

# Genetic resources of the fodder legumes tagasaste and escobón (*Chamaecytisus proliferus* (L. fil.) Link *sensu lato*) in the Canary Islands

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## Summary

Germplasm from 184 cultivated, semi-cultivated and wild populations of *Chamaecytisus proliferus* (L. fil.) Link (Fabaceae: Genisteae) was collected in the islands of El Hierro, La Palma, La Gomera, Tenerife and Gran Canaria (Canary Islands) between June and August 1989. Herbarium specimens, soil samples and *Rhizobium* nodules were also collected from most populations. The ecology of tagasaste and escobón is described. Seeds are conserved in the Centro de Conservación de Recursos Fitogenéticos, Apartado 1045, 28800, Alcalá de Henares, Madrid, Spain.

## Introduction

*Chamaecytisus proliferus* (L. fil.) Link (Fabaceae: Genisteae) forms a taxonomic complex that is endemic to the Canary Islands. Within this complex, tagasaste (*C. proliferus* var. *palmensis* (Christ) Hansen & Sunding) is an outstanding fodder tree which is used widely in the Canary Islands and has achieved some importance in Australia and New Zealand. It is presumed that the genetic base of the material cultivated in Australia and New Zealand is very narrow. Most of the material cultivated in both countries is apparently derived from seeds sent from Tenerife through Kew to Australia in 1879 (Anon., 1891). Tagasaste is also found naturalized in the Republic of South Africa (Orpen, 1907), Portugal (Pereira-Countinho, 1913), Java (Backer and Bakhuizen, 1963), the Hawaiian Islands (Neal, 1965), California (Muntz, 1968), Kenya and Tanzania (Milne-Redhead and Polhill, 1971) and northern Africa (Quezel, 1987), which indicates that tagasaste could play an important role in agroforestry systems in different environments.

Following an ecological and botanical survey in the Canary Islands in 1989, a preliminary classification of material collected can be made. This classification is provisional and is based on our first field observations. In the absence of any other taxonomy we have used the recent classification by Martínez (unpublished). However, through studies currently being undertaken at the University of Birmingham and the University of La Laguna (Tenerife), it is expected that definitive taxonomic categories will be described. The seven types are:

- (1) Typical tagasaste (*Chamaecytisus proliferus* (L. fil.) Link var. *palmensis* (Christ) Hansen & Sunding).
- (2) White tagasaste. Plants of this morphological group do not seem to fall within the range of variation described in previous taxonomic studies.
- (3) Typical escobón *Chamaecytisus proliferus* (L. fil.) Link var. *proliferus*).
- (4) White escobón of Tenerife. This morphological type does not seem to fall into any of the taxa previously quoted in the literature.
- (5) Escobón of southern Gran Canaria. Although Martínez and other authors regarded this morphological type as *Chamaecytisus proliferus* (L. fil.) var. *perezii* (Hutchinson) Kunkel, this botanical combination is synonymous with *C. proliferus* (L. fil.) Link var. *canariae* (Christ) Kunkel.
- (6) White escobón of Gran Canaria (*Chamaecytisus proliferus* (L. fil.) Link var. *canariae* (Christ) Kunkel).
- (7) Escobón of El Hierro (the last botanical name was given within *Cytisus* as *C. proliferus* L. fil. var. *hierrensis* Pitard in Pitard and Proust (1908)).

## Strategies for germplasm collecting

It is believed that tagasaste is predominantly outbreeding. Webb and Shand (1985) suggested that both allogamy and autogamy occur in tagasaste, and that selective abortion of selfed flowers might favour the retention of cross-pollinated embryos. Woodfield and Forde (1987) found similar results and they concluded that outcrossing plays a very important role in the reproductive biology of tagasaste. Consequently, germplasm was collected following procedures for outcrossing species suggested by Hawkes (1980) and Marshall and Brown (1983). Mass sampling was

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carried out and seeds from 50 randomly selected plants per population were collected, whenever possible, and our aim was to collect alleles from as many environments as possible. Almost all the populations from the different environments of the islands were sampled, but this meant that seeds were collected sometimes from fewer than 50 plants. Collecting sites were about 3 km apart and were chosen following the patterns of geographical and climatic variation within each island. Emphasis was placed on collecting material from wild populations, since within forage plants it is expected that these are the major sources of genetic variation (Marshall and Brown, 1983).

