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Invading plants at high altitudes on Tenerife especially in the Teide National Park

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DICKSON, J. H., RODRIGUEZ, J. C. & MACHADO, A., 1986. **Invading plants at high altitudes on Tenerife, especially in the Teide National Park.** Eighty-three flowering plants are discussed as successful, failed or potential invaders of the Teide National Park, Tenerife, a caldera at 2000 m altitude and above with a largely endemic native flora. Two important methods of invasion are considered. Firstly, there was dispersal by pastoralism, goat-herding, an ancient practice which stopped over 30 years ago. Secondly, the development of mass tourism in the last 25 years has brought a fresh influx of alien plants. Many of the 83 invaders discussed have had only transient occurrences, but 30 are well-established, 15 being grasses among which *Bromus tectorum* and *Vulpia myuros* are the most abundant. *Chenopodium vulvaria* and *Poa pratensis* are new to Tenerife and *Dactylis glomerata* subsp. *hispanica* is new to the Canary Islands. Control measures are outlined. Attempts have already been made to contain *Avena barbata*, *Lactuca serriola* and *Chenopodium* species.

ADDITIONAL KEYWORDS:—Alien plants – conservation measures – dispersal – Tenerife Flora.

CONTENTS

INTRODUCTION

The caldera of Las Cañadas at altitudes of 2000 m (6500 ft) and above, has long been renowned for its distinctive flora consisting largely of endemic species (Bramwell & Bramwell, 1974; Machado, 1979a; Ortuño, 1980). These species

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grow in a severely testing habitat which has exceedingly well-drained skeletal soils under the strong ultraviolet radiation of often cloudless skies, with low precipitation and relative humidity. They are subjected to great diurnal and seasonal variations of temperature (Fernadopullé, 1976; Ortuño, 1980). Especially cold temperatures occur in the low lying areas, the caldera bottoms between 2000 and 2200 m (Cañadas-Kaltsee, Voggenreiter, 1974). The absolute minimum recorded by R. Wegner in 1911 in Cañada de la Grieta (2078 m) is −16.1°C. The mean annual temperature is 9°C and the 30 year mean of precipitation at Izana (2300 m) is 463 mm.

Limited by these factors, the sparse flora comprises a largely shrubby and mostly very open vegetation. *Spartocytisus supranubius* (L.) Webb & Berth. and *Adenocarpus viscosus* (Willd.) Webb & Berth., two of the most abundant species, are leguminous shrubs. The former has been shown to have N-fixing nodules (C. T. Wheeler, personal communication). It gives its name to the class *Spartocytisetea nubigeni* of Voggenreiter (1974), the most extensive vegetation type with up to 25 species. Endemic annuals are absent, a lack characteristic of the whole Canarian flora, and herbs are few. Outstanding examples of the latter are *Echium auberianum* Webb & Berth. and *Viola cheiranthifolia* Humb. & Bonpl. The *Viola* with only one or two other species comprises the class *Violetea cheiranthifoliae* of Voggenreiter.

A few springs and small streams are the only permanently wet areas in the National Park. They support a vegetation in which the large tussocks of *Carex calderae* A. Hans. and the tall *Mentha longifolia* (L.) Huds. are conspicuous.

Rocky slopes locally support *Echium wildpretii* Pears. ex Hook fil., found also at high altitudes in the Taburiente National Park, La Palma (Machado, 1979b). It forms gigantic rosettes of narrow leaves and finally 2 m or more high columns of thousands of red flowers. Carlquist (1974) has drawn attention to its similarity with *Argyroxiphium* species of Hawaii; such lifeforms can be seen as adaptations to withstand the rigours of high altitude life at low latitudes, though no ecophysiological studies have been carried out as yet on the Canarian plants.

Above 1800 m *Pinus canariensis* Chr. Sm. ex DC has markedly thinned out and 2000 m is about the natural altitudinal limit of the tree. In the early 1950s the "*Patrimonio Forestal del Estado*" established several experimental stands of *Pinus* species and other conifers with the aim of afforestation in and around Las Cañadas. *Pinus radiata* D. Don was selected first and during 1954–55 about 114 hectares were planted in Cañada Blanca and Cañada del Capricho. In 1956 *Cedrus atlantica* (Endl.) Carrière, which thrives, was planted at a few localities, and scattered *Pinus canariensis* (approximately 72 h) were planted on the eastern side of the Guajara–Ucanca escarpment; all these pines have now been removed but some *Cedrus atlantica* still remain.

The caldera and the towering peak of Teide, reaching 3718 m (12 198 ft) form the National Park, established firstly in 1954 with an area of 11 685 ha and re-established in 1981 to the extent of 13 571 ha (Fig. 1). They are now readily accessible by road and cable-car (operational since 1971). About a million visitors come each year to the National Park by car and bus, arriving at all seasons, except when snow infrequently blocks passage. These numerous vehicles and tourists come from the low-flying areas of Tenerife and other Canary Islands where alien plants abound as weeds, ruderals and garden plants. Propagules must arrive frequently but intrusive species are, for the most part,

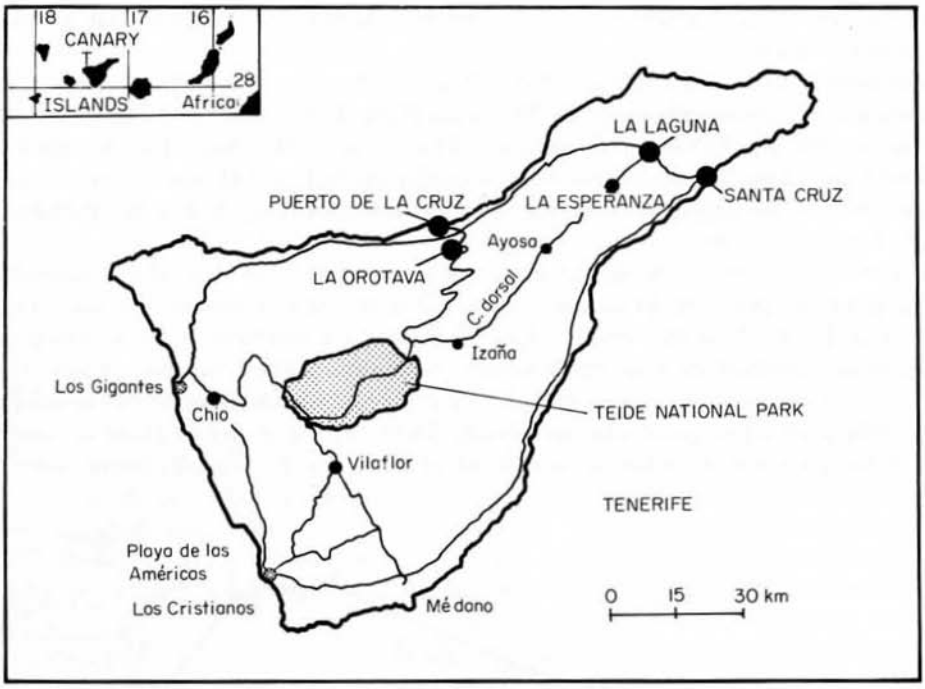

Figure 1. Map of Tenerife showing the location of the Teide National Park.

inconspicuous. However, invaders are far from being absent and twenty nine have become well established. Only a few workers have recorded alien plants growing in Las Cañadas (on Tenerife a cañada is an alluvial plain within the caldera). Though 19th century scientists from Humboldt onwards have visited Las Cañadas and climbed Pico de Teide, Sventenius (1946) appears to have been the first to attempt a comprehensive listing of the flora. Firstly, he discussed "Plants restricted to the Canary Islands" and secondly, under the heading "Other species not exclusively Canarian, which form part of the flora of Las Cañadas", he listed 31 species. He did not specify which of the latter he thought were anthropochorous invaders. Buch (1819, 1825), *Bourgeau*, Bolle (1861), Christ (1885, 1888) all gave some records which have relevance to this paper.

Seemingly unaware of Sventenius' list, Lid (1967) recorded the altitudinal limits of plants, including many weeds, on Tenerife and other Canary Islands which he visited seven times between 1954 and 1967 but mostly in the 1960s. He, too, did not specify which plants he thought were introductions in Las Cañadas. Lid's numerous records make it clear that many species classed as weeds have altitudinal limits about 1500 m (4920 ft) on Tenerife; this is the limit of cultivation at Vilaflor on the south slope of the island. With only slight reference to Sventenius and Lid, Hansen (1970) discussed briefly the introduction flora of Las Cañadas. Sventenius gathered specimens from Las Cañadas until the 1960s; these have been published by Santos & Fernandez (1977–1982).

