been observed in irrigated areas of gardens. It has failed to get established, probably due to the lack of naturally occuring water courses.

ARACEAE
Dracunculus vulgaris (?E) Mediterranean
Appears to be spontaneous, especially within the Alameda Gardens. It is not clear whether the species is native to the western Mediterranean. If it is, then it could well be native to Gibraltar. If not, it is certainly well established though limited in its distribution.

Zantedeschia aethiopica S. Africa
Well established in the Alameda Gardens and other gardens, but not fully naturalised as it rarely sets seed in Gibraltar away from wet conditions. Plants will however multiply vegetatively.

BIGNONIACEAE
Tecomaria capensis S. Africa
Well established as a garden hedging and climbing plant in the older gardens including The Mount, The Alameda Gardens and The Convent. Seed setting is limited and there is no evidence of successful germination in the wild. Propagation from runners is regular but only results in extension of stands. No evidence of true naturalisation.

CACTACEAE
Opuntia ficus-indica Mexico
Fully naturalised as elsewhere in the region. Occasionally encountered on the Upper Rock. The largest concentration is on the upper Europa Advance area (Hole in the Wall). Also on Europa Foreshore.

Opuntia vulgaris Mexico
Several specimens well established on sand slopes on eastern side. No evidence yet of naturalisation.

COMPOSITAE
Conyza bonariensis S. America
Conyza albida S. America
Ruderals widely naturalised in the region. Mentioned by Wolley Dod (1914) as widespread in gardens and on waste ground.

Senecio tamoides S. Africa
An aggressive species that spreads vegetatively and sets seed readily. It has extensively covered areas of the lower western slopes and near Bruce's Farm on the Upper Rock, where it strangles local vegetation and excludes native climbers. Presumably spreads also by seeds, but germination, though it may well occur, has not been observed oustide gardens. This species was not mentioned in any of the floras prior to Linares (1990 & 1993), so that presumably its expansion is fairly recent.

Senecio bicolor cinerarea Mediterranean
Wolley Dod mentions that this species was "quite naturalised" in the Europa area and around Governor's Cottage. It continues to be common there and grows as if it were native. Presumably Wolley Dod believed it to be introduced as it was not mentioned by earlier authors. If so it must have been introduced in the very late 19th or early twentieth century. Otherwise it may just have been overlooked by earlier authors, although this seems unlikely.

CONVOLVULACEAE
Ipomoea purpurea West Indies
A scandent that quickly outgrows gardens, but there is no evidence of spreading away from the vicinity of where it has been planted.

Ipomoea cairica Tropical W. Africa
As for *Ipomoea purpurea*

CRASSULACEAE
Aeonium arboreum Morocco
Fully naturalised on south-western and south-eastern cliffs of the Rock. May be native (Lamb 1994).

Aeonium haworthii Canary Islands
Established, apparently naturalised, around Catalan Bay. A few individual plants on isolated locations on southeastern and south-western scree slopes (Europa Advance and Camp Bay) (Lamb 1994).

EUPHORBIACEAE
Ricinus comunis Tropical Africa
There are very few plants of this species in Gibraltar, mainly in the South District. It was once more widespread, and has tended to disappear as waste ground has become built up. The three locations given for the species by Wolley Dod (1914) no longer have any "waste land".

FABACEAE
Albizzia lophantha W. Australia
Naturalised and growing mainly on parts of the lower western slopes, notably Devil's Gap. A species of waste ground that, like *Ricinus communis* was probably once more widespread.

Robinia pseudacacia North America
Established and propagating by seeds and suckers, but only within garden areas, notably the Alameda Gardens.

Spartium junceum W. Mediterranean
Although native to the region it appears to be introduced to Gibraltar as it grows only near human habitation as an apparent garden escape. Kelaart (1846) was also of this opinion. It is particularly well established at the north end of Windmill Hill Flats.

Acacia cyanophylla W. Australia
Well established in and near gardens within which it sets seed and germinates regularly.

Acacia cyclops Australia
A population is established on the east sand slopes and is apparently self-maintaining. Bell (1845) mentions an acacia growing on the "back of the hill" which could be this species.

Wisteria sinensis Asia
A traditional garden plant with some old specimens, notably in the gardens of the Supreme Court, the Garrison Library and the Convent. Will set seed which germinate in gardens, but there is no evidence of it becoming established elsewhere.