Ten herbarium specimens were also collected from each population. These are held in the herbaria of the University of Birmingham (BIRM) and of the La Orotava Botanic Gardens (ORT).

*Rhizobium* nodules were collected from as many populations as possible and preserved according to the procedures of Date and Halliday (1979). At present they are preserved at  $-20^{\circ}\text{C}$  at the University of Birmingham, UK.

A list of the species found growing at each collecting site was compiled according to the methods proposed by Braun-Blanquet (1932), since the islands have been studied intensively from a phytosociological point of view. General features of the habitat were recorded based on the indications of Hawkes (1983). Climatological data for each site were obtained directly from El Instituto para Conservación de La Naturaleza and from other published sources (Anon., 1975, unpublished; Rivas-Martínez, 1987).

#### Samples collected

A total of 196 samples was collected from 184 localities in the islands of El Hierro, La Palma, La Gomera, Tenerife and Gran Canaria by the team of the University of Birmingham and the Centro de Investigación y Tecnología Agrarias (CITA). Fig. 1 shows the areas where the different samples were collected. Table 1 summarizes the germplasm collected. No collecting was done in the islands of Fuerteventura and Lanzarote since these are too dry to support tagasaste and escobón.

The seeds have been deposited in the seed bank of the Centro de Conservación de Recursos Fito-genéticos, Apartado 1045, 28800, Alcalá de Henares, Madrid, Spain.

#### Distribution and frequency of *Chamaecytisus proliiferus sensu lato* types

The distribution of wild tagasaste and escobón is closely associated with major vegetation types in the islands.

The laurel wood is the plant community found on the northern slopes of the islands between 800 and 1000 masl. It has *Laurus azorica* (Seub.) Franco and *Persea indica* (L.) K. Spreng as dominant species. The heath belt is found between 1000 and 1200 masl on the northern slopes of the islands. The most abundant species within this plant community are *Erica arborea*

Table 1. Morphological types of *Chamaecytisus proliiferus sensu lato* collected in the Canary Islands

| Morphological type  | Island       | No. of samples |
|---|--------------|----------------|
| Tagasaste   | El Hierro    | 3              |
| Escobón of El Hierro  | El Hierro    | 2              |
| Cultivated tagasaste  | La Palma     | 19             |
| Wild tagasaste  | La Palma     | 5              |
| White tagasaste   | La Palma     | 6              |
| 'Tagasaste híbrido' (? tagasaste × white tagasaste hybrid)            | La Palma     | 4              |
| Tagasaste   | La Gomera    | 2              |
| Typical escobón   | La Gomera    | 7              |
| Tagasaste   | Tenerife     | 15             |
| Typical escobón   | Tenerife     | 60             |
| White escobón of Tenerife   | Tenerife     | 3              |
| Tagasaste   | Gran Canaria | 8              |
| Wild white escobón of Gran Canaria                                    | Gran Canaria | 16             |
| Semi-cultivated white escobón of Gran Canaria                         | Gran Canaria | 2              |
| 'Escobón mulato' (? white escobón of Gran Canaria × tagasaste hybrid) | Gran Canaria | 1              |
| Escobón of southern Gran Canaria                                      | Gran Canaria | 43             |
| TOTAL   |              | 196            |

L. and *Myrica faya* Ait. The pine forest has *Pinus canariensis* Chr. Sm. ex DC. as the dominant species. This forest is found between 1500 and 2000 masl on the northern slopes of the islands and between 800 and 2000 masl on the southern side.

