THE HISTORY OF THE VEGETATION OF GIBRALTAR.

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Abstract

Nineteenth Century writings on the botany of Gibraltar, together with older historical texts and old prints and photographs, allow the piecing together of the recent history of the vegetation of the Rock of Gibraltar. Together they provide the most thorough account of the vegetation of any sierra in the region. The history of the vegetation is presented as interpreted from these historical works using also data from more recent investigations. Conclusions are arrived at on the future possible directions of the vegetation and on suggested measurements for combining conservation of the present vegetation, its development in the future, and the preservation of is species richness.

Resumen

Las obras de botánicos desde el Siglo XVI, y escritos de historiadores anteriores dan una idea sobre como han cambiado las comunidades vegetales del Peñón de Gibraltar durante cerca de tres siglos.

Estos trabajos, junto a pinturas y fotografias antiguas de Gibraltar han sido estudiadas. Usando también datos recientes sobre la vegetación de la Roca se discuten las posibles direcciones que ha llevado la vegetación gibraltareña y las acciones que son necesarias para poder conseguir la conservacion de la vegetación existente, la continuación del desarrollo de ésta y el mantenimiento de la presente riqueza florística.

Introduction

References to the flora of Gibraltar can be traced back to the 16th Century (Cortés 1994a). Although information on vegetation in these floras is sparse, a unique opportunity is afforded by them to be able to take a historical look at the development of an area of Mediterranen scrub. There must be few, if any sierras in Andalucía that have had so much written about plants and climate over the past 250 years as Gibraltar has had.

This paper looks mainly at the vegetation that covers most of the western slopes of Gibraltar and parts of the eastern areas (Figure 1).

Methods

Most references to the flora of Gibraltar are lists of plant species that have been found on Gibraltar, but give little direct account of the vegetation and plant communities found there at the time. Until the latter part of this century the interest in floral lists was much greater than any interest in the ecology and ecological considerations determining the species that were found. While some plants can be taken as indicator species, it is difficult to interpret many of the older plant lists which give no indication of the frequency of occurence of the plant nor how predominant it was in any given area. In order to gain an insight into the plant communities within historical times, old texts have had to be read closely and interpreted with the experience of the present situation in Gibraltar and the surrounding area. Old postcards and other photographs have also been studied and interpreted in the light of published information. A relatively recent phytosociological study (Cortés 1979) and subsequent observations have been used to extrapolate the changes to the future and consider possible implications for the conservation of the vegetation of Gibraltar.

Climate

The climate of Gibraltar is Mediterranean. The main climatological data are given in Table 1. Cortés (1979) analysed climatic data from Kelaart (1846) in comparison to data up to 1977. He reported fluctuations in mean temperatures, as would have been expected, with a relatively warm period in the mid 1900s and particularly low minimum temperatures from 1909 to 1911. Temperature differences were not significant, however, but there was a significant peak in rainfall also around 1909-1923, and especially low rainfall in the 1800s (Kelaart's data). It must be pointed out that Kelaart's data are limited and that, as they were probably collected in areas different to present records, they are not directly comparable. Similar difficulties are encountered in long term comparisons of data from the Meteorological Office at RAF Gibraltar, as the precise location of the instrumentation has changed periodically. In any case no significant trends have emerged since records began (J. Allen, pers. comm.).

In the light of Emberger's (1955) classification of bioclimate, an annual rainfall of 798mm places Gibraltar in the subhumid bioclimatic zone, while the mean minimum temperature of the coldest month is greater than 7°, placing Gibraltar in the hot variant of this type. Within Emeberger's (1955) climogramme, Gibraltar lies within the range attributed to his Olea-Ceratonion, but outside the range of *Quercus coccifera,* (except in the cold period from 1909 to 1911).

On the whole it is not considered that the climate has changed sufficiently in the last 150 years to have made much if any contribution to changes in vegetation.