GERANIACEAE
Pelargonium inquinans/P. x hybridum
(=P. inquinans x P. zonale) S. Africa
This species and/or hybrid, still to be accurately identified, appears spontaneously in parts of the Upper Rock and is apparently naturalised, notably in the Douglas Path area. Kelaart (1846) states that several species of *Pelagornium* were cultivated in the Alameda Gardens.

GRAMINAE
Arundo donax Asia, ? Mediterranean
Established in parts of Gibraltar, presumably after being planted, *e.g.* Europa Pass. The best established stands, despite repeated cutting, are at the North Front Cemetery, which is close to a former lagoon, the only area where it could possibly have been native. Valdes *et al.* (1987) suggest it was originally introduced to the area from Asia.

Pennisetum clandestinum Montane E. Africa
A common lawn grass that has spread vegetatively from where originally planted and tends to exclude other species. Notably at lower end of Engineer Road.

IRIDACEAE
Iris albicans Arabia
Some small stands established on the Upper Rock and Windmill Hill.

LILIACEAE
Antholyza aethiopica S. Africa
Fully naturalised in gardens and firebreaks on the Upper Rock where it has recently escaped from cultivation and is spreading rapidly to the exclusion of native vegetation.

Aloe arborescens S. Africa
Large stands have grown where they have been planted in gardens (notably Alameda and The Mount), on the Upper Rock, on the east sand slopes and at Europa Advance. Do not set seed despite regular visits by birds as potential pollinators (Cortes 1982) and do not spread to new sites by natural means. Bell (1845) mentions a "black Aloe" that flowered in December, as this species does.

Aloe vera S. Africa
There is a very small population of these on the eastern sand slopes. No evidence of spreading or setting of seed.

Aloe saponaria S. Africa
There are stands of this species on Europa Point Foreshore and at Europa Advance. This species has similar characteristics to *Aloe arborescens.*

Aloe brevifolia S. Africa
Three very small stands exist at Europa Advance. No evidence of spreading.

Freesia refracta S. Africa
This species is naturalised in gardens and parts of the Upper Rock, notably the firebreak near Bruce's Farm and the lower slopes near Jews' Gate.

Dracaena draco Canary Islands & Madeira
The Dragon Tree has been in cultivation in Gibraltar for several hundred years and is now established in the wild in diverse parts of Gibraltar (Cortes 1994c).

MYOPORACEAE
Myoporum laetum Australia
This species fruits readily and seeds sometimes germinate in gardens, but there is no evidence of it becoming established.

MYRTACEAE
Eucalyptus camaldulensis Australia
The more common species of Gum tree in Gibraltar. Most are planted, but seedlings and saplings occur in certain areas near mature trees.

Eucalyptus globulus Australia
Similar situation to *E. camaldulensis,* although it is less common and seedlings rarely occur.

OLEAECEAE
Fraxinus angustifolia S. Europe
Native in wet habitats in nearby Spain. Most or all mature specimens in Gibraltar probably planted (mainly in and around South District gardens), but a few young plants appear spontaneous.

OXALIDACEAE

Oxalis pes-caprae S. Africa

Abundant and fully naturalised as in most of the Mediterranean. It was mentioned by Kelaart (1846) as sometimes being thought by visitors that it was native (as is often the case today). Kelaart claims that it arrived in Gibraltar around 1826 as he had been informed by a Captain Mitchell that it was not found in Gibraltar before then. Wolley Dod (1914) stated that it had increased enormously in recent years.

Oxalis articulata C. & S. America

Locally common and naturalised, especially in and around gardens. Not mentioned by Wolley Dod (1914) or earlier authors.

PALMAE

Phoenix canariensis Canary Islands

Grown widely as an ornamental. Seeds germinate readily in garden situations, and possibly elsewhere. Appears to be becoming established on the east sand slopes.

PAPAVERACEAE

Papaver somniferum Origin undetermined

Naturalised in waste ground. Kelaart (1846) found it in abundance in gardens (where it is now rarely found). Wolley Dod (1914) described it as an escape on the North Front, where in fact it still occurs in the North Front Cemetery.

PHYTOLACCACEAE

Phytolacca americana N. America

Spontaneous in and around gardens.

Phytolacca dioica Argentina

Widely planted ornamental in Gibraltar, occasionally seed germinates, but not naturalised here.