#### (1) Typical tagasaste

Within the *C. proliiferus* complex only typical tagasaste is cultivated. This plant is also known by the following names: 'tagasaste', 'satagaste' and 'escobón negro' (Gran Canaria), and 'tagasaste negro', 'tagasaste mollar' and 'tagasaste hembra' (La Palma). Pérez de Paz *et al.* (1986) claimed that this morphological type was also endemic in El Hierro, La Gomera and Tenerife. However, wild populations of typical tagasaste were found only in La Palma and we believe that it is endemic to this island and was subsequently introduced as a cultivated plant to El Hierro, La Gomera, Tenerife and Gran Canaria. Plants of typical tagasaste bear dark green, glabrous leaves and large seeds. This is the morphological form which is used as a fodder tree in Australia and New Zealand.

Wild populations of tagasaste are rather rare since rabbits and overgrazing have relegated them to inaccessible cliffs. Nevertheless this taxon seems to be associated with the communities of the sunny and open areas of the laurel wood and the heath belt zones of northern and northeastern La Palma.

Four different ways of cultivating tagasaste were observed:

- within clear areas in the pine forest of La Palma where there are no cultivated terraces;
- along the borders of cultivated terraces as a secondary crop, where the main crop is maize, barley, potato, onion or brassicas;

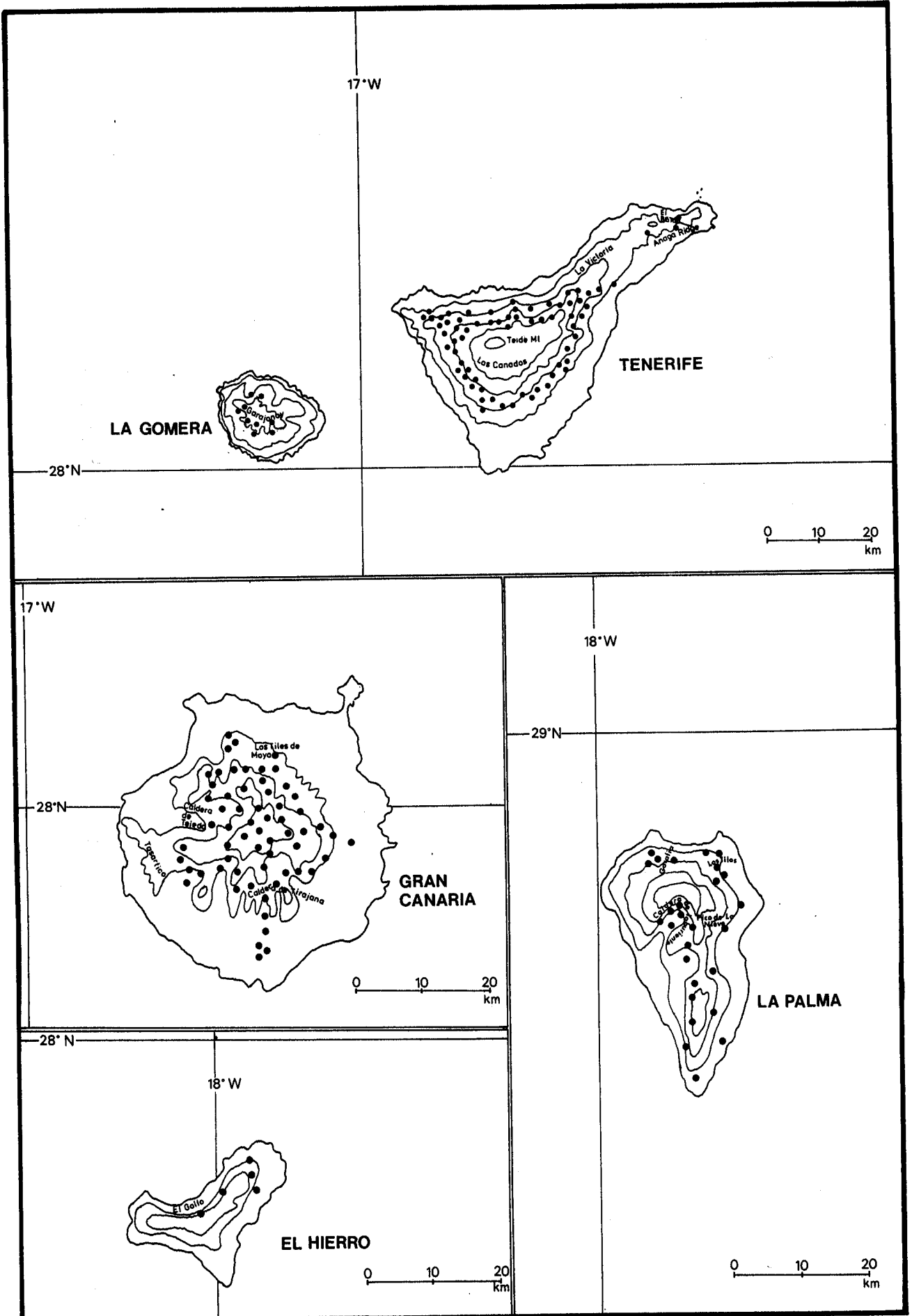


Fig. 1. Collecting sites of *Chamaecytisus proliferus sensu lato* in the Canary Islands

- associated with other crops such as fig, almond, peach, medlar, pear, apple, vine, maize or brassicas; and
- as a monoculture.

Other endemic plants were also found to be utilized as forages in some cultivated tagasaste sites. Species such as *Sonchus pinnatus* Ait. ssp. *palmensis* (Sch.Bip.) Aldridge or *Rumex lunaria* L. are cultivated together with tagasaste in some areas of La Palma and El Hierro. Other endemic species such as *Teline stenopetala* (Webb & Berth.) Webb & Berth. var. *stenopetala*, *Hypericum inodorum* Mill., *Adenocarpus foliolosus* (Ait.) DC. were observed in a semi-cultivated state in tagasaste fields in La Palma and Tenerife. Non-endemic species such as *Bituminaria bituminosa* (L.) Stirton and *Erica arborea* L. were also found semi-cultivated as associated forages with tagasaste in all parts of the archipelago.