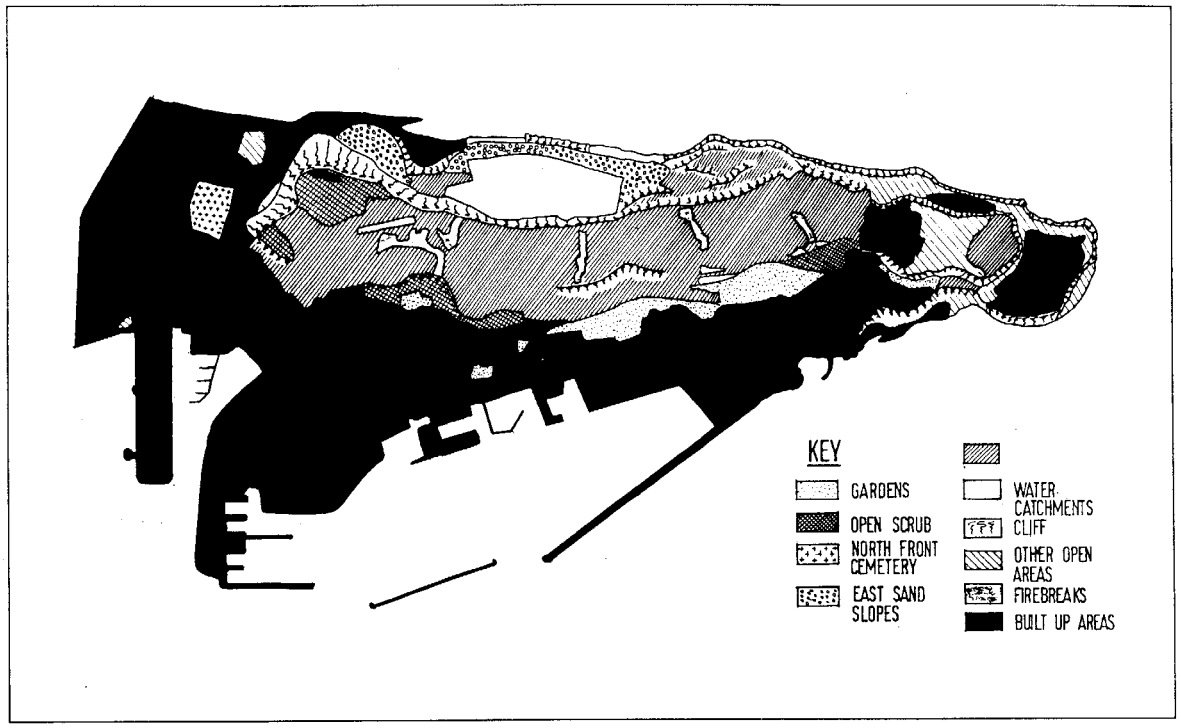

Figure 1. Gibraltar: Vegetation 1994.