In a short discussion of the flora of Las Cañadas, Kunkel (1980) gave a selection of ruderal species regarded as introduced by pastoralism,

reafforestation and tourism; this is based almost entirely on the work of Sventenius (1946).

On brief visits from 1979 to 1985, while teaching undergraduates, the senior author has recorded aliens in the National Park. For 5 days in December 1982, accompanied by Señor C. Rodriguez Pinero and Mr Alan Fairweather, he visited most of the localities listed by Sventenius, Lid and Hansen. For 6 days in June 1983, accompanied by Dr C. Turner and again by Señor Rodriguez, he made further searches.

Plants could have been brought to Las Cañadas by the indigenous, prehispanic people, the Guanches, who left many traces within the area of the National Park (Cuscoy, 1968). Las Cañadas represented a very important communal herding area in the annual transhumance by the Guanches. Until about 1950, numerous goats were grazed in Las Cañadas. In the National Park now only a very few goats are permitted. They belong to Señor Juan Evora, the last of the pastoralists, who has a cottage at Boca Tauce (Fig. 2) Sventenius' list

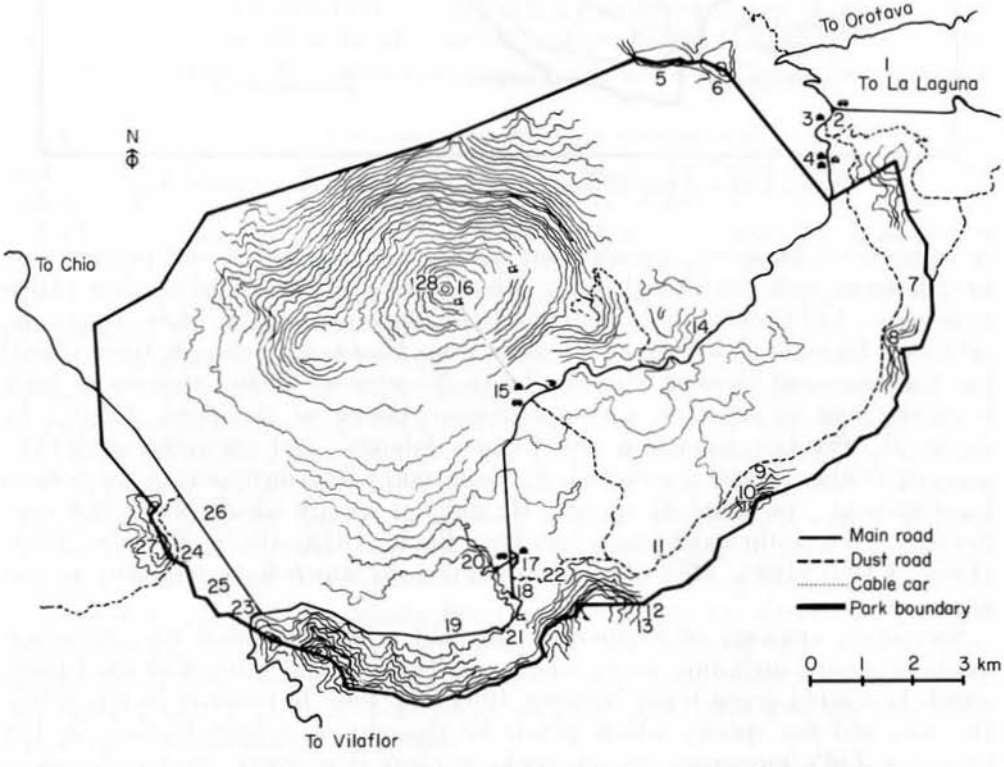

Figure 2. Map of the Teide National Park, commonly referred to as "Las Cañadas". Only some contours shown. The studied localities are numbered as follows. 1, Montaña del Alto, 2100 m. 2, Bar el Portillo, 2050 m. 3, Centro de Visitantes, 2050 m. 4, Caserio del Portillo, 2100 m. 5, La Fortaleza, 2100 m. 6, El Cabezon, 2100 m. 7, Montaña de Diego Hernandez, 2100 m. 8, Risco Verde, 2050 m. 9, Fuente de la Grieta, 2050 m. 10, Topo de la Grieta, 2250 m. 11, Cañada del Monton de Trigo, 2100 m. 12, Fuente de Guajara I, 2400 m. 13, Fuente de Gujara II, 2400 m. 14, Minas de San Jose, 2250 m. 15, Base del Teleferico, 2300 m. 16, La Rambleta, 3500 m. 17, Parador de Turismo, 2050 m. 18, Los Azulejos, 2050 m. 19, Llano de Ucana, 2000 m. 20, Roques de Garcia, 2050 m. 21, Barranco del Riachuelo, 2050 m. 22, Cañada del Capricho, 2150 m. 23, Boca de Tauce, 2000 m. 24, Los Coralles, 2000 m. 25, Cañada de Chavao, 2000 m. 26, Llano de la Santidad, 2000 m. 27, Fuente del Cedro, 2100 m. 28, Cono del Teide, 3700 m.

is important for showing what species were present when goatherding was still practised extensively. These are species perhaps dispersed by pastoralism, conceivably even by the very ancient husbandry. However, in the absence of plant-bearing archaeological deposits there is no way of doing more than guess at which species may have been prehistoric introductions. Though herds of goats are no longer found in the National Park, rabbits, introduced since the Spanish conquest in the late 15th century, are widespread, and there is also a small population of moufflon, established very recently (February 1971).

The great influx of tourists began after Sventenius' work in the 1940s. Lid's records made mostly in the 1960s and Hansen's records made in 1964 and 1965 refer to the early period of mass tourism while those presented in this paper apply to the present, long after the abandonment of pastoralism but with continuing effects of tourism.

As early as 1819 Buch, in his list of plants for the Canary Islands, indicated 126 introduced species including some, especially orchids, which now would be regarded as natives. For many non-endemic Canarian plants because of a very sparse palaeobotany, which is uninformative, and also a lack of pre-1800 botanical literature it is even more difficult to distinguish native from long-established alien than it is for the British flora (Webb, 1985). Many taxa are listed in the next section as "Native or long-established alien" because there is no sure way of making the choice. Bunbury (1856) was aware of the problem, as was Lems (1960) who, nevertheless made the distinction. Sunding (1979) considers that some estimates of the numbers of introductions are too high. Hansen & Sunding (1985) in their check list of the Macaronesian flora did not indicate status, apart from endemism. Some of the plants discussed below may be indigenous in Tenerife and natural colonizers to about 2000 m. *Vulpia myuros* (L.) C.C. Gmel. is a cogent example. Stace & Cotton (1980: 156) state that this grass is "often casual or naturalised outside its native area, the precise limits of which are obscure"; another closely similar example is *Bromus tectorum* L. (Smith, 1980). Both these species are common in the National Park. That they carry no indigenous insects, but support alien Hemiptera and aphids, is a subsidiary reason against accepting their native status. A few other species (examples are *Spergula pentandra* L., *Myosotis ramosissima* and *Asterolinon linum-stellatum* (L.) Duby) may be natives just reaching their uppermost limits at the edges of the caldera, or even higher in the case of *Gnaphalium luteo-album* L. However, for the most part, it is clear that the species are recent invaders of the National Park or its immediate surroundings, whether natives, long-established aliens or modern introductions to the Canary Islands. Only one endemic, *Urtica stachyoides* Webb & Berth., is considered as a probable recent invader of the National Park.

The landscape is illustrated in Figures 3 & 4.

CATALOGUE OF INVADING SPECIES

There follows an annotated list of species certainly or probably alien in the National Park or adjacent areas at and above 1800 m. *Marrubium* excepted, deliberately planted, mostly woody species (in the vicinity of buildings) are not listed; none shows signs of spreading. They include *Agave americana* L., *Alcea rosea* L., *Prunus armeniaca* L., *P. domestica* L., *P. dulcis* (Miller) D. A. Webb and *Pyrus communis* L. Nor is there any discussion of the purely ephemeral occurrences of

Figure 3. Teide from Los Azulejos (18, Fig. 2) with the buildings of Parador de Turismo (17, Fig. 2) on the right.