Farmers of the El Paso district (La Palma) and La Caldera de Taburiente National Park (La Palma) told us that within tagasaste sites there are sometimes individual plants that cattle prefer because they are more tender. These specimens are known by the name 'mollar' and can be distinguished because they are easier to prune.

Small farmers from the Canary Islands usually cut tagasaste at the site of cultivation and take it as fresh forage to the cattle stalls.

## (2) White tagasaste

Plants of this morphological group have large seeds and hairy, silver leaves. It is found within the arid pine forest of La Palma. This plant is known as 'tagasaste azul' in the north of La Palma whereas in the rest of the island it is called 'tagasaste blanco'. The best sites for white tagasaste were found within La Caldera de Taburiente National Park in La Palma. It formed extensive scrub towards the bottom of deep gullies ('barrancos') in an area where the pine forest is not so dense. This habitat has rather sandy soils and in some areas it can be regarded as the transition between the pine forest and the hygrophyllic communities of *Salix canariensis*. The latter species community can only be found on the banks of the few streams that exist in the archipelago.

White tagasaste is probably a frost-resistant plant. Specimens from one population were found within a frost area. Farmers from La Caldera de Taburiente and northern La Palma reinforced this view and stated that this was one of the differences between the two kinds of tagasaste. Plants of white tagasaste were also observed at 2400 masl in the Roque de Los Muchachos mountains within a zone which has frost during winter. On the other hand, white tagasaste was also found in areas regarded as frost free.

Wild typical tagasaste was observed growing together with white tagasaste within the scrub of La Caldera de Taburiente, although white tagasaste was much more abundant. Specimens with intermediate characters between typical tagasaste and white tagasaste were observed and it seems that hybridization

occurs frequently between these types. Typical tagasaste was also seen as a cultivated plant within La Caldera de Taburiente. The few farmers who live there mentioned that both kinds of tagasaste were good forage although they preferred typical tagasaste.