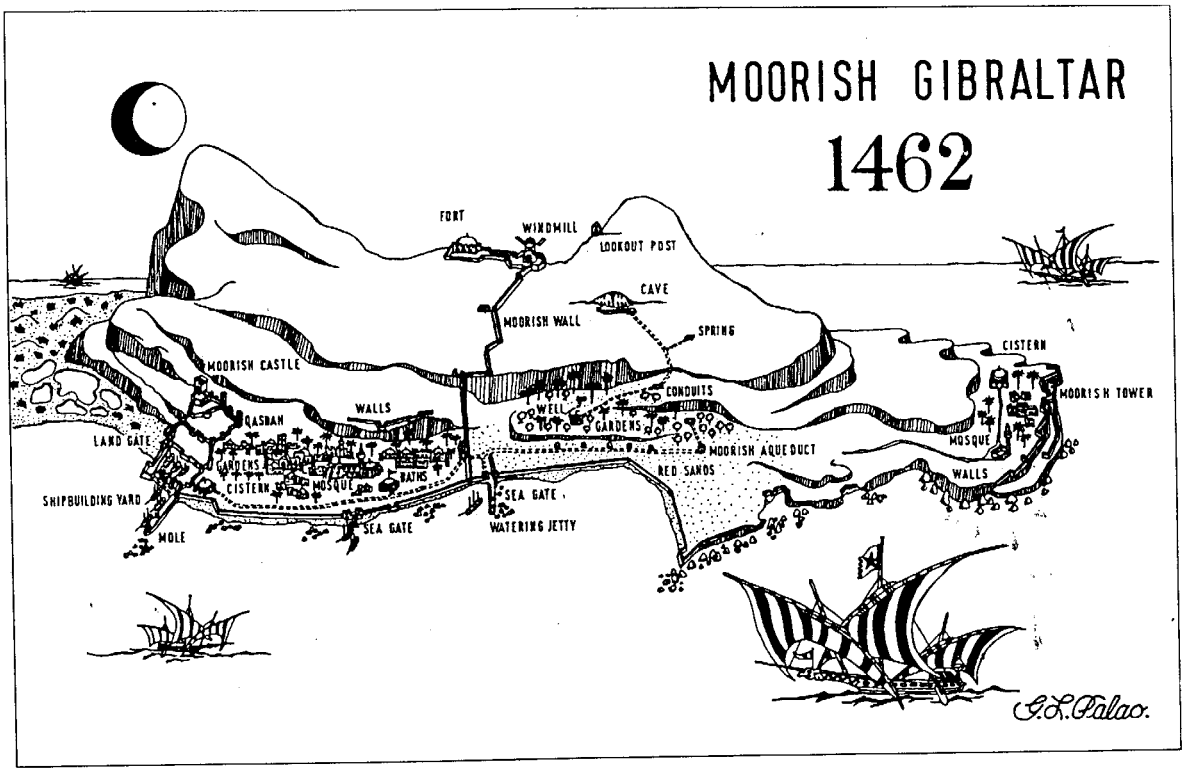

Figure 2. Gibraltar in 1462. From: The Rock of the Gibraltarians (Jackson, 1987).

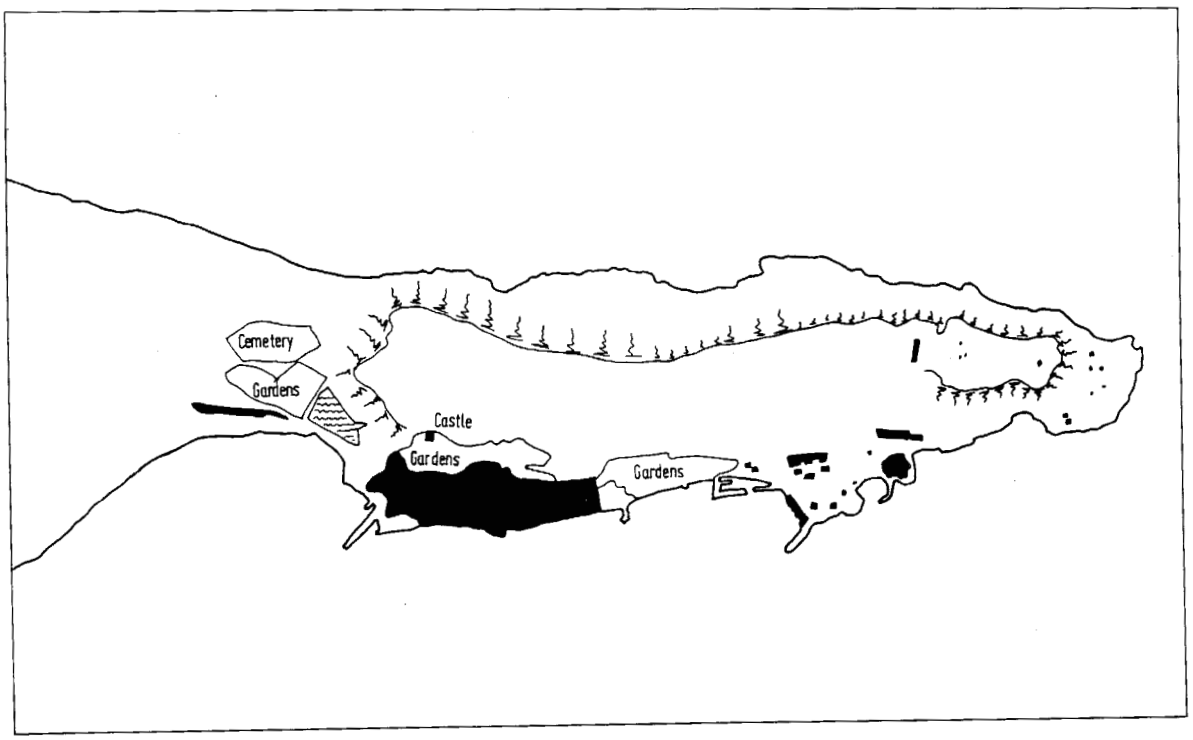

Figure 3. Gibraltar: Built up areas 1874.

