Bioclimatology and climatophilous vegetation of Gomera (Canary Islands)

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The bioclimatic belts of Gomera are established and the potential distribution of its climatophilous vegetation series mapped accordingly. PCA and DCA analyses explain the significance of thermic factors related to altitude, and rainfall or humidity conditions (mist precipitation) in the distribution of bioclimatic belts and vegetation series. A map of potential natural vegetation is produced by considering several additional abiotic environmental factors, and the current distribution of potential vegetation remnants or their substitute communities. Three new climatophilous associations (Neo-chamaeleo pulverulentae–Euphorbietum balsamiferae, Violo rivinianae–Myricetum fayae, Cisto gomerae–Pinetum canariensis), one new climatophilous subassociation (Brachypodio arbusculae–Juniperetum canariensis subass. ericetosum arboreae), two potential edaphophilous new associations (Euphorbietum aphyllae, Euphorbio berthelottii-Retamatetum rhodorhizoidis), one new potential edaphophilous subassociation (Cisto gomerae–Pinetum canariensis subass. juniperetosum canariensis) and two serial new associations (Micromerio gomerensis–Cistetum monspeliensis, Adenocarpo foliolosi-Chamaecytisetum angustifolii) are described. Commentaries and phytosociological tables of the potential natural vegetation communities and the other communities described are given.

Key words: bioclimatology, Canary Islands, ecology, Gomera, phytosociology, syntaxonomy, vegetation series

Introduction

This is one of a series of papers dealing with the bioclimatology and vegetation of the Canary Islands: Tenerife (Del-Arco et al. 2006a), Hierro and La Palma (Del-Arco et al. 1996, 1999a), Gran Canaria, (Del-Arco et al. 2002), Lanzarote (Reyes-Betancort et al. 2001), and Fuerteventura (Rodríguez-Delgado et al. 2005). This paper establishes a relationship between the bioclimatic belts and climatophilous vegetation series of Gomera.
Several phytosociological studies of the island have been made (Fernández-Galván 1983, Mester 1987, Oberdorfer 1965), Fernández-Galván (1983) being the most general. Despite this we describe several new potential and substitutional syntaxa and, based on bioclimatic and phytocoenotic information we map the climatophilous vegetation series. Additionally, we provide a more complete map of the potential natural vegetation.

**Study site**

Gomera is situated at 28°01′–28°13′N and 17°06′–17°21′W, in a central western position within the Canary archipelago, off the African continent (Fig. 1). Like the rest of the Canaries, it is a volcanic oceanic island; the datings for its subaerial volcanic phases range from 9.4–8.4 Ma for its shield volcano, and the subsequent lava flows extend up to 1.9 Ma. The island is highly eroded and there has been no recent volcanic activity (Paris et al. 2005). It is the second smallest island of the seven, with a surface area of 373 km² and rises to 1487 m a.s.l. near its centre (Garajonay). It has a more or less circular shape flattened in the NE quadrant, and its main axes are 22 km (N–S) between Punta de Los Órganos (N) and Punta del Becerro (S) and 25 km (W–E) between Punta de La Calera (W) and Punta de San Cristóbal (E). The relatively flat centre of the island is the highest part: the central plateau, with an undulating relief descending to around 800 m a.s.l. The generally deep ravines have a radial arrangement, with sharp ridges in the north and more or less flat ridges in the south. The heads of the main ravines have extensive erosion basins, and their mouths usually open into valleys, where the main human settlements are situated. Most of the island has a basaltic composition and the Basal Complex crops out in the north. All the island is spotted by intrusive acidic volcanic formations: salic plugs and “fortalezas” exposed by erosion. The coast is mainly rocky and only a few dark grey volcanic
sand beaches have developed at the mouth of some ravines; other beaches are formed of basaltic pebbles and boulders. The only organogenic whitish sand spot of the island is at Puntallana, in the E (Niebla et al. 1985). The island is subject to a trade-wind regime generating clouds over its windward slopes, which extend to the summit and even overflow it (Ceballos & Ortúñio 1951, Huetz de Lemp 1969, Arozena 1991).