PINACEAE

Pinus pinea Mediterranean

Pinus halepensis Mediterranean

Both pines are native to the region, but specimens in Gibraltar are either in gardens (notably Alameda Gardens) or planted on the Upper Rock between 80 and 170 years ago (Cortes 1979). There is only little regeneration in the scrub of the Upper Rock, probably due to both density of the vegetation and high consumption of pine nuts by large populations of Black Rats *Rattus rattus frugivorus* (A. Santana, pers. comm.). Germination is frequent within Alameda Gardens, but seedlings rarely succeed in getting established. *Pinus pinea is* the more common species in Gibraltar. Kelaart (1846) mentions *Pinus sylvestris* as planted on the higher parts of the Rock. This was either a misidentification or the trees did not survive. The species is not subsequently mentioned for Gibraltar. The only specimen of Scots Pine found in Gibraltar, a 12 metre specimen in the Alameda Gardens, died in 1990.

PLUMBAGINACEAE

Plumbago capensis S. Africa

Spreads aggressively by vegetative means within gardens. Does not set seed and cannot be considered to be naturalised.

PORTULACACEAE

Talinum caffrum S. Africa

A weed of cultivation occurring spontaneously in gardens, especially in areas receiving water in summer.

SIMARBOUBACEAE

Ailanthus altissima N. China

Aggressive coloniser by means of suckers and seeds. Established in gardens, notably Alameda Gardens where an obliteration programme is in place. Also The Mount where it is replacing native vegetation. Has invaded places well away from gardens, including parts of the east sand slopes, and is fully naturalised.

SOLANACEAE

Cestrum parqui S. America

Naturalised in the region. Rare on waste ground in some parts of Gibraltar. Wolley Dod knew it as an occasional escape with one bush on the isthmus threatened by a new road. It is no longer found on the isthmus.

Datura innoxia America

Naturalised in the region. In Gibraltar grows on sandy areas on Windmill Hill Flats.

Nicotiana glauca Argentina/Chile

Naturalised in Gibraltar as elsewhere in the region, growing in walls and waste ground.

TAMARICACEAE

Tamarix gallica Mediterranean

Tamarix parviflora Mediterranean

Planted as windbreaks and ornamental mainly in windswept areas *e.g.* Windmill Hill, east side, Europa Point). A feature in the landscape in some areas but not naturalised. Wolley Dod (1914) mentions *T. africana* cultivated near the cemetery on the isthmus. There is none there today.

TROPAOELACEAE

Tropaeolum majus Tropical America

Not fully naturalised but frequently "escapes" from gardens.

ULMACEAE

Ulmus minor Mediterranean

Some trees apparently planted, but there is a stand in The Mount which may have been established naturally.

UMBELLIFERAE

Petroselinum crispum S.E. Europe, W.Asia

Naturalised on the bare rocky slopes on the northwesternmost part of the Upper Rock. It is mentioned by Wolley Dod (1914) as occuring at Rock Gun (its present station) and "Buffadero Gate", presumably at Windmill Hill Flats, where it does not occur any longer. Presumably it is of cultivated origin, it is becoming rare.

VALERIANACEAE

Centranthus ruber Mediterranean

Kelaart (1846) saw these on walls and fissures in rock, but always near gardens and thought them introduced. Wolley Dod (1914) was of the same opinion. The impression is still similar. Both red and white flowering forms occur.

VERBENACEAE

Lantana camara W. Indies

Widespread in and near cultivation. Germinates readily and established within gardens and at North Front Cemetery.

Discussion and Conclusions

The annotated list of 66 species can be summarised as follows:

Fully naturalised species: 44

Near-naturalised/ established within gardens: 10

Others: 12

The 44 species considered naturalised have been divided according to their region of origin in Table I.

There will be historical as well as the obvious climatological reasons for this breakdown. It is suggested that the introduced plants arrived at Gibraltar via two main routes. The first proposed is via neighbouring Spain, either through human agency or, in some cases of plants that had become well established in the hinterland, naturally. This would indicate that the longer established plants, most widely naturalised in the region would fall into this category. It is most likely too that these would be plants from the Americas with which Spain had the greatest contact historically. This is borne out by such species as *Amaranthus blitoides, A. muricatus, Agave americana, Conyza bonariensis, Oxalis articulata, Cestrum parqui, Datura innoxia, Nicotiana glauca, Phytolacca americana* and *Opuntia ficus-indica.*

The Spanish route is also indicated for the few Macaronesian species.Similarly, some of the Mediterranean species *(e.g. Nerium oleander, Spartium junceum, Fraxinus angustifolius* and *Centranthus ruber)* will probably have come in via Spain. These are notably more ornamental species.