Wood (1989) found that white tagasaste produced fewer seeds than typical tagasaste. However we observed that both morphological types produced many seeds and we found only one population of white tagasaste that bore few seeds. In early September 1989 we tried to collect seeds of frost-resistant white tagasaste outside the La Caldera de Taburiente in the dry pine forest of northern La Palma. Although large populations of white tagasaste were observed in Pico de La Nieve (Santa Cruz de la Palma district) and above Galería de Minaderos (Garafía district), none of the plants found had any pods. Local people told us that the pods had shed their seeds by August.

## (3) Typical escobón

This form has narrow leaves and small seeds. It is found mainly within the area of the pine forest of Tenerife and of the low altitude shrubland of La Gomera. Pérez de Paz *et al.* (1986) stated that the dense reforestation of *Pinus canariensis* and *Pinus radiata* D. Don accomplished in Tenerife from 1940-50 led to the disappearance of typical escobón from some zones of the island. Our first ecological studies indicate that typical escobón does not grow well within these reforested areas since the habitat is too shady.

Typical escobón is called 'tagasaste criollo' in La Gomera, whereas in Tenerife it is known as 'escobón'. This morphological type was found not only within the clear areas of the pine forest but also forming dense scrub that replaces the forest when the latter has been cut down. Typical escobón can grow under frost conditions, and extensive escobón scrub reaches the high altitude areas of Tenerife. Typical escobón was never found cultivated, although many of the populations studied had been severely grazed.

Typical escobón was also observed growing in rather arid areas in the south of Tenerife. Populations found at the lowest altitudes were associated with species such as *Plocama pendula* Ait. and *Euphorbia obtusifolia* Poir, which are usually found under very dry conditions. This morphological type also has a weedy habit and was observed growing on roadsides and on abandoned cultivated sites in association with *Prunus dulcis* and *Ficus carica*.

## (4) White escobón of Tenerife

Plants of this morphological type have small seeds and broad, hairy, silver leaves. It is found within the zone of the laurel wood and heath belt of Tenerife, but not as dense scrub which often follows the destruction of these communities.

It occurs quite rarely and tends to grow on sunny cliffs in the forest. Only one population of white escobón of Tenerife was found forming a scrub; that was in the upper part of El Batán, on the Anaga



Fig. 2. Collecting escobón in the high altitude scrub in Tenerife

Ridge, in the northeast of the island. Farmers in this area confirmed that white escobón scrub was once very common but almost all of it had been cut down.

We also found some cultivated tagasaste plants from Accession 167 that showed some leaf characters that seemed to indicate that introgression might have occurred from white escobón of Tenerife.



Fig. 3. Collecting escobón in the Canary pine forest in southern Tenerife

### (5) Escobón of southern Gran Canaria

This escobón type has narrowly obtrullate, golden leaves and small seeds that are usually pale brown in colour. It is endemic in the pine forest of Gran Canaria where it is called 'escobón'. Some populations of this morphological group seem to be extremely drought tolerant. They were associated with species such as *Rubia fruticosa* Ait. or *Ceballosia fruticosa* (L. fil.) Kunkel, which are characteristic of the arid plant communities of the archipelago. Escobón of southern Gran Canaria has a weedy habit and quite often forms thick scrub that invades road slopes and abandoned, cultivated terraces.

### (6) White escobón of Gran Canaria

This is found within the laurel wood area of Gran Canaria where it is known as 'escobón blanco'. Morphologically it is very similar to white escobón of Tenerife although it seems that the Gran Canaria group has broader leaves and smaller seeds. Reports on the cultivation of *C. proliferus* var. *canariae* (Kuntze, 1891; Ceballos and Ortuño, 1951; Lid, 1967) in Gran Canaria do not fully agree with our field observations. Some populations of Gran Canaria white escobón were seen under semi-cultivated conditions in the northeast of the island. None of the local people we met said that these plants had been planted, although this variety was observed within fenced, cultivated sites and was used widely as a fodder tree, mainly to feed sheep. Farmers pruned it so that the plants developed into small trees, and sheep can only graze the lowest branches.