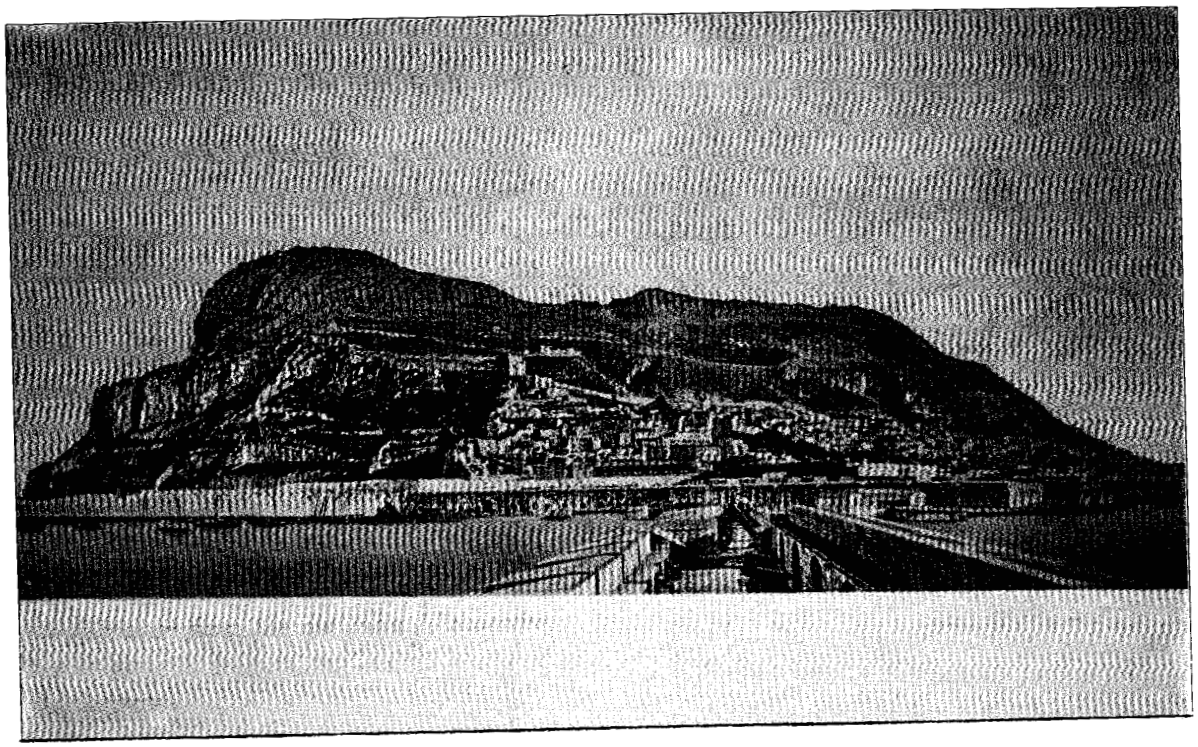

Figure 4. Gibraltar in the late 1800s.

The History of the vegetation

The history of the vegetation of Gibraltar is in many ways unique, but in many others parallels that of the rest of Iberia and of the Mediterranean region in general. In the Quarternary, after the last glaciation, conditions in the region were relatively moist, and a cover of evergreen sclerophyllous forest and pines dominated the Mediterranean lands. This vegetation achieved its maximal development in the tenth to the second millenium BC (Tomaselli 1977). The growth of civilisations along the Mediterranean Basin led to the cutting down and burning of forests, first for land for livestock and agriculture and later for extracting timber largely for shipbuilding. The destruction caused was out of proportion to the actual need of the human population (Quezel 1977). The needs for grazing were considered so important that special provision was made for grazing rights in the *jus pascendi* of the Romans. Cicero and Pliny agreed that Rome's forest heritage had been destroyed by excessive grazing. In Spain the mesetas were equally laid bare during eight centuries of nomadic grazing. Forests were removed during the Moorish occupation and later during Spain's sea-going days of the Armada and colonial rule in South America. Even the degraded scrub was removed for making charcoal (Tomaselli 1977).