The second route suggested is more recent, post 1704 (when Gibraltar was taken by the British). Gibraltar was a port of call for ships traveling between Australia, South Africa and Britain. Seeds and plants could well have been left in Gibraltar either accidentally or even as gifts for officers' gardens. If this was the case, Gibraltar could have been the first point of entry to Europe of some of the South African plants now so well established in European gardens. Evidently some South African and Australian species are widespread in Europe and it is not being claimed here that all or indeed any entered Europe via Gibraltar, but it is a possibility. In the case of species such as *Senecio tamoides, Antholyza aethiopica* and *Amaryllis bella-donna,* which are frequent in Gibraltar but'not in the region, it is possible that Gibraltar may have been a point of entry with at least regional significance.

In general a greater number of plant species grow well in at least slightly protected situations than have become naturalised. This is due to three main reasons. The first is the inability of many of the species to set seed, either for genetic or climatic reasons. The second and third are the inability of seeds, if set, to germinate and for seedlings to become established in the wild. The main limiting factor here appears to be water, as seeds are seen to germinate and seedlings become established in irrigated areas within the Gibraltar Botanic Gardens. It is the sensitivity to the operating climatic conditions at these relatively delicate stages that may have prevented the establishment of other species in the wild in Gibraltar. While this is a relative safeguard against unwanted colonisation by potentially invasive species, it is not an absolute safeguard as species such as *Carpobrotus edulis* and *Senecio tamoides* have become pest species even with this handicap. For the sake of the conservation of the native flora great care must therefore be taken before the introduction of new genetic material of existing species or of new species. The Gibraltar Botanic Garden has an important role to play in preventing this and in closely monitoring its own activities in order to avoid unwanted introductions and escapes.

Acknowledgements

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Table I. Origin of naturalised species in Gibraltar.

The Americas	14
South Africa	10
Mediterranean	10
Australia	3
Macaronesia	2
Asia	2
Other	3
TOTAL	44

Appendix I.
List of introduced species:

* = FULLY NATURALISED

*Agave americana**
*Carpobrotus edulis**
*Amaranthus blitoides**
*Narcissus tazetta**
*Leucojum autumnale**
*Dracunculus vulgaris**
Tecomaria capensis
Opuntia vulgaris
*Conyza albida**
*Senecio bicolor cinerarea**
Ipomoea cairica
*Aeonium haworthii**
*Albizzia lophantha**
Spartium junceum
*Acacia cyclops**
*Pelargonium inquinans P. x hybridum**
*Pennisetum clandestinum**
*Antllolyza aethiopica**
Aloe vera
Aloe brevirolia
*Dracaena draco**
*Eucalyptus camaldulensis**
*Fraxinus angustifolia**
*Oxalis articulata**
*Papaver somniferum**
Phytolacca dioica
*Pinus halepensis**
*Talinum caffrum**
*Cestrum parqui**
*Nicoliana glauca**
Tamarix parviflora
Ulmus minor
*Centranthusruber**
*Agave ghiesbreghtii**
*Disphyma crassifolium**
*Amaranthus muricatus**
Amaryllis bella-donna
Nerium oleander
Zantedeschia aethiopica
Opuntia ficus-indica
*Conyza bonariensis**
*Scnecio lamoides**
Ipomoea purpurea
*Aeonium arboreum**
*Ricinus communis**
Robinia pseudacacia
Acacia cyanophylla
Wisteria sinensis
*Anundo donax**
*Iris albicans**
*Aloe arborescens**
*Aloe saponaria**
*Freesia retracla**
Myoporum laetum
Eucalyptus globulus
*Oxalis pes-caprae**
Phoenix canariensis
*Phytolacca americana**
*Pinus pinea**
Plumbago capensis
*Ailanthus altissima**
*Datura innoxia**
Tamarix gallica
Tropaeolum majus
*Petroselinum crispum**
*Lantana camara**