Figure 4. View to the south from near the summit of Teide (28, Fig. 2) showing the rim of the caldera. The buildings of Parador de Turismo at the far left with Roques de Garcia (20, Fig. 2) at the middle left.

discarded food plants; *Solanum tuberosum* (Barranco Riachuelo, 1983) and *Triticum aestivum* L. (Bar El Portillo, 1983).

For each taxon there is a short statement on its occurrence on Tenerife. Localities within and outside the National Park are listed separately and

chronologically by investigator. Numbers refer to localities shown on Fig. 2. Italicized names refer to herbarium collectors with the date of their collection or observation. For a few difficult taxa there are taxonomic comments. Nomenclature follows Hansen & Sunding (1985).

AMARANTHACEAE

Amaranthus hybridus L.
TENERIFE: Long-established alien. Widespread weed at low altitudes. NATIONAL PARK: 17 Hansen, 1970.

APIACEAE

Torilis leptophylla (L.) Rchb. fil.
TENERIFE: Native or long-established alien. Widespread weed at low to moderate altitudes. NATIONAL PARK: Fuente de la Piedra, *Sventenius*, 1944. 21 *Rodriguez*, 1984.

ASTERACEAE

Calendula arvensis L.
TENERIFE: Native or long-established alien. Abundant weed and ruderal at low to moderate altitudes. NATIONAL PARK: 23 *Dickson* et al., 1983. 5 *Rodriguez*, 1984.

Dittrichia viscosa (L.) Greuter
TENERIFE: Native or long-established alien. Abundant ruderal, extending into barrancos and on slopes, at low to moderate altitudes. Map in Voggenreiter (1974: 656). NATIONAL PARK: Cañada de la Pila, *Sventenius*, 1967. 18, 21 *Dickson* et al., 1982, 1983. OUTSIDE NATIONAL PARK: 13 *Dickson* et al., 1983. UNLOCALIZED: 2250 m Lid, 1967.

Filago pyramidata L.
TENERIFE: Native or long-established alien. Widespread weed at low to moderate altitudes. OUTSIDE NATIONAL PARK: 27 *Sventenius*, 1956. 1 *Rodriguez*, 1981, *Dickson* et al., 1983.

Gnaphalium luteo-album L.
TENERIFE: Native or long-established alien. Widespread at low to moderate altitudes. NATIONAL PARK: 9 *Sventenius*, 1944. 16 *Turner & Rodriguez*, 1983, 1984. OUTSIDE NATIONAL PARK: 13 *Dickson* et al., 1983.

Lactuca serriola L.
TENERIFE: Native or long-established alien. Abundant ruderal at low to moderate altitudes. NATIONAL PARK: 7 *Sventenius*, 1948. 17 Hansen, 1970; *Dickson*, 1981–85. 9, 18 *Dickson* et al., 1982. OUTSIDE NATIONAL PARK: 4 *Dickson* et al., 1982.

Logfia gallica (L.) Coss. Germ.
TENERIFE: Native or long-established alien. Widespread weed at low to moderate altitudes. OUTSIDE NATIONAL PARK: unlocalized 1800 m, Lid, 1967.

Sonchus oleraceus L.

TENERIFE: Native or long-established alien. Common weed at low to moderate altitudes. NATIONAL PARK: 17 *Dickson* et al., 1981–1983.

Tragopogon porrifolius L. subsp. *australis* (Jord.) Nym.

TENERIFE: *Tenerife:* Native or long-established alien. Common ruderal at low to moderate altitudes. NATIONAL PARK: 5, 7 Fuente de la Piedra, *Sventenius*, 1944. 23 Lid, 1967; *Dickson* et al., 1983. OUTSIDE NATIONAL PARK: Cordillera Dorsal up to Vista Valle Orotava 2150 m *Lid*, 1967.

BORAGINACEAE

Myosotis ramosissima Rochel

TENERIFE: Native or long-established alien. Widespread mostly at moderate altitudes. NATIONAL PARK: 7 *Sventenius*, 1953. 9 *Sventenius*, 1944. 21 *Dickson* et al., 1983, *Rodriguez*, 1984. OUTSIDE NATIONAL PARK: 27 *Sventenius*, 1957.

BRASSICACEAE

Capsella bursa-pastoris (L.) Med.

TENERIFE: Native or long-established alien. Widespread weed at low to moderate altitudes. NATIONAL PARK: 10 Sventenius, 1946.

Sisymbrium irio L.

TENERIFE: Native or long-established alien. Common ruderal at low to moderate altitudes. NATIONAL PARK: 17 *Dickson* et al., 1983–85, *Rodriguez*, 1984.

CAMPANULACEAE

Campanula erinus L.

TENERIFE: Native or long-established alien. Common in dry habitats at low altitudes. NATIONAL PARK: 5 where "Escasa", Sventenius 1946. Segunda Muralla two plants at roadside, *Machado*, 1979.

CARYOPHYLLACEAE

Cerastium glomeratum Thuill.

TENERIFE: Native or long-established alien. Widespread weed and ruderal at low to moderate altitudes, mostly in forest zones. NATIONAL PARK: 10 Sventenius, 1946.

Moehringia pentandra Gay

TENERIFE: Native or long-established alien. Widespread weed at low to moderate altitudes. OUTSIDE NATIONAL PARK: 12 *Sventenius*, 1966, *Dickson* et al., 1983.

Petrorhagia nanteuillii (Burn.) Ball & Heywood

TENERIFE: Native or long-established alien. OUTSIDE NATIONAL PARK: Unlocalized SW Tenerife 1600–1800 m, Voggenreiter, 1975.

Sagina apetala Ard.

TENERIFE: Native or long-established alien. Widespread at low to moderate altitudes. NATIONAL PARK: 10 Sventenius, 1946; 9 *Rodriguez*, 1981; *Dickson* et al., 1982, 1983.

Silene gallica L.

TENERIFE: Native or long-established alien. Widespread weed and ruderal at low to moderate altitudes. NATIONAL PARK: 17 one plant only, *Dickson & Rodriguez*, 1985. OUTSIDE NATIONAL PARK: 4 one plant only, *Dickson & Rodriguez*, 1984.

Silene vulgaris (Moench) subsp. *commutata* (Guss.) *Hayek*

TENERIFE: Native or long-established alien. Widespread weed and ruderal at low to high altitudes. Map in Voggenreiter (1974: 673). NATIONAL PARK: 5, 10 *Sventenius*, 1944, 1946 "escasa". Las Cañadas 1000 m, Larsen, 1960. 18 Sventenius, 1946, Lid, 1967, *Dickson* et al., 1982. 15 *Dickson*, 1980–85. 8, 21, 23, 24 *Dickson* et al., 1982. 22 *Dickson* et al., 1983. 20 *Rodriguez*, 1984. OUTSIDE NATIONAL PARK: Entre Arenas Negras y El Portillo, *Sventenius*, 1966. 4 *Dickson* et al., 1982. UNLOCALIZED: 2250 m. Lid, 1967.

Spergula pentandra L.

TENERIFE: Native or long-established alien. Widespread weed at low to moderate altitudes. NATIONAL PARK: Montana Guajara, *Sventenius*, 1944. 27 *Sventenius*, 1956. 6 *Dickson* et al., 1982. 21 Rodriguez, 1984

Stellaria media (L.) Vill.

TENERIFE: Native or long-established alien. Widespread arable weed at low to moderate altitudes. NATIONAL PARK: "Quelle der Angostura im Circus am Pic.", Buch, 1825, 17 *Sventenius*, 1953. 23 *Sventenius*, 1956. OUTSIDE NATIONAL PARK: 2 *Dickson* et al., 1983–85.

CHENOPODIACEAE

Chenopodium album L.

TENERIFE: Native or long-established alien. Widespread weed at low altitudes. NATIONAL PARK: 17 Hansen, 1970, *Dickson* et al., 1982–85. OUTSIDE NATIONAL PARK: 2 *Dickson* et al., 1983–85. 4 *Dickson* et al., 1982–85.

Chenopodium ambrosioides L.

TENERIFE: Long-etablished alien. Widespread weed at low altitudes. NATIONAL PARK: 11 *Dickson* et al., 1982, 1983.

Chenopodium murale L.

TENERIFE: Native or long-established alien. Abundant weed at low altitudes. NATIONAL PARK: 5 *Sventenius*, 1956, *Rodriguez*, 1984. 23 Lid, 1967; *Dickson* et al., 1983.

Chenopodium vulvaria L.