The history of the vegetation of Gibraltar is closely interrelated with the human history of the Rock on which much more has been written. It is likely that the cover of the Rock once consisted of the Quarternary sclerophyllous forest climax, combined with cliff and open ground in the sandy areas. There is little written record of vegetation before the British occupation of 1704. However, Portillo (ca 1620) and his transcribers and translators James (1771) and Ayala (1782) confirm that there was no town on Gibraltar until after AD711, when the Moors built the castle and associated buildings. Before that time it was visited by Phoenicians and others, but was relatively inaccessible and probably had been little influenced by Man. According to these writers, "The hill has undergone some changes". It was once covered with trees, but by the time Ayala wrote there were "but few left upon it", except those in gardens. He reports an oral folklore that trees developped a disease in Gibraltar and were therefore cut down. Bell (1845), in his translation of Ayala, explains that there were trees in Spanish days when people were sent to Gibraltar to restore their health. James (1771) says that there were many trees and vines even to the year when the Spaniards attempted to surprise the garrison over the "middle hill" (1704). He states that many continued until 1727 when the regiments, "who were encamped to the southwards, had leave to cut some for their firing, which they took in its full latitude and levelled almost the whole."

It would not be difficult to believe that encamped soldiers, beseiged and lacking fuel, could remove the bulk of Gibraltar's vegetation. It is also likely that the army preferred there to be no cover on the Rock to conceal possible intruders. Bell, without claiming authority, suggests that trees clothed Gibraltar when the Phoenicians built Carteia and suggests too that the Moors shipped wood from Gibraltar to North Africa (whether or not this wood was from Gibraltar itself is not clear). He said that Gibraltar now was, however "entirely barren, there being neither grass nor shrub, and the ground, covered with sharp, loose stones, ... has a disagreeable aspect". Portillo had early insight into ecological conditions and stresses the many different types of habitat that could be found on such a small place as Gibraltar, including rocky crags, wet crags, caves, exposed sites, heavy soils and sands. Returning to the theme of trees, he states that these were mainly Carobs *Ceratonia siliqua,* which were quite tall and grew mainly near the castle, where the soil was better. This presumably referred to the Moorish Castle on the north end of the Rock, whose extent in those days was considerably greater than today's Tower of Homage. It probably referred to the flatter areas on the lower slopes of the Rock, now built up, rather than to the area of Willis's, above Moorish Castle, now covered in scrub. He refers to many bushes, including wild olive, vines, figs, prickly pears *(Opuntia ficus indica)* and ivy *(Hedera helix).*

