

A study on distribution and population size of *Androcymbium hierrense* (Colchicaceae) an endangered taxon, in La Palma Biosphere Reserve (Canary Islands)

Félix Manuel Medina^{1,2*} & Raúl Fernández de León³

¹Servicio de Medio Ambiente, Cabildo Insular de La Palma, Avenida Los Indianos n° 20-2° piso, 38700 Santa Cruz de La Palma, Canary Islands, Spain; felix.medina@cablapalma.es

²Island Ecology and Evolution Research Group (IPNA-CSIC), Astrofísico Francisco Sánchez 3, 38206 La Laguna, Tenerife, Canary Islands, Spain

³Reserva Mundial de la Biosfera La Palma, Avenida Marítima 3, 38700 Santa Cruz de La Palma, Canary Islands, Spain. ugranfir@gmail.com

Abstract

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The scarce knowledge on the distribution of the natural populations of the Canarian endemic *Androcymbium hierrense* (Colchicaceae), an endangered species in the island of La Palma hampers the identification of priorities for undertaking actions for its conservation. Here we present a survey in which, the species is distributed in 14 locations grouped into two differentiated areas. This result represents an increase of ca. 200% in the occupancy area known for the species until now. A total of 15010 individuals were recorded: 1294 individuals in the northern parts of the island (Garafía), and 13716 in the east (Mazo). The species exhibits an average density of 8.80 ± 24.03 SD ($n=1559$) and an estimated population size of 21593-24851 individuals (with a 95% confidence interval), given a total population of 217995 plants for the entire species distribution area on the island. Considering these estimates and the current distribution of the species, it is important to analyse its actual conservation status in La Palma both at regional and global scales, taking into account that the main threat for the species is habitat destruction by human activities.

Key words: abundance, *Androcymbium hierrense*, conservation, distribution, endemic species, protected areas

INTRODUCTION

Biosphere Reserves are recognised areas of representative environments which have been internationally designated within the framework of UNESCO's MAB Program for their value to conservation through providing the scientific knowledge, skills and values to support sustainable development (Bridgewater & Cresswell, 1998). A relative small area (511 ha) in La Palma Island was declared a Biosphere Reserve in 1983 (El Canal y Los Tiles). Nevertheless, considering both the natural values of this island and that conservation activities were only carried out during a long period after that declaration, the entire island was declared as Biosphere Reserve in 2002 to comply with the other two functions of these natural areas: sustainable development and logistic support for research and educational purposes (UNESCO, 1996). Therefore, La Palma Island Biosphere Reserve harbours a rich biodiversity at regional and national scale. More than 5434 terrestrial species (1056 of them endemic) have

Resumen

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El escaso conocimiento que se posee sobre la abundancia y distribución de *Androcymbium hierrense* (Colchicaceae), una especie vegetal endémica y amenazada del archipiélago canario presente en la isla de La Palma, impide que se puedan establecer las medidas adecuadas para su conservación. En un censo llevado a cabo en 2005, cuyos resultados se presentan en esta contribución, muestran que la especie está distribuida en 14 localidades correspondientes a dos áreas diferentes. Este resultado supone un incremento aproximado del 200% en su área de ocupación conocida hasta la actualidad. Se contabilizaron un total de 15010 individuos: 1394 plantas en el norte de la isla (Garafía) y 13716 individuos en el este (Mazo). La especie presenta una densidad media de 8.80 ± 24.03 SD ($n=1559$) y un tamaño poblacional estimado de 21593-24851 individuos (con un intervalo de confianza del 95%), dando una población total de 217995 ejemplares para el total de su área de distribución en la isla. Considerando los resultados obtenidos en este trabajo, sería necesario actualizar su estado de conservación, tanto en la isla de La Palma como a nivel regional y global, teniendo en cuenta que la mayor amenaza para la especie es la destrucción del hábitat como consecuencia de la actividad humana.

Palabras clave: abundancia, *Androcymbium hierrense*, áreas protegidas, conservación, distribución, especies endémicas

been listed in its territory (Martín & al., 2005a), and 879 vascular plant species have been described with a 20 % of endemic species. Habitat destruction and, overall, the introduction of invasive species are the most important threats for the conservation of native species on islands worldwide (Mack & al., 2000, Whittaker & Fernández-Palacios, 2007), and the Canary Islands are not an exception (García-Casanova & al., 2001). Of the total of 366 species considered as threatened in the Canarian archipelago (Martín & al., 2005b), 22 (15 of them plants) are present in La Palma Island (Martín & al., 2005a).