TENERIFE: Rare alien. No previous occurrences. NATIONAL PARK: 15 *Dickson*, 1981–85. 17 *Dickson* et al., 1983–85.

EUPHORBIACEAE

Euphorbia segetalis L.

TENERIFE: Native or long-established alien. Common weed and ruderal mostly at low altitudes. NATIONAL PARK: 5 *Sventenius*, 1944. 7 *Sventenius*, 1963. 8 *Rodriguez*, 1984.

Mercurialis annua L.

TENERIFE: Native or long-established alien. Abundant weed at low altitudes. NATIONAL PARK: 5 "mas o menos escasa", Sventenius, 1946.

FABACEAE

Aspalthium bituminosum (L). Fourr.

TENERIFE: Native or long-established alien. Abundant, very variable ruderal from low to high altitudes. Cultivated as a fodder plant. NATIONAL PARK: 5 "Escasa", Sventenius, 1946. 23 *Sventenius*, 1956. 18 *Sventenius*, 1967, *Dickson* et al., 1982. 5, 21 *Dickson* et al., 1982. 20, 25 *Rodriguez*, 1983.

Trifolium arvense L.

TENERIFE: Native or long-established alien. Common weed at low to moderate altitudes. NATIONAL PARK: 21 *Rodriguez*, 1984. OUTSIDE NATIONAL PARK: Cordillera Dorsal 1800 m, Lid, 1967. Orotava to Las Cañadas road 1900 m, *Dickson* et al., 1983.

Trifolium glomeratum L.

TENERIFE: Native or long-established alien. Widespread weed at low to moderate altitudes. OUTSIDE NATIONAL PARK: "Unter Llanos de las Retamas vor dem Portillo", Buch, 1825. Mt. Amarinja 1800 m, Lid, 1967.

FUMARIACEAE

Fumaria muralis Sonder ex Koch subsp. *muralis*

TENERIFE: Long-established alien. Widespread weed at low to moderate altitudes. NATIONAL PARK: 5 *Sventenius*, 1944 "Muy escasa" and "in fissuras rupium umbrosis" No. 2076.

Sventenius published his 1944 material as *F. officinalis* L.; Nos. 2076 and 14219 were re-determined as *F. muralis* by Santos & Fernandez (1978).

Fumaria bastardii Boreau

TENERIFE: Long-established alien? Status poorly known. NATIONAL PARK: 5 *Sventenius*, 1956 "±escasa" and 1963 "Fissuras humosas de las rocars y al pie de ellas. Bastante escasa". 5 *Rodriguez*, 1984.

Sventenius' Nos. 14211 and 14214 were determined tentatively as *F. bastardii* by Santos & Fernandez. Material which may also be that species was gathered by Rodriguez who also found *Fumaria* plants, as yet undetermined, at Roques de Garcia. Voggenreiter (1975) found unspecified *Fumaria* in southwest Tenerife between 1600 and 2100 m.

GERANIACEAE

Erodium cicutarium (L.) L'Hér.

TENERIFE: Native or long-established alien. Abundant at low to moderate altitudes. NATIONAL PARK: Sventenius, 1946 "Mas o menos abundante en

todas Las Cañadas"; Fuente de la Piedra, 1944; Entre los Roques y Fuente de las Piedra, 1945; 18, 1966. "Cañadas, wayside weed, 1900 m", Larsen, 1960. 17, 23 *Dickson* et al., 1983–85. Cordillera Dorsal to 1800 m, Lid, 1967. 4 *Rodriguez*, 1985.

LAMIACEAE

Marrubium vulgare L.

TENERIFE: Native or long-established alien. Common mostly at low altitudes. NATIONAL PARK: 23 *Dickson* et al., 1983–85.

Marrubium grows abundantly in front of the cottage of Señor Juan Evora who may have planted it many years ago for its supposed health giving properties.

MALVACEAE

Malva parviflora L.

TENERIFE: native or long-established alien. Very abundant weed and ruderal at low to moderate altitudes. NATIONAL PARK: 15 *Dickson*, 1981, not seen 1982 and 1983.

Malva nicaeensis All.

TENERIFE: Native or long-established alien. Weed and ruderal and low to moderate altitudes. NATIONAL PARK: 17 *Dickson* et al., 1982–1984.

ONAGRACEAE

Chamaenerion angustifolium (L.) Scop.

TENERIFE: Poorly known alien. Unrecorded from low to moderate altitudes. NATIONAL PARK OR OUTSIDE: Bolle, 1861; Schenck, 1907.

This species was reported by Bolle (1861: 22) from the "Hohen Wusten" and probably merely repeated by Schenck (1907). Nobody has ever seen this unexpected species again. In the absence of confirmation some doubt must attach to this record of a species which has no other occurrences in Macaronesia and is rare in southern Europe and very rare in North Africa where there is only a report from Morocco (Myersclough, 1980).

OXALIDACEAE

Oxalis corniculata L.

TENERIFE: Long-established alien. Abundant weed at low to moderate altitudes. OUTSIDE NATIONAL PARK: 2 where "Escasa", Sventenius, 1946.

Oxalia pes-caprae L.

TENERIFE: Recently established alien. Extremely abundant noxious weed and ruderal at low to moderate altitudes. OUTSIDE NATIONAL PARK: 4 *Dickson & Rodriguez*, 1984–85.

PAPAVERACEAE

Eschscholzia californica Cham.

TENERIFE: Recently established alien. Widespread ruderal at low to high altitudes. OUTSIDE NATIONAL PARK: Road from Esperanza to Izaña at 1700 m,

Sventenius, 1961. Heights of Ayosa 2000 m roadside *Dickson* et al., 1983. Mt. Armanija 1800 m, *Lid*, 1967.

Papaver somniferum L.

TENERIFE: Native or long-established alien. Common weed and ruderal at low to moderate altitudes. NATIONAL PARK: 19 *Sventenius*, 1950. 17 *Dickson* et al., 1983–85.

PLANTAGINACEAE

Plantago major L.

TENERIFE: Native or long-established alien. Widespread but seldom abundant ruderal at low altitudes. NATIONAL PARK: 9 "Observados pocos ejemplares" Sventenius, 1946. OUTSIDE NATIONAL PARK: 2 *Dickson*, 1984.

POLYGONACEAE

Polygonum aviculare L.

TENERIFE: Native or long-established alien. Widespread weed and ruderal at low to moderate altitudes. NATIONAL PARK: 17 *Rodriguez*, 1984.

PRIMULACEAE

Anagallis arvensis L.

TENERIFE: Native or long-established alien. Common weed at low to moderate altitudes. OUTSIDE NATIONAL PARK: 27 *Sventenius*, 1956.

Asterolinon linum-stellatum (L.) Duby

TENERIFE: Native or long-established alien. Widespread at low to moderate altitudes. NATIONAL PARK: 21 *Rodriguez*, 1984. OUTSIDE NATIONAL PARK: 1 *Rodriguez*, 1981.

RESEDACEAE

Reseda luteola L.

TENERIFE: Native or long-established alien. Common ruderal. NATIONAL PARK: 14 One plant only at roadside, *Rodriguez*, 1983. OUTSIDE NATIONAL PARK: Road between El Portillo and Casa Forestal, *Sventenius*, 1956. Izana 2200 m, *Rodriguez*, 1983.

RUBIACEAE

Galium aparine L.

TENERIFE: Native or long-established alien. Common weed at low to moderate altitudes. NATIONAL PARK: 13 *Sventenius*, 1956. 7 *Dickson* et al., 1983. *Outside national park:* Rq. Pedro Gil, 1800 m, Sventenius, 1963. 2 *Dickson* et al., 1983.

Galium parisiense L.

TENERIFE: Native or long-established alien. Widespread at low to moderate altitudes. NATIONAL PARK: 21 *Dickson* et al., 1983. OUTSIDE NATIONAL PARK:

Aguamansa, 1800 m, *Sventenius*, 1945 (presumably *above* Aguamansa which lies at only 1000 m). 1 *Dickson* et al., 1983.

Galium scabrum L.

TENERIFE: Native or long-established alien. Widespread at low to moderate altitudes. OUTSIDE NATIONAL PARK: 1 *Dickson* et al., 1983.

SOLANACEAE

Solanum nigrum L.

TENERIFE: Native or long-established alien. Common weed at low altitudes. NATIONAL PARK: 20 *Rodriguez*, 1983–85.

URTICACEAE

Urtica stachyoides Webb & Berth.