Typical tagasaste was also found in northeastern Gran Canaria, but under cultivation. Local farmers confirmed that the tagasaste had been planted. Some semi-cultivated plants that farmers called 'escobón mulato' were found within this area. They seemed to be hybrids of tagasaste and white escobón. The leaf hairiness and flowering time of these plants was intermediate between those of tagasaste and white escobón. Farmers rated 'escobón mulato' a poorer forage than either tagasaste or white escobón and described it as very bitter. In this area tagasaste is regarded as a better fodder legume than white escobón.

Wild, dense, white escobón scrub was very often observed in the zone and it is suggested that it arose spontaneously as a result of the destruction of the laurel wood that covered this area until the last century. This form of escobón was frequently found colonizing disturbed areas and abandoned, cultivated fields.

### (7) Escobón of El Hierro

This is the rarest morphological form of the *C. proliferus* complex. This plant is found on the cliffs of the heath belt of El Golfo (El Hierro). Its leaves are broadly obovate, hairy and silver in colour. It has large seeds, most of them with a width/length ratio almost equal to one.

### *In situ* conservation

Populations of typical and white tagasaste are conserved within La Caldera de Taburiente National Park (El Paso district, La Palma) and the Unesco Biosphere Reserve of Los Tilos y El Canal (Los Sauces district, La Palma). Populations of typical escobón are conserved in the National Parks of Garajonay (La Gomera) and Las Cañadas del Teide (Tenerife). The local Nature Reserve of Los Tiles de Moya (Gran Canaria) harbours populations of white escobón of Gran Canaria. However it was found that populations conserved within all these reserves are often grazed by animals and widely used by small farmers of the area. Once the projected network of Canary Islands nature

reserves is established, the most important wild populations of the *C. proliferus* complex will be conserved. The most rare morphological types of this complex (El Hierro escobón, Tenerife white escobón and wild typical tagasaste) will also be included within several of the nature reserves of this network.

### Prospects for future collecting

The six populations listed below were identified late in September 1989, but it was not possible to collect seeds:

- two populations of white escobón of Tenerife from El Batán (Anaga Ridge) and the laurel wood of La Victoria de Acentejo district;
- two populations of frost-resistant white tagasaste from Pico de La Nieve and the pine forest of Garafía district in La Palma;
- a population of apparently drought-tolerant southern Gran Canaria escobón found in Tasartico region; and
- a population of El Hierro escobón found in the western extreme of El Golfo.

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### Résumé

*Ressources génétiques de légumineuses fourragères tagasaste et escobón (Chamaecytisus proliferus (L. fil.) Link sensu lato) dans les îles Canaries*

Du germoplasme de 184 populations cultivées, semi-cultivées et sauvages de *Chamaecytisus proliferus* (L. fil.) Link (Fabaceae: Genisteae) a été collecté dans les îles de El Hierro, La Palma, La Gomera, Ténérife et Grande Canarie (îles Canaries) entre juin et août 1989. Des spécimens d'herbier, des échantillons de sol et des nodules avec *Rhizobium* ont également été prélevés pour la plupart des populations. L'écologie du tagasaste et de l'escobón est décrite. Les graines sont conservées au Centro de Conservación de Recursos Fitogenéticos, Apartado 1045, 28800, Alcalá de Henares, Madrid, Espagne.

### Resumen

*Recursos fitogenéticos de las leguminosas forrajeras tagasaste y escobón (Chamaecytisus proliferus (L. fil.) Link sensu lato) en las Islas Canarias*

Germoplasma de 184 poblaciones cultivadas, semicultivadas y silvestres de *Chamaecytisus proliferus* (L. fil.) Link (Fabaceae: Genisteae) se colectó en las islas de El Hierro, La Palma, La Gomera, Tenerife y Gran Canaria (Islas Canarias) durante los meses de Junio y Agosto de 1989. También se colectaron pliegos de herbario, muestras de suelo y nódulos de *Rhizobium*. Se describe la ecología de tagasaste y escobón. Semillas de esta colección se encuentran conservadas en el Centro de Conservación de Recursos Fitogenéticos, Apartado 1045, 28800, Alcalá de Henares, Madrid, España.