One of these plant species is *Androcymbium hierrense* A. Santos, a member of family Colchicaceae. Although it is not included in the Spanish or in the World Conservation Union (IUCN, 2012) endangered species list, it is indeed considered as an *endangered* taxon by the Spanish Red Data Book (Bañares & al., 2004, Moreno, 2008), and with the category of *threatened* in the Canarian endangered species list (Martín & al., 2005b). This species presents a

* Corresponding author.

small distribution area in La Palma Island, being mainly threatened by habitat destruction and, most probably, by grazing by introduced herbivores (Bañares & al., 2004; Mesa-Coello, 2000).

One of the most important informations for the conservation of any endangered plant species is the location of its populations (Keith, 2000). Thus, in the Canaries, the poor knowledge on the abundance and distribution of natural populations of most endemic endangered plant species clearly stands in the way of their adequate conservation (Carqué-Álamo & al., 1997). Our main aim in this contribution is to describe the current distribution and population size of *Androcymbium hierrense* on La Palma Island in order to determine priorities for its conservation.

Natural history of *Androcymbium hierrense*

Androcymbium hierrense is an herbaceous plant with a tunicate corm, showing an alternate disposition of leaves (Santos, 1977) (Fig. 1). It is a geophyte with an annual vegetative cycle, which spends the unfavourable period buried as a tunicate corm (Santos, 1977). Plants emerge in November and flower in February; they are hermaphrodite, preferentially xenogamous, facultatively autogamous, and probably entomogamous; vegetative reproduction through corm duplication is frequent, and the distribution of individuals is clumped (Pedrola-Monfort & Caujapé-Castells, 1998). In La Palma, *A. hierrense* inhabits basaltic soils, rocky places, or soils with sandy texture in the open communities

of xerophytic shrubs (*Kleinio-Euphorbietae canariensis*, del Arco & al., 1999) found in the lowest elevations.

The genus *Androcymbium* represents a disjunct distribution between northern and southern Africa (Caujapé-Castells & al., 2001). Only two of the ca. 50 species recognized in the genus occur in the Canary Islands: *A. hierrense* in the western islands of La Palma, La Gomera, and El Hierro, and *A. psammophilum* in the eastern islands of Lanzarote and Fuerteventura (Pedrola-Monfort & Caujapé-Castells, 1998, Arechavaleta & al., 2010). Because of slight differences between the population of *A. hierrense* from La Gomera and the other two islands, Reifenberger (1990) proposed the existence of two distinct subspecies, *A. hierrense* subsp. *macrospermum* (from La Gomera) and *A. hierrense* subsp. *hierrense* (from La Palma and El Hierro). Nevertheless, Pedrola-Monfort & Caujapé-Castells (1995) did not find evidence to support this subdivision taking into account morphological and molecular evidences (Martín Cáceres & al., 2004).

MATERIAL AND METHODS

Study area

The Canarian archipelago is situated in the Atlantic Ocean, and the easternmost island (Fuerteventura) is barely some 100 km off the African continent. With an area of 728 km² and a maximum altitude of 2426 m a.s.l. (Roque de Los Muchachos), the island of La Palma (28° 40' N, 17° 50' E)



Fig. 1. Detail of *Androcymbium hierrense*.