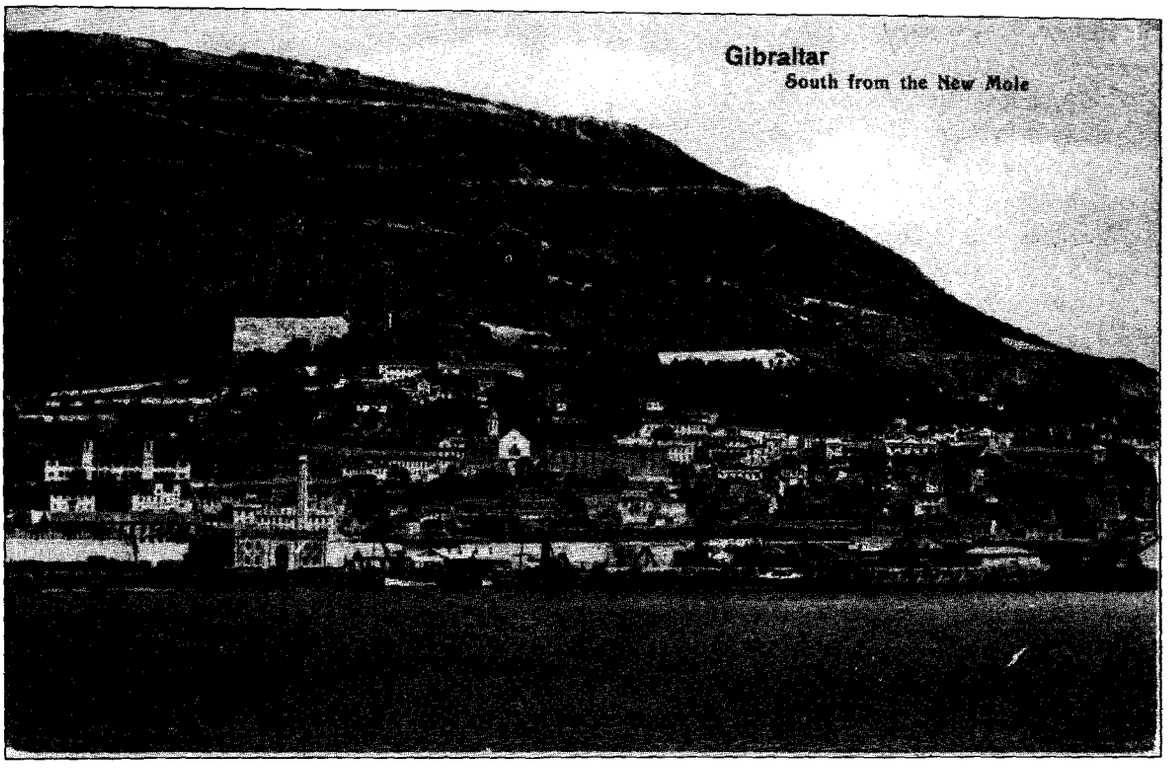

Figure 5. The south western slopes of Gibraltar in the late 1800s / early 1900s.

Bell, referring to the south of the Rock, mentions that most of it above and south of the naval hospital was "barren and rocky". He highlights the lack of shelter for cattle but stresses that the area was not destitute of vegetation, springing among the rocks after the first rains. In summer he claims noth ing could be seen but barren rocks and palmetto shrubs *(Chemaerops humilis).* This contrasts with the reference of Debeaux & Dautez (1888) that the Europa area was covered in dense vegetation, which could not be found elsewhere in Gibraltar, and may indicate some development of this between the late 1700s and the late 1800s. By implication, the vegetation elsewhere was not dense. Kelaart (1846) states that the vegetation of the rock was "comparatively of a diminutive kind". Bell (1845) refers to the "general sterility of the place" and Kelaart (1846) again writes that "... on entering the Mediterranean Straits, Gibraltar appears to be a barren rock". Wolley Dod (1914) quotes Gaudichaud (1817) as remarking upon the total absence of all trees taller then *Chemaerops humilis,* though Wolley Dod thought this must have been an exaggeration. Prints and photographs of Gibraltar in the mid to late 1800s give the appearance of such a barren rock with little sign of trees or shrubs. The vegetation "levelled" in 1727 was evidently kept low. It is well known that this was done by the grazing of goats, some of which were kept in Gibraltar until the mid 20th Century. Wolley Dod (1914) also remarks that the southern parts of the Rock had been less affected by the grazing of goats than the west slopes.

The species composition of the upper slopes of the Rock can be gleaned from reference to the works of Kelaart (1846) and Debeaux & Dautez (1888) primarily. Boissier (1837) also gives an insight. Most of the plants highlighted

by these authors as they describe various walks in the area are plants of open ground, including *Daphne gnidium,* given as common by Kelaart (now rare in Gibraltar), *Jasminum fruticans, Lavandula dentata, Genista linifolia* and *Scolymus hispanicus.* Kelaart highlights the predominance, near St Michael's Cave, of members of the "broom tribe", including *Genista linifolia,* which still occurs in Gibraltar but is not significant in the area of St Michael's Cave, and also *Cytisus (Sarothamnus) baeticus* which does not occur in Gibraltar today. Both are species of low open scrub, which have now been replaced by others in this area.

By 1846 (Kelaart 1846) there were plans to introduce trees specifically to provide shade because the Rock was so devoid of cover. Kelaart mentions Lientenant Governor George Don's plans to plant bella sombras *Phytolacca dioica,* poplars *Populus* spp. and "firs", and gives his opinion that planting "should be further carried out on the high parts of the rock".

This was in contrast with Wolley Dod's belief. Writing in 1914 he remarked that the variety of plants was lower than in other areas because the recent removal of goats and the building of an "unclimable fence" (around the 300m contour) had kept the goats out and the subsequent growth of dense vegetation had crowded out much of the undergrowth. Wolley Dod did not refer to trees introduced to the Upper Rock areas, so it is likely that much of this was done after his day.

Figure 6. Gibraltar in 1993.

Present vegetation

Since the removal of the goats from the upper reaches, tree planting has been the main direct interefernce by man in the vegetation. Stine Pines *Pinus pinea* and Aleppo Pines *P. halepensis* have been introduced, as have Eucalypts *Eucalyptus camaldulensis* and *E. globulus.* A number of other species have also become naturalised (Cortés 1994b), notably *Senecio tamoides* and *Antholyza aethiopica.* Both these species are adversely affecting natural communities.