TENERIFE: Endemic. Widespread at low altitudes. NATIONAL PARK: In small cave near 20 *Rodriguez*, 1984.

Urtica urens L.

TENERIFE: Native or long-established alien. Common arable weed at low to moderate altitudes. NATIONAL PARK: 23 *Dickson* et al., 1983.

VALERIANACEAE

Centranthus calcitrapa (L.) Oufr.

TENERIFE: Recently established alien. Widespread at low altitudes. NATIONAL PARK: 6 Sventenius, 1946. OUTSIDE NATIONAL PARK: Near Izaña, 1900 m, *Rodriguez*, 1984.

JUNCACEAE

Juncas bufonius L.

TENERIFE: Native or long-established alien. Widespread at low to moderate altitudes. NATIONAL PARK: 21 *Dickson* et al, 1982, 1983.

LILIACEAE

Asphodelus aestivus Brot.

TENERIFE: Native or long-established alien. Widespread weed at low to moderate altitudes. NATIONAL PARK: 22 *Rodriguez*, 1983. 17 *Dickson*, 1983.

POACEAE

Agrostis castellana Boiss. & Reut.

TENERIFE: Native or long-established alien. Widespread at low altitudes. NATIONAL PARK: 1 *Dickson*, 1981, 1982, disappeared 1984. OUTSIDE NATIONAL PARK: 2 Sventenius, 1946. 13 *Dickson* et al., 1983.

Aira caryophyllea L.

TENERIFE: Native or long-established alien. Widespread at low to moderate altitudes. NATIONAL PARK: 6 2100 m, *Sventenius*, 1944. OUTSIDE NATIONAL PARK: 27 *Sventenius*, 1956. Mtn Armarniga, 1800 m, Vista Valle Orotava, 2100 m, Lid, 1967. 1 *Rodriguez*, 1981, *Dickson* et al., 1983.

Avena barbata Pott. ex Link

TENERIFE: Native or long-established alien. Widespread and abundant weed from low to high altitudes. NATIONAL PARK: Las Cañadas 2300 m *Sventenius*, 1944. 23 Lid, 1967. 25 *Rodriguez*, 1982. 5, 6, 18, 21 *Dickson* et al., 1981. 20 *Rodriguez*, 1983. OUTSIDE NATIONAL PARK: 13 and Orotava Road, *c.* 1900 m, *Dickson* et al., 1983.

Avena sterilis L.

TENERIFE: Native or long-established alien. Widespread weed, especially at low altitudes. OUTSIDE NATIONAL PARK: 27 *Sventenius*, 1956.

Bromus madritensis subsp. *kunkelii* H. Scholz. (*Bromus rubens* auct. canariesium, non L.)

TENERIFE: Native or long-established alien. All the Canarian material of *B. rubens* needs revision in the light of the work of Scholz (1981). "*B. rubens*" is common from low to high altitudes. NATIONAL PARK: *Sventenius*, 1946 Las Cañadas, labelled *B. Tectorum* var?". 23 Lid, 1967 as *B. rubens*. 9, 8, 21 *Dickson* et al., 1982. Near 7 *Dickson* et al., 1983, OUTSIDE NATIONAL PARK: Orotava road, *c.* 1900 m, *Dickson* et al., 1983.

All the gatherings made in 1982 and 1983 are *B. madritensis* susp. *kunkelii*. Sventenius' and Lid's materials (sub nomen *B. tectorum* var? and *B. rubens*) are all is taxon which Scholz (1981) has argued may be a Canarian endemic (only confirmed from Tenerife and Gran Canaria so far) or that it may be found elsewhere. An obvious place to search for it was northwest Africa where it was found in 1983 (Scholz, personal communication). Though the value of this taxon is disputable (P. M. Smith, personal communication), it is one of the more conspicious grasses in the National Park where "typical" *B. madritensis* has yet to be found.

Bromus madritensis L. subsp. *madritensis*

TENERIFE: Native or long-established alien. Abundant weed a low to moderate altitudes. OUTSIDE NATIONAL PARK: Vista Valle Orotava 2150 m, Lid, 1967.

Bromus rigidus Roth

TENERIFE: Long-established alien. Abundant weed at low to moderate altitudes. NATIONAL PARK: 23 Lid, 1967. 17 *Dickson*, 1981, not seen 1982 or 1983. 9, 18, 23, 24 *Dickson* et al., 1982. 3, 22 *Dickson* et al., 1983. OUTSIDE NATIONAL PARK: 27 *Sventenius*, 1956. 4 *Dickson* et al., 1982. 2 *Dickson* et al., 1983.

Bromus tectorum L.

TENERIFE: Native or long-established alien. Rare at low altitudes? Abundant at moderate to high altitudes. NATIONAL PARK: 6 "muy copioso", *Sventenius*, 1944, "±abundante" 1966; *Dickson* et al., 1982. 5 "±escasa", *Sventenius*, 1956; *Dickson* et al., 1982. 7 *Sventenius*, 1966; *Dickson* et al., 1983. 19, 23 Lid, 1967. 18 Lid, 1967; *Dickson*, 1981. 17 *Dickson*, 1981. Roque de Peral, 9, 23, 24

Dickson et al., 1982. 12, 22 *Dickson* et al., 1983. 21 *Rodriguez*, 1984. OUTSIDE NATIONAL PARK: 2 "copiosissimo", *Sventenius*, 1944. 27 "Muy abundante", *Sventenius*, 1956. Cordillera Dorsal, 1550 m; Observatoric Izana, 2300 m; Cumbre Vilaflor, 2200 m, Lid, 1967. 2 *Rodriguez*, 1981, *Dickson* et al., 1983. 1, 3 Orotava Road, 1900 m, *Dickson* et al., 1983. UNLOCALIZED: "Hohen Wusten," Bolle, 1861.

Chloris truncata R. B.

TENERIFE: Recently established alien. Little known from low altitudes. NATIONAL PARK: Las Cañadas, *c.* 2200 m, Hansen, 1970.

Cynodon dactylon (L) Pers

TENERIFE: Native or long-established alien. Widespread weed at low to moderate altitudes. NATIONAL PARK: 17 *Dickson* et al., 1982, 1983, 1984.

Cynosurus echinatus L.

TENERIFE: Native or long-established alien. Widespread weed and ruderal at low to moderate altitudes. OUTSIDE NATIONAL PARK: 1800 m unlocalized, Lid, 1967. 4 *Dickson & Rodriguez*, 1984.

Dactylis glomerata L. subsp. *glomerata* L. and subsp. *hispanica* (Roth) Nyman.

TENERIFE: Recently established (?) alien. Rare at low and high altitudes. NATIONAL PARK: 2 *Sventenius*, 1954. 17 *Dickson*, 1981–85. 21 *Dickson* et al., 1982–1985.

Impressed by its abundance in Morocco, Stebbins & Zohary (1959) commented on the absence of this polymorphic grass as a natural inhabitant of apparently suitable, rocky slopes in the Canary Islands, where it is a rare grass. Lems considered it an escape from cultivation on Tenerife and Hansen (1973b: 39) thought that on Gran Canaria it was likely to have been introduced with lawn grass seed. At Parador de Turismo, *D. glomerata* subsp. *glomerata* grows in the flower beds and so is very obviously a weed, along with several other species there. However, the occurrence at Barranco Riachuelo is different. Here in December 1982, there was a stand, *c.* 1.6 × 0.7 m, of several dried up plants up to 0.7 m tall (infructesences) on a boulder-strewn slope of 200° aspect at *c.* 2130 m. These plants are referable to *D. glomerata* subsp. *hispanica*, new to the Canary Islands. *Dactylis glomerata* is known at higher altitudes in North Africa, 2400 m (Bellows, 1959) and in southern peninsular Spain, 2900 m (Tutin, 1980).

Gastridium ventricosum (Gouan) Schinz & Thell.

TENERIFE: Native or long-established alien. Widespread at low to moderate altitudes. NATIONAL PARK: 20 *Sventenius*, 1944, *Dickson & Rodriguez*, 1984 5, 21, 26 *Dickson* et al., 1982, *Dickson* et al., 1983, 22. OUTSIDE NATIONAL PARK: 1 *Dickson* et al., 1983.

Holcus lanatus L.

TENERIFE: Native or long-established alien. Widespread but local (?) at low altitudes. OUTSIDE NATIONAL PARK: 17 *Dickson* et al., 1983.