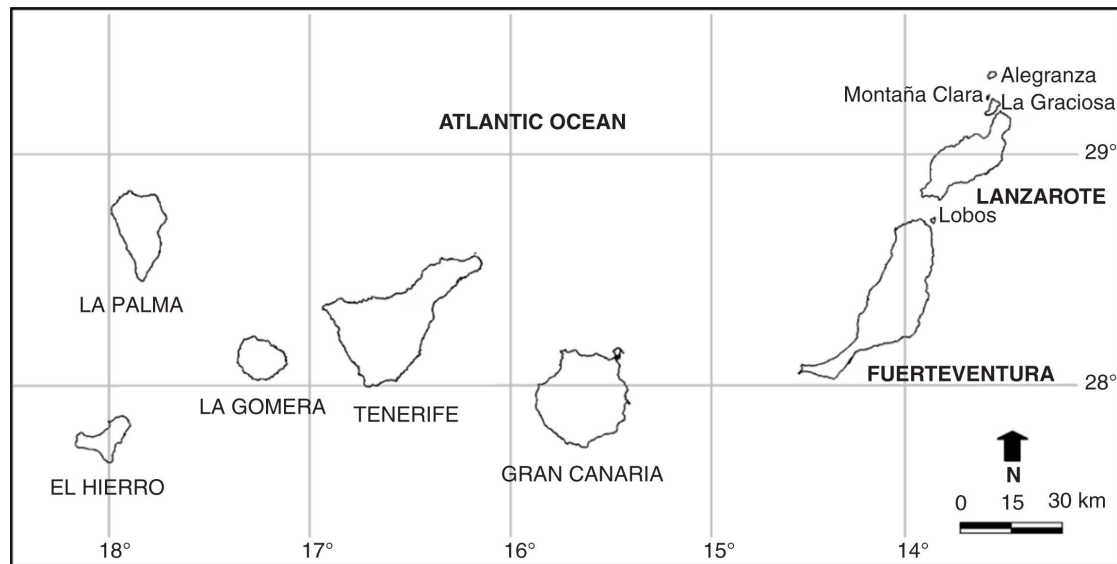


Fig. 2. Map of Canarian Archipelago showing the location of La Palma Island Biosphere Reserve.

is located in the north-west of the archipelago (Fig. 2). This island's climate is influenced by the ecological zones associated with its high altitude, the wet north-east trade winds, and the mountain orientation (Afonso, 1985). The annual rainfall is 400.9 mm (with seasonal differences [winter 49.9%, autumn 30.7%, spring 18.7% and summer 0.7%, Marzol-Jaén, 1984]), and the mean annual temperature is 18.3 °C (Marzol-Jaén, 1984), ranging from 15 °C in January to 22.3 °C in August. The different vegetation belts present in the island are related to the altitudinal variation in temperature and precipitation (see Santos, 1983 and del Arco & al., 1999 for details). We visited an area located in the xerophytic scrubland habitat on the lowest parts of the Island. The vegetation of this area is characterized by the *Kleinio-Euphorbietae canariensis* association, featuring shrubby vegetation dominated by species such as *Euphorbia lamarckii*, *Retama rhodorhizoides*, *Lavandula canariensis*, *Kleinia neriifolia*, *Echium breviflorum*, *Micromeria herpophylloides*, *Rubia fruticosa* and *Periploca laevigata* (Bañares & al., 2004).

Methods

The distribution of *Androcymbium hierrense* in La Palma Island was estimated on the basis of previous information of its distribution (Mesa-Coello, 2002), and by visiting all the surrounding areas that offer a potential habitat for the species. Each new distribution area was measured and georeferenced in a map using GPS and a GIS program (Arcview 3.2, ESRI, 1992).

Taking into account the clumped distribution of individuals (Pedrola-Monfort & Caujapé-Castells, 1998), and in order to know the real distribution range of the species, an index of dispersion was calculated following Dale (1999) and Ludwig & Reynolds (1988). This calculation is based on counts of the number of plants in a set of n quadrats. After the calculation of the average number of plants and sample variance, the index of dispersion formula is:

$$I_d = \sum_{i=1}^n (x_i - \bar{x})^2 / \bar{x},$$

where I_d is the index of dispersion, and x_i is the number of plants in each quadrat (Dale, 1999).

Censuses were carried out in 2005, from March to April, after the plant's flowering period and before its burying as bulb. Two different census strategies were employed depending on the location of the populations. In the eastern parts of the island, characterised by a dense cover of high vegetation (over 95% and 125 cm, respectively), we followed transects across contiguous quadrats of 2×5 m (following Keith, 2000; Fig. 3), and the total number of plants present in each quadrat was counted. Four different plant stages were considered: mature, non reproductive, juvenile, and plants affected by herbivores. On the other hand, in the northern parts of the island, all individuals were counted in a specific area, due to the small size of the area of species occurrence. Subsequently, we derived an estimate of the total population cover in relation to the total distribution area. Interval confidence (95%) was generated using Monte Carlo Analysis from MS-Excel tools. Taking into account that the species can reproduce asexually, clonal plants were not considered in order to avoid bias during the censuses (Bullock, 1996).