However, the main changes in the vegetation of the upper western slopes since 1914 have been related to the growth of shrubs from an open ground *pseudosteppe* situation to a closed *matorral* and in cases woodland. While floristic composition should not be taken into account when considering the classification of matorral or *maquis* (Tomaselli 1977) it is true that, as a result of natural seral changes, a number of species of open ground have been lost while others have contracted their range (presumably) into the remaining clear areas of screes or firebreaks, which have had to be cleared as from the early years of this century. In the five classifications of the taller *maquis* of Gibraltar given by Cortés (1979) *(low maquis, low/high maquis, high maquis, high maquis/woodland* and *woodland)* only 17 species scored 4 or 5 on the Braun Blanquet (1951) association analysis (Table 2). The dominance of shrubs/small trees which bear fleshy fruit is obvious as is the prevalence of scandents and, in the taller formations, of plants of shady woodland floor *(Smyrnium olusatrum, Acanthus mollis, Vinca difformis).* All these species have been recorded in Gibraltar previously by Wolley Dod (1914) and earlier authors, so that they apparently expanded from refugia in sheltered areas, cliffs, etc., on the removal of the grazing domestic livestock. The fact that they are largely bearers of soft fruit will have facilitated their spread by means of dispersal by birds. This will not have been the case with other former species of the woodlands of Gibraltar, notably *Ceratonia siliqua* and *Quercus ilex.* The change in floristic composition of the Upper Rock on the removal of the goats is reflected in the loss from Gibraltar of species formerly growing on the Upper Rock (Cortés 1994a), and also in the loss from areas of the Upper Rock of species of open ground now found only in other parts of Gibraltar. An example is *Ononis reclinata,* formerly growing on the south and west slopes of Gibraltar. There have been changes too to the faunistic communities of Gibraltar. Unfortunately no historical studies on invertebrates exist, but birds of open ground recorded nesting by Irby (1875) (Dartford Warbler *Sylvia undata* and Black Wheatear *Oenanthe leucura)* no longer do so while rare breeders at the time like the Blackcap *Sylvia atricapilla,* a bird of tall scrub and woodland, are now common. The trend continues with a recent upsurge in the breeding population of another woodland bird, the Great Tit *Parus major* and increasing recording of other species like Green Woodpecker *Picus viridis* and Tawny Owl *Strix aluco.*

The other major development has been the growth of the town of Gibraltar. The town saw little growth between the 1600s and the late 1800s. Bell (1845) states that in 1755 there were no more than 400 houses in the town. Kelaart (1846) states that the Town measured 5820 feet by 1000 feet (about 1900m by 350m). Maps of Gibraltar up to the late 19th Century show little expansion from the lower northern slopes of the Rock. Kelaart (1846) states that Gibraltar had 70-80 acres capable of cultivation out of a total 200 acres, but only 40 acres out of these were in cultivation, including over 15 acres as parks and gardens. There was little change in this between 1846 and the early 1900s, when the needs of modern warfare gradually resulted in an expansion of built-up areas. This was especially so during the Second World War (1939-45) when the airfield was built on the isthmus destroying an area of cultivation and rich in plants of sands and wetland. Shortly after this an expanding population placed even greater demands, not only on the isthmus, leading to the reclamation of a brackish water lagoon, but upwards and southwards. With the fortunate exception of most of the

Alameda Gardens, which had been established in 1816, the red sands south of town were built over. This resulted in the loss to this area of many species including *Glaucium flavum* given by Debeaux & Dautez (1888) as found "on maritime sands near the Alameda", and the beds of *"Ononis"* and *"Verbascum sinuatum"* that Kelaart (1846) recorded there. The reclamation to form the Dockyard removed the maritime element from the area. The only remnants of these beds are a few plants of *Ononis cossoniana* still growing on the southern end of the Botanic Gardens. Other range contractions in Gibraltar have included that of *Hedysarium coronarium,* now only found on Windmill Hill Flats, formerly on the "littoral on the west coast of Gibraltar" (Debeaux & Dautez 1888). The spread in builtup areas can be discerned from comparing Figures 2 to 3 with Figure 1, while the development of the vegetation can be seen by comparing Figures 4 and 5 with Figure 6.