Hordeum murinum L. subsp. *leporinum* (Link) Asch. & Graebn.

TENERIFE: Native or long-established alien. Widespread, abundant ruderal at low to moderate altitudes. NATIONAL PARK: 17, 21, 23 *Dickson* et al., 1982,

1983. OUTSIDE NATIONAL PARK: 1983, 2, 3 *Dickson* et al., UNLOCALIZED: 2200 m, Lid, 1967.

Lamarakia aurea (L.) Moench

TENERIFE: Native or long-established alien. Widespread weed and ruderal at low to moderate altitudes. NATIONAL PARK: 5 *Sventenius*, 1963, *Rodriguez*, 1984. 7 2300 m, *Sventenius*, 1944. 20 *Rodriguez*, 1984.

Lolium perenne L.

TENERIFE: Native or long-established alien. Widespread at low to moderate altitudes. NATIONAL PARK: 17 *Dickson* et al., 1981–85. In the flowerbeds at the hotel some plants appear to be *L. perenne* subsp. *multiflorum* (Lam) Husnot and others to be *L. perenne* subsp. *perenne*.

Phalaris canariensis L.

TENERIFE: Native or long-established alien. Widespread weed especially at low altitude. OUTSIDE NATIONAL PARK: 2 *Dickson*, 1984.

Piptatherum coerulescens (Desf.) P. Beauv.

TENERIFE: Native or long-established alien. Widespread at low to high altitudes. NATIONAL PARK: 20 *Sventenius*, 1944. 5 *Sventenius*, 1963; *Dickson* et al., 1982. 6, 18, 19 and 23 Lid, 1964. Canada de la Pilas, *Rodriguez*, 1981. 22 *Dickson* et al., 1983. OUTSIDE NATIONAL PARK: Christ, 1888 "reg subalpina probe chasna 1882 in V. Asken". El Portillo—Arenas Negras, *Sventenius*, 1944. Vista Valle Oratava, 2100 m, Lid, 1967.

Piptatherum miliaceum (L.) Coss.

TENERIFE: Native or long-established alien. Widespread ruderal at low to moderate altitudes. NATIONAL PARK: 5 *Sventenius*, no date. 18 Hansen, 1970; 17 *Dickson*, 1981, 18 *Dickson* et al., 1982–1984.

Poa annua L.

TENERIFE: Native or long-established alien. Widespread, common weed and ruderal at low to moderate altitudes. NATIONAL PARK: 9 "mas o menos abundante", Sventenius, 1946. 18 *Dickson*, 1981 one plant only, not seen 1982 or 1983. 28 *c.* 3700 m, *Rodriguez*, 1984. 17 *Dickson & Rodriguez*, 1985.

Poa pratensis L.

TENERIFE: Rare, recently arrived alien. No previous records from Tenerife. In the Canary Islands elsewhere only in Gran Canaria (*Hansen*, 1936). NATIONAL PARK: 17 *Dickson* et al., 1983. OUTSIDE NATIONAL PARK: 2 *Dickson* et al., 1983, 1984.

Poa trivialis L.

TENERIFE: Native or long-established alien. Widespread at low altitudes. NATIONAL PARK: 18 Hansen, 1970.

Polypogon fugax Nees ex Steud.

TENERIFE: Native or long-established alien. Widespread at low to high altitudes. NATIONAL PARK: 10±abundante, *Sventenius*, 1945. 19 "On a wet cliff", Lid, 1967. Las Cañadas, unlocalized, Hansen, 1970. 9, 18, 23 *Dickson* et al., 11, 13. *Dickson* et al., 1983. OUTSIDE NATIONAL PARK: Cordillera Dorsal, 2000 m, Lid, 1967.

Polypogon viridis (Gouan) Breistr.
TENERIFE: Native or long-established alien. Widespread at low altitudes. NATIONAL PARK: 19, 2180 m "on a wet cliff", Lid, 1967; 9 *Dickson* et al., 1983.

Trachynia distachya (Hasselq. ex L.) Link
TENERIFE: Long-established alien. Abundant at low to moderate altitudes. 2200 m. NATIONAL PARK: 17 *Dickson* et al., 1983–85. 5 *Rodriguez*, 1984. OUTSIDE NATIONAL PARK: "South of El Sombrerito, El Pinar, 2200 m (= La Cumbre de Vilaflor), 5 May 1964" Herbarium Oslo, Lid, 1967.

Vulpia bromoides (L) S. F. Gray
TENERIFE: Native or long-established alien. Common at low to moderate altitudes. NATIONAL PARK: "Las Cañadas de Teyde", Herbarium, Royal Botanic Garden, Edinburgh, *Bourgeau*, 1846. 16 *Turner & Rodriguez*, 1983; *Rodriguez*, 1984. OUTSIDE NATIONAL PARK: unlocalized, 1800 m, Lid, 1967.

Vulpia myuros (L.) C. C. Gmel.
TENERIFE: Native or long-established alien. Widespread and common at moderate to high altitudes. NATIONAL PARK: "Las Cañadas de Teyde", Herbarium, Royal Botanic Garden, Edinburgh, *Bourgeau*, 1946. 20 *Sventenius*, 1944. 28 3650 m, *Sventenius*, 1945. 16 *Sventenius*, 1948. Piedras Amarillas, *Dickson*, 1981. Roque de Peral, 5, 6, 9, 18, 21, 26 *Dickson* et al., 1982, 1983. 7, 22 *Dickson* et al., 1983. OUTSIDE NATIONAL PARK: 27 *Sventenius*, 1956. 2 2100 m *Sventenius*, 1951, 1969. Orotava road, 1900 m 13 *Dickson* et al., 1983. UNLOCALIZED: 2200 m, Lid, 1967.

ORIGINS, DISPERSAL AND STATUS OF THE INVADING SPECIES

Omitting some species he had already gathered, Sventenius in 1946 published about 76 vascular plant species comprising the flora of Las Cañadas. In 1980 Kunkel listed about 94 taxa for the same area. Restricting consideration to native species, Ortuño (1980) listed about 57 vascular plants as the flora of the Teide National Park. All these figures were underestimates. The total vascular plant flora, both native and alien, as recorded from 1819 to the present, in or near Las Cañadas, numbers about 125 species. In this paper, we have listed 83 species of which 69 have more-or-less strong claims to be considered aliens in the National Park. Four other alien species (and one subspecies) have been recorded in areas at or above 1800 m outside but close to the National Park. The majority of the invading plants are very successful weeds in Europe. In the Mediterranean area many are abundant, conspicuous ruderals, good examples being *Calendula arvensis*, *Dittrichia viscosa*, *Aspalthium bituminosum*, *Avena barbata* and *Piptatherum miliaceum*. In the Sahara such species as *Cynodon dactylon*, *Gnaphalium luteo-album*, *Juncus bufonius*, *Piptatherum coeruleseeus*, *Polypogon semiverticillatus*, and *Sonchus oleraceus* are more or less widespread (Ozenda, 1977).

Some of the invaders are species which have been spread throughout the World by Europeans. At least seven of the aliens in the National Park, or surroundings, grow on Mauna Loa, Hawaii (Mueller-Dombois, 1981; Mueller-Dombois & Bridges, 1981) where *Holcus lanatus* and *Cynodon dactylon* reach their greatest abundances in the montane parkland between 1500 and 2000 m. No less than 22 of the aliens discussed in this paper are species which have reached the Tristan da Cunha islands, one of the most remote archipelagoes in the

World (Wace & Dickson, 1965; Groves, 1981). An outstanding example is *Chenopodium album*, one of the five most widely distributed plants in the World; it reaches over 3000 m in Utah and 3650 m in the Himalaya (Williams, 1963). Others are *Plantago major* and *Poa annua* which has been found at *c.* 3800 m in Argentina (Fries, 1905). On Pico del Teide, at *c.* 3700 m, *Poa annua* has reached higher than any other vascular plant in the Canary Islands apart from the endemic *Viola cheirantheifolia*. Sventenius (1946) recorded *Vulpia myuros* at *c.* 3650 m. At Rambleta (16, Fig. 2) *Gnaphalium luteo-album* and *Vulpia bromoides* grow on moist fumarolic rocks at *c.* 3500 m. Around springs on Montaña de Guajara (12 and 13, Fig. 2) the following invaders reach *c.* 2400 m: *Agrostis castellana*, *Avena barbata*, *Bromus tectorum*, *Dittrichia viscosa*, *Holcus lanatus*, *Moehringia pentandra* and *Polypogon fugax*.