RESULTS

The current distribution of *Androcymbium hierrense* in La Palma Island is shown in Fig. 4. This species was distributed in 14 locations over two differentiated areas: one in the north, Garafía (three localities at Barranco de Fagundo and one at Punta del Escanchado), and another one in the east Mazo (four localities at Montaña del Azufre, and six in Tegalate) (Fig. 4). Six localities are new: one in the north (Punta del Escanchado) and five in the east (Montaña del Azufre, Lomo 2 Los Morenos, Lomo del Acebuche and Salto Tegalate North), entailing an increase in the species occupancy area of 200%, approximately.

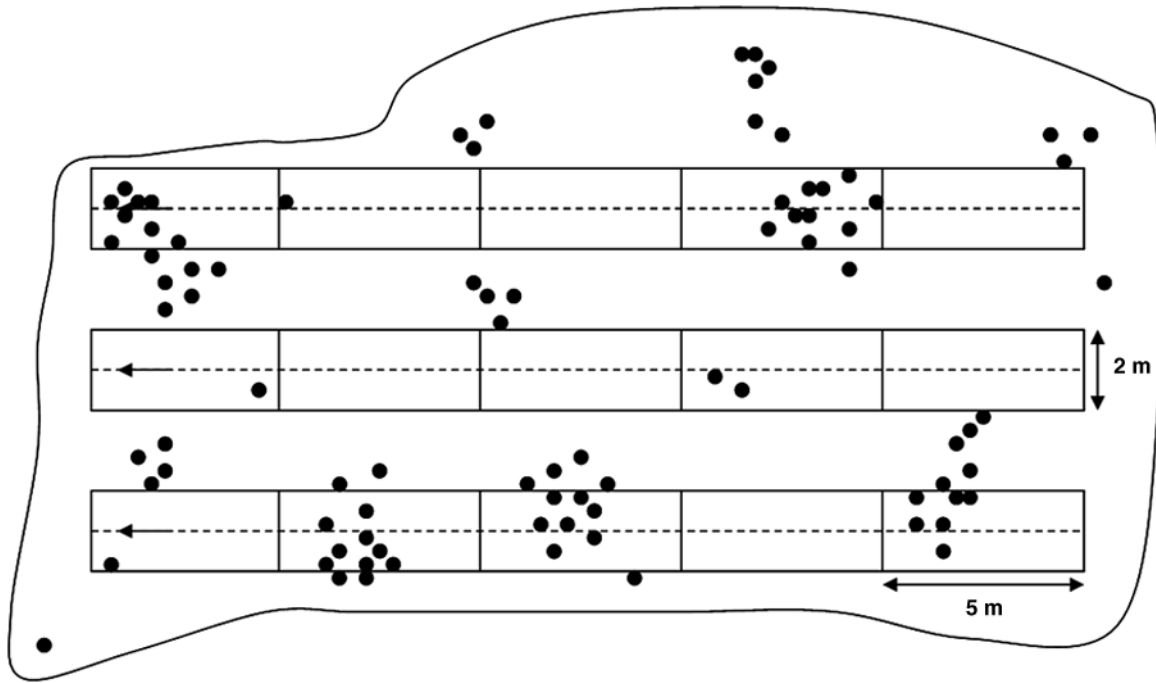


Fig. 3. Census model for *Androcymbium hierrense* in La Palma Island. Dots: individual plants. Arrows: census direction.