Cortés (1979) examined the vegetation of the western slopes of Gibraltar in relation to the heights of key species also, and used association analysis and principal components analysis of data from 84 quadrats to arrive at the classification of vegetation referred to above, and illustrated in Figure 1, while referring also to other classical methods of categorising Mediterranean scrub vegetation, notably Daget *et al.* (1968). Cortés (1979) found the vegetation of the west slopes, with the exception of the pseudosteppe of the firebreaks and open cliff vegetation, to be a mosaic of patches of varying density and height of vegetation which, taken as a whole, could be considered a complex low-woody-herbaceous community (Daget *et al.* 1968). Within this there was a certain amount of woodland with trees with defined trunks, but of a maximum height of no more than 8m.

The main component of the maquis was High maquis or a dense, tall-woody community in the sense of Daget *et al.* (1968). Two forms of low maquis were also identified, one with similar species to the high maquis, and another with a predominance of *Pistacia lentiscus, Genista linifolia* and *Chemaerops humilis*. There were other areas defined as garrigue or a complex low-woody-herbaceous community (Daget *et al.* 1968) and a complex version described as maquio-garrigue whose characteristic feature was the fact that there were tall shrubs of some species (especially *Olea europaea*) within a much more open area rich in grasses and herbaceous species.

The future of the vegetation.

The purpose of this paper is not to analyse or re-analyse the vegetation classifications of Cortés (1979). However the above reference has been made in order to highlight various features of Gibraltar's present vegetation. The variation in types of scrub reflects a dynamic situation, one that is still changing and developing towards a climax, depending evidently on other conditions such as soil depth and gradient. As the vegetation has continued to mature since Cortés's early field studies, the overall height of the maquis has increased, areas of high maquis have extended, and there are more areas that could be defined as woodland. This would suggest a tendency towards a further decrease in the number of species found on the Upper Rock. The presence in areas of etiolated specimens of open ground species such as *Narcissus papyraceus and Iris filifolia* confirm this trend. The spread since 1979 of two trees, *Laurus nobilis* and *Celtis australis* within the Upper Rock also shows a tendency towards a woodland climax. Particular instances where this has not been so have continued to be the firebreaks and areas which have been burnt which, as predicted by Cortés (1979) continue to be colonised rapidly by *Genista linifolia*. However, the firebreaks on the southern end of Gibraltar have not now been cleared for two years. This is rapidly resulting in the growth of matorral to the detriment of open ground species. A similar change is occuring in areas below the old unclimable fence from which the goats were removed more recently (1940s - 1950s). The vegetation is growing denser and threatening species of open ground including orchids (Linares 1994) and

even species of low scrub like *Calicotome villosa*. Table 3 illustrates the suggested succession scheme for Gibraltar (Cortés 1979).

A decision needs to be made on whether the vegetation of Gibraltar is to be allowed to continue to develop naturally or whether it is preferable to maintain a high diversity of species growing on the Rock. This diveristy is falling and set to fall further as a result both of natural and man-induced changes. The natural threat has been discussed above. Man-induced changes include plans for a road on the lower slopes of the Rock and for the quarrying of the talus on the east ~ide. The establishment in 1992 of a statutory nature reserve on the Upper Rock being marketed on the strength of the variety of its flora and fauna seem to confirm a desire to maintin diversity. If this is to be so, then areas outside the nature reserve need to be protected from the pressure of urban development and areas within the reserve require urgent habitat management including the regular clearing of firebreaks, while allowing designated areas of woodland to continue to mature. Management plans have been prepared in the past (e.g. Cortés 1978, GONHS 1988) and would require only small modifications in order to be implemented. Research into the developing plant communities of Gibraltar needs to continue also so that in future trends and changes can be readily quantified and do not rely on intuitive interpretation of old writings.

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Table 1.
Gibraltar climatic information.

Mean annual temperature:	18.2 C
Mean temperature of coldest month:	13.4 C
Mean temperature of warmest month:	24.2 C
Mean yearly minimum temperature:	14.9 C
Mean yearly maximum temperature:	21.4 C
Meam annual rainfall:	768 mm

Table 2.
Species scoring 4 and 5 in Braun Blanquet degree of presence (from Cortés 1979)

Olea europaea	*Asphodelus albus*
Osyris quadripartita	*Acanthus mollis*
Pistacia lentiscus	*Clematis cirrhosa*
Rhamnus alaternus	*Aristolochia baetica*
Asparagus albus	*Lonicera implexa*
Ferula tingitana	*Tamus communis*
Oxalis pes-caprae	*Vinca difformis*
Geranium purpureum	*Smyrnium olusatrum*
Urginea maritima	

Table 3.
Suggested sheme for succession on Gibraltar.