For the most part these invading species are common in the Canary Islands in general and Tenerife in particular, where they have been known since botanical recording began in the first half of the 19th century. From that century, however, there are only a few records of invading species in areas about or above 1800 m: *Aira caryophyllea*, *Bromus tectorum*, *Chamaenerion angustifolium*, *Erodium cicutarium* and *Piptatherum coerulescens* (Bolle, 1861, Buch, 1825, Christ, 1855, 1888).

There are some exceptions to these generalizations. *Chloris truncata*, an Australian native, appears to be little known on Tenerife and *Lolium perenne* subsp. *perenne* is a rarity on the island, as is *Dactylis glomerata*. *Dactylis glomerata* subsp. *hispanica* has no previous records from the Canary Islands. Two other somewhat unexpected invaders are *Chenopodium vulvaria* and *Poa pratensis*, both found for the first time on Tenerife. On Hierro, Pitard & Proust (1909: 327) knew *Chenopodium vulvaria* at "Bords des chemins de la region maritime" at 400 m and Lid (1967) found it in a potato field at 950 m. Otherwise it was unknown in the Canary Islands until discovered at the cable-car where the few poorly grown plants grew on laid pumice gravel under the cables at the base. In Europe it is a low altitude weed or arable fields and waste ground. At Vilaflor (1983) the species was found in a luxuriant state in the moist shelter of street flowerbeds. At the Parador it grows poorly on bare soil of exposed little-tended flowerbeds. It is widespread in the Atlas Mountains and in the central and western Sahara (Ozenda, 1977). The locality at the cable-car is perhaps best paralleled by a high altitude occurrence in Algeria; the details from a herbarium sheet in the Royal Botanic Garden, Edinburgh are "Ahaggar Mountains, Asskrem region. Dry wadi and surrounding areas, in gravely soil, 2700 m 6 August 1966. *F. H. Ogden* No. *24*". At both its localities in the National Park *Poa pratensis* is wellgrown (to 80 cm) in the shelter of flower beds. The only previous record for the Canary Islands is that made by Hansen (1973) at Guia, Gran Canaria, where the habitat was a lawn.

There is no clear evidence that the reafforestation of the 1950s led to the establishment of alien plants. Similarly there are no grounds for concluding that the pumice gatherers who formerly climbed high up the south slope of Guajara brought any lasting introductions. However, 27 species which may have reached Las Cañadas as a result of goat-herding are marked P in Table 1. It is possible that two of these have benefited from the release of grazing pressure. *Aspalthium bituminosum* and *Silene vulgaris* were described as "scarce" by Sventenius. The former is specifically mentioned by Kunkel (1976) as acceptable to grazing

Table 1. Status of the Invading Plants in the Teide National Park and surroundings above 1800 m

GROUP A. SUCCESSFUL INVADERS			
X+P	*Aira caryophyllea*	X+T	*Lactuca serriola*
X+P↑	*Aspalthium bituminosum*	X+?PT?	*Lamarckia aurea*
X+P	*Avena barbata*	+P	*Marrubium vulgare*
X+P	*Bromus madritensis* subsp. *kunkelii*	X+P	*Myosotis ramosissima*
X+P	*B. rigidus*	X+P	*Piptatherum coerulescens*
X+P	*B. tectorum*	X+PT	*P. miliaceum*
X+T	*Chenopodium album*	X+T	*Polypogon fugax*
X+T	*C. murale*	X+T	*P. viridis*
+P?/T	*Dactylis glomerate* subsp. *hispanica*	+P	*Sagina apetala*
X+T	*Dittrichia viscosa*	X+P↑	*Silene vulgaris*
X+P↓	*Erodium cicutarium*	X+P	*Spergula pentandra*
X+?P/T?	*Euphorbia segetalis*	XPT	*Torilis leptophylla*
+P?T?	*Fumaria bastardii*	X+P	*Tragopogon porrifolius*
X+P	*Gastridium ventricosum*	PT?	*Vulpia bromoides*
X+P	*Gnaphalium luteo-album*	X+P	*V. myuros*
X+T	*Hordeum murinum*		
GROUP B. RECENT DISCOVERIES, TOO SOON FOR ASSESSMENT			
P?T	*Asphodelus aestivus*	PT	*Poa annua*
T	*Asterolinon linum-stellatum*	T	*P. pratensis*
PT	*Calendula arvensis*	T	*Polygonum aviculare*
T	*Chenopodium ambrosioides*	T	*Reseda luteola*
T	*C. vulvaria*	T	*Silene gallica*
T	*Cynodon dactylon*	T	*Sisymbrium irio*
T	*Dactylis glomerata* subsp. *glomerata*	T	*Solanum nigrum*
T	*Galium parisiense*	T	*Sonchus oleraceus*
T	*Juncus bufonius*	T	*Trachynia distachya*
T	*Lolium perenne*	T	*Trifolium arvense*
T	*Malva parviflora*	P?T?	*Urtica stachyoides*
T	*M. micaeensis*	P	*U. urens*
T	*Phalaris canariensis*		
GROUP C. POTENTIAL INVADERS			
T	*Agrostis castellana*	T	*Holcus lanatus*
T	*Anagaliis arvensis*	T	*Logfia gallica*
P	*Avena sterilis*	T	*Mochringia pentandra*
T	*Bromus madritensis* subsp. *madritensis*	P	*Oxalis corniculata*
T	*Cynosurus echinatus*	T	*O. pes-caprae*
T	*Eschscholzia californica*	T	*Petrorhagia nanteuilii*
T	*Filago pyramidata*	P	*Trifolium glomeratum*
T	*Galium scabrum*		
GROUP D. FAILED INVADERS			
T	*Amaranthus hybridus*	P	*Fumaria muralis*
PTS	*Campanula erinus*	PTS	*Galium aparine*
P	*Capsella bursa-pastoris*	P	*Mercurialis annua*
P	*Centranthus calcitrapa*	PTS	*Papaver somniferum*
P	*Cerastium glomeratum*	P	*Plantago major*
P	*Chamaenerion angustifolium*	T	*Poa trivialis*
T	*Chloris truncata*	PTS	*Stellaria media*

X, Widespread; +, well -established; P, probably brought by pastoralism (mostly pre-1950); ↓, declined since pastoralism ceased; ↑, increased since pastoralism ceased; T, probably brought by tourism (post 1950); S, sporadic invader, never establishing.

animals; goatherds are known to have spread seeds along the tracks to ensure supplies of fodder. In the southern parts of its extensive Eurasian and North African range *S. vulgaris* reaches 3000 m or more as in the Alps, Turkey and the Himalaya. The plants in the National Park are the tetraploid *S. vulgaris* subsp. *commutata*. Apart from Larsen's cytological study (1960) little or no work appears to have been done on Canarian populations of this highly polymorphic species (Aeschiman & Bocquet, 1980; Marsden-Jones & Turrill, 1957). Both white and red flowered variants are common on Tenerife. The subspecies which grow mostly at high altitudes in Europe (Chater & Walters, 1964) are unknown on the Canary Islands where only *S. vulgaris* subsp. *commutata* was known until *S. vulgaris* subsp. *angustifolia* (Mill.) Hayek was reported from Hierro by Hansen (1979). The suggestion by Melzheimer & Damboldt (1973) that tetraploid *S. vulgaris* is adapted to arid conditions accords with the evident ability of the species to thrive in the National Park. Only at the cable-car does *S. vulgaris* grow in a roadside habitat where it must be very recent arrival (on breeze block rubble on a made slope). Elsewhere in the National Park it is often, but not exclusively, on sheltered places as near the old buildings of the pastoralists. *S. vulgaris* is ". . . reputed to be a good fodder plant" (Salisbury, 1961: 185). Both *S. vulgaris* and *Aspalthium bituminosum* are among the preferred food plants of the very few remaining goats in the National Park and both can be described as widespread and locally abundant there. *Pterocephalus lasiospermus* Link ex Buch, described by Sventenius (1946: 163) as "Epecie rara y con tendencia a ser muy escasa" is now abundant as is *Cheirolophus argutus* (Nees) Holub (*Centaurea arguta* Nees) given as "Muy rara" by Sventenius (1946: 158). These two endemics may also have benefited from the change in land use.