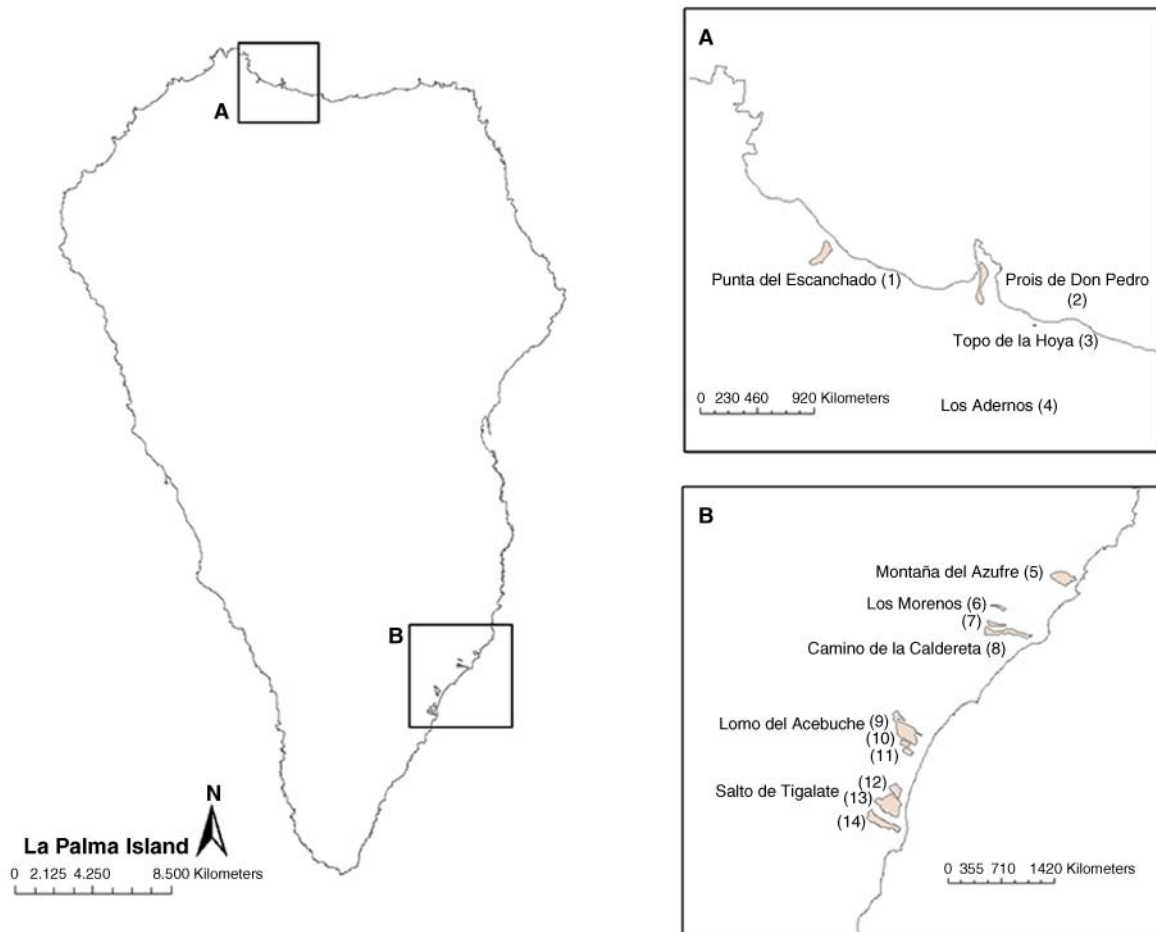


Fig. 4. Map of La Palma showing the distribution of *Androcymbium hierrense*. A: Garafia, B: Mazo. Numbers correspond to localities in table 1.

Table 1. Population of *Androcymbium hierrense* in La Palma Island Biosphere Reserve.

No. map	Locality	Sampled area (m ²)	No. plants	Total area (m ²)	Estimated population
GARAFÍA					
1	Punta del Escanchado	350	17	12656.7	615
2	Prois de Don Pedro	1718	1124	13006.5	8509
3	Topo de la Hoya	170	90	170.0	90
4	Los Adernos	25	63	25.0	63
MAZO					
5	Montaña del Azufre	4761	964	37865.5	7667
6	Los Morenos	1300	1992	5595.2	8574
7	Lomo 2 Los Morenos	1690	3693	8273.3	18079
8	Camino La Caldereta	3080	1339	33252.7	14456
9	Lomo 1 Acebuche	850	1096	65877.4	84943
10	Lomo 2 Acebuche	240	112	7020.0	3276
11	Lomo 3 Acebuche	160	0	160.0	0
12	Llano 1 Salto Tigalate N	840	364	17432.7	7554
13	Veril Salto Tigalate N	2810	898	61540.6	19667
14	Salto Tigalate S	3730	3258	50949.7	44502
	Total	21564	15010	313665.3	217995

As expected, *Androcymbium hierrense* presented a clumped distribution with a high index of dispersion ($Id=102219.93$; $\chi^2_{100}=149.45$; $p<0.001$).