By contrast, several species listed in Table 1 appear to have declined. Sventenius recorded *Cerastium glomeratum* and *Capsella bursa-pastoris* at Topo de la Grieta (10, Fig. 2) and *Plantago major* and *Poa annua* at Fuente de la Grieta, a spring where goats were watered (9, Fig. 2). They are not there now, nor elsewhere in the National Park, and along with 11 other species, can be considered as failed invaders (Table 1). *Plantago major* is well known for its resistance to trampling (Sagar & Harper, 1964) as is *Poa annua*, a species absent from desert and semidesert areas because of susceptibility to drought (Hutchinson & Seymour, 1982). Perhaps they benefited from the trampling and manuring by goats and vanished when the herding stopped. However, about 15 years ago water pipes were laid from Fuente de la Grieta to the cable-car and to Caserio del Portillo. Consequently the area of perpetually wet ground decreased and this may have contributed to the disappearance of the *Poa* and the *Plantago*.

For *Erodium cicutarium* Sventenius used the word "abundant" though qualified "more or less". This species must have declined greatly though it has invaded the flowerbeds of the Parador de Turismo and occurs in quantity at Señor Evora's cottage. Perhaps its former abundance was related to the pastoralism, though exactly how is not clear. In Utah, it has been noticed that both *Bromus tectorum* and *Erodium cicutarium* were abundant after burning or sagebrush–grass communities (Kearney, Briggs & Schultz 1914). Extensive fires can hardly be the explanation for Las Cañadas. Though *Spartocytisus* was used in the production of charcoal, there is no evidence of deliberate burning of the vegetation of Las Cañadas; the sparseness of the vegetation and the broken

nature of the terrain strongly militate against widespread fires, natural or man-made. Another species considered common by Sventenius (1946: 170) was *Rumex bucephalophorus* L. subsp. *canariensis* (Steinh.) Rech. fil. He states "Bastante abundante en los lugares humedos de todas Las Cañadas". Searches in wet places have all proved negative. A drastic decline or disappearance seems to have taken place, for which there is no obvious explanation.

Many of the invading species are strongly or exclusively connected with disturbed or totally artificial habitats. At the Parador de Turismo the flowerbeds support 17 species of weeds, eight of which occur nowhere else within the National Park. Outside the National Park, at Caserio del Portillo and Bar El Portillo, there are concentrations of invading plants. Within the Park there are concentrations, apart from by Parador de Turismo at the base of the Telferico and at Los Azulejos. The arrival of many of the species is clearly connected with development of tourism. If not in flowerbeds, the majority of the invading species occur at roadsides or by buidings where they have not only greatest chance of arrival and survival in sheltered conditions but also, in the case of the hotel flower-beds especially, of growing on enriched soils. Enriched, sheltered habitats also exist away from habitations and roads. *Solanum nigrum* has only one locality in the National Park; a few plants grow at the mouth of a small cave where the ground is heavily manured by pigeons (near 20, Figure 2). Similarly *Urtica stachyoides*, an annual, weedy endemic of low altitudes, occurs in an even smaller cave (also near 20, Figure 2) on moist organically rich soil (enriched by hunters and their animals?).

However, of the 83 species of vascular plants, no less than 30 have been reported only at single localities. Fourteen species can be readily accepted as failed invaders (Table 1). This is cogent evidence for great difficulty of survival and spread, even for short periods, in the National Park. This is hardly surprising because of the extreme environmental conditions to which only a small number of species, mostly edemics, have adapted over long periods of time. However, 29 species listed in Table 1 are well-established, in most cases at widely spaced localities in or near the National Park. Some, notably grasses such as *Bromus tectorum* and *Vulpia myuros*, are abundant well away from the grossest human disturbance. *B. tectorum* is a native of the Mediterranean area and also of the western Himalaya (Bor, 1960). In Egypt it occurs in waste places, along walls and on roofs as well as in the desert (Tackholm & Tackholm, 1941). Like the other *Bromus* species discussed here, *B. tectorum* is an introduction in the United States where it is widespread "Along roadsides, banks and wasteplaces" (Hitchcock, 1951: 56) It is abundant in the grasslands of the intermontane region of Idaho where it ousted the native *Agropyron spicatum*, formerly dominant (Harris, 1967). In that state it reaches 2750 m (Klemmedson & Smith, 1964). This weed which is difficult to control (Young *et al.*, 1969) can behave as an ephemeral or a summer or winter annual (Mack & Pyke, 1983). *Vulpia myuros* was known to Buch (1825) in the pine forests "Auf der Cumbre von Teneriffa nicht selten". Bourgeau gathered it and *V. bromoides* from Las Cañadas in 1846. Ceballos & Ortuño (1951) referring to the Spartocytisetea nubigeni, recorded *V. myuros* as frequent. Though perhaps never as abundant as *Bromus tectorum*, it is almost as widespread as that species in the National Park. Sventenius' locality was only about 70 m below the summit of the island.

Finally, consideration can be given to species (Group C of Table 1), which

are potential invaders growing close to but not yet within the National Park. Some might become aggressive. A notable case is *Eschscholzia californica*, a genetically variable endemic of California which has become weedy within that state and elsewhere such as Chile where it is abundant in the coastal hills (Stebbins, 1965).

Another is *Oxalis pes-caprae*, an extremely abundant weed in the agricultural areas. Though growing only in small quantity in a very sheltered site at Caserio del Portillo (4, Fig. 2) this genetically variable species might spread elsewhere because it has been known to tolerate −9°C in California (Baker, 1965).

Of the most abundant, conspicuous ruderals at low altitudes many have yet to be recorded at high altitudes. Good examples are *Achryanthes aspera* L., *Ageratina adenophora* (Spreng.) King & Robins., *Pennisetum setaceum* (Forssk.) Chiov. and *Rhynchelytrum repens* (Wild.) C. E. Hubb. The edaphic and climatic exigencies of the National Park may well preclude any invasion by such species other than purely transient occurrences as in the cases of *Amaranthus hybridus* and *Chloris truncata*.

CONTROL OF THE INVADING SPECIES AND CONSERVATION

The Convention of the Conservation of European Wildlife and Natural Habits (Bern Convention) includes under article 11.2.b. the following general provision "to control strictly the introduction of non-native species". This is an internationally accepted policy to be applied to natural environments, and especially to areas that have been selected for long term conservation, such as national parks. This policy is based on sound ecological reasons. The profusion which alien species can attain in new environments is familiar throughout the World, not least on oceanic islands with notoriously unstable and vulnerable ecosystems because of the simplicity of the communities and genetic poverty.

As is consistent with the philosophy of Owens (1972), the principal aim of the management of the Teide National Park is the maintenance of the natural ecosystems; this demands protection of the landscape, the indigenous fauna, flora and vegetation, geology, water and air. A subsidiary goal is the restoration of communities altered by man. The master plan for the Park (ICONA, 1983) includes the Policy "Eliminar las especies vegetales exóticas en el Parque". In 1983 at several localities within the Park alien plants were removed manually and burned; species involved were *Avena barbata*, *Bromus* species, *Silene vulgaris*, *Vulpia myuros* and especially *Chenopodium* species and *Lactuca serriola*.

The planted conifers do not merely have a visual impact. Supporting an alien entomological fauna, they have now largely been removed though *Pinus canariensis* needs treatment with trioxone because of an ability to coppice. As yet few of the alien herbaceous species present serious problems though *Bromus tectorum* and *Vulpia myuros* are so abundantly established and widespread as to be beyond any feasible control measures.

No simple management strategy can be developed for all the alien plants in the Park; each case should be analysed separately. Nevertheless, some general measures can be suggested.

(1) No cultivation of plants other than endemics at any place in or near the Park. Some endemics notably the spectacular *Echium wildpretii* are already

cultivated at the Parador de Turismo or at the Caserio del Portillo, and others, especially *Argyranthemum teneriffae* Humphr., *Erysimum scoparium* (Brouss. ex Willd.) Wettst., *Spartocytisus* and *Pterocephalus lasiospermus* are very attractive. Hence there is little or no need for importations.

(2) Frequent monitoring of roadsides and tourist areas within the National Park and in areas close by, and of roadsides of the main roads leading to the National Park. Special emphasis should be devoted to well-known potentially aggressive species.

(3) Eradication of alien plants from infested areas which act as disperal centres. Active control of aggressive species and elimination of new immigrants before successful establishment takes place.

(4) Promulgation of the National Park rules prohibiting the introduction of any kind of propagules of alien plants into the area. The reasons for this measure should be given as part of the information.

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