A total of 15010 individuals were counted during the census (Table 1). In the north of the island (Garafía), where the species was more narrowly distributed, only 1294 plants were observed (Fig. 5). Although in some places we were able to count all plants, we only surveyed 8.75% of the total possible area in these localities (ca. 25850 m²). This entails an estimated population of 9277 individuals in the northern parts of the island (Table 1). By contrast, in the eastern parts of the island (Mazo), where a census method was used, 13716 individuals were counted, representing the main proportion of the total island population (Table 1, Fig. 5). In this case, species presents a mean density of 8.80 ± 24.03 SD ($n=1559$) given a 95% confidence intervals of 12316-15574 plants.

Finally, these figures give a total population of *Androcymbium hierrense* for La Palma Biosphere Reserve ranging from 21593 to 24851 plants. Taking into account that the sample area is only 6.9% of the total occupied area by the

species, the total population for the entire distribution area could be conformed by at least 217995 individual plants (Table 1).

DISCUSSION

Comparing our results with a survey previously carried out (Mesa-Coello, 2002), the distribution of *A. hierrense* species has increased by a high proportion ca 200%). The cause for such discordance is probably due to the employed methodology used in the previous study, where only a monitoring program of the known populations at that time was performed. The predictive maps obtained in a preliminary study by our group (Medina & al., 2007), detected new possible locations of distribution of *A. hierrense* on La Palma. Although we used these data to find the new localities reported in this research close to the known distribution range, a more thorough search for all predicted localities was not possible. For this reason, it is likely that new populations could be recorded based on the geographic information system analysis. Actually, in March 2011, a new population of this species composed by few hundreds of plants was discovered in Montaña de La Laguna, in the western parts of the island (Laura Concepción, pers. com.). Species distribution modelling constitutes an important predictive tool for ecology and conservation biology (Guisan & Thuiller, 2005). This is the first time that such a great effort has been undertaken to assess the current status of this endangered species following the potential distribution predicted by GIS procedures (Medina & al., 2007).

The distribution of annual plant species on a local scale can be limited by their dispersal limitation (Primack & Maio, 1992). As commented, *Androcymbium hierrense* has a low dispersal capacity, so it tends to occur almost exclusively in suitable habitat patches (Pulliam, 2000) as occurred in our case where we should counted more than the 99.6% of the total previously knowing population.

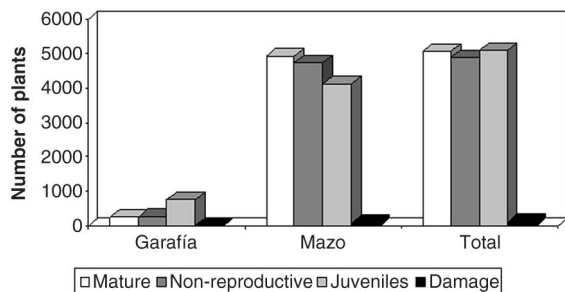


Fig. 5. Number of different plant stages of *Androcymbium hierrense* counted in La Palma during the survey.



Fig. 6. Human activities act as the principal threat for the conservation of *Androcymbium hierrense* on La Palma Island Biosphere Reserve. The image shows the rubbish dump whose construction entailed the destruction of one of the locations of *A. hierrense* (Los Morenos).

Although population structuring was not the main objective of this study, the observed unbalance between the different age classes (Fig. 5) seems to indicate that the population is fragile due to the existence of some factor that limits recruitment as it has been highlighted in other endangered species in the Canary Islands (Marrero-Gómez & al., 1999). From these results, though herbivory is not the main threat for the species but habitat destruction it is important to take this into account in order to avoid undeliverable effects on this plant species.

Conservation priorities

Taking into account the population size and the current distribution of the species, we consider it of utmost interest to reassess the present status of this species in La Palma Island at global and regional scales following the criteria of the World Conservation Union (IUCN, 2001) and the Canary Island Government (Martín & al., 2005b). On the other hand, considering the strong pressure created by introduced herbivores such as rabbits, rats or livestock (cows and goats), we support Bañares & al. (2004) view who established habitat destruction by human activities as the main threat for the species. In this respect, one of the largest localities for *A. hierrense* on La Palma (Los Morenos, see Table 1 and Fig. 4) was recently destroyed by the construction of a rubbish dump (Fig. 6). This work emphasizes the utility of species distribution modelling for conservation purposes. The performed model distribution (Medina & al., 2007) has allowed us both to select a nearby area where relocate part of the affected population, and to discover new populations of this endangered species in the Biosphere Reserve.

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