The current vascular plant flora has a high degree of Canary endemism (over 24%), though the Mediterranean influence is dominant (La-Roche & Rodríguez-Piñero 1994, Wells & Lindach 1994, Marrero & Pérez-de-Paz 1998, Acebes et al. 2004). The different zonal vegetation belts of the island, in order of altitude, are: Euphorbia scrub (African Rand Flora origin), juniper woodland (Mediterranean origin), evergreen laurel forest (only on trade-winds facing slopes; Thetian-Tertiary origin), and pine woodland (Mediterranean origin) (Del-Arco & Rodríguez-Delgado 1999). From a biogeographical point of view, Gomera is a Sector of the Western Canary Subprovince, Canary Province, Canary Subregion, Mediterranean Region (Rivas-Martínez 2002).

Material and methods

Data and bioclimatic classification system

This bioclimatic study was performed using data from 14 thermopluviometric meteorological stations and 13 additional pluviometric stations operated by the National Meteorological Institute (Fig. 1 and Table 1). Thermopluviometric diagrams (Rivas-Martínez 2007) were drawn for some stations selected as representative of the different bioclimatic combinations (Fig. 2).

According to the World Bioclimatic Classification System (Rivas-Martínez 1995), the Canary Islands fit within the Mediterranean macrobioclimate, which is an extratropical macrobioclimate characterized by aridity ($P < 2T$) for at least two months after the summer solstice, among other features. Only three of its seven constituent bioclimates can be recognized in the Canary Islands: oceanic-desertic, oceanic-xeric and oceanic-pluviseasonal. Ic (continentality index), Io (ombrothermic index) and $P > 2T$ are used to define them. This classification provides a basis for establishing the bioclimatic belts of any territory by using a combination of thermotype, bioclimatic, and ombrotype.

Thermotypes are the spaces within an ITC (compensated thermicity index) gradient. Ombrotypes are the spaces within an Io gradient. Bioclimatic belts are defined as the successive types or groups of physical media along an altitudinal or latitudinal cliseries. They are not the same as vegetation belts, which are the plant community complexes or vegetation series ascending up an altitudinal cliseries.

In addition to the above combination used in the bioclimatic formula, we include the presence or absence of clouds (Peina et al. 1997, Del-Arco et al. 1999a, 2002, 2006a) to refine the characterization of bioclimatic belts. This allows apparently similar belts on north-facing slopes under the influence of trade-wind clouds (t.w.c. hereafter) to be differentiated from those on dry south-facing slopes.

Indices are used to establish thermotypes, bioclimates, and ombrotypes. ITC, used to establish thermotypes, is defined as follows: $\text{ITC} = \text{IT} \pm C$, given that $\text{IT}$ (thermicity index) = ($T + M + m$) $\times 10$, where $T$ = mean annual temperature, and $M$ and $m$ are the mean maximum and minimum temperatures of the coldest month. $C$ is the compensation value: when the continentality index ($\text{IC} = \text{difference between mean temperatures of the warmest and coldest months of the year}$) is $< 9$ (oceanic) or $> 18$ (continental), a compensation value ($C$) is subtracted or added to $\text{IT}$ to obtain $\text{ITC}$. This value is used in the extratropical territories of the Earth (north of 27°N and south of 27°S) to compensate for the extra winter cold of highly continental territories or the extra winter warmth in highly oceanic ones, so that the resulting compensated thermicity index (ITC) is comparable all around the Earth. In the territory studied, only compensations for IC values $< 9$ are needed. This compensation value is obtained from:

$$C = (9.0 - \text{IC}) \times 10.$$

Io, used to establish bioclimates and ombrotypes, is defined as follows: $\text{IO} = (Pp/Tp) \times 10,$
Table 1. Climatic and bioclimatic data from the stations studied.

<table>
<thead>
<tr>
<th>No.</th>
<th>Stations</th>
<th>Elev.</th>
<th>T</th>
<th>M</th>
<th>m</th>
<th>It</th>
<th>Ic</th>
<th>Itc</th>
<th>Tp</th>
<th>Tv</th>
<th>Fp 1</th>
<th>Fp 2</th>
<th>Fs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>15.2</td>
<td>0</td>
<td>2.2</td>
<td>0.2</td>
<td>15.2</td>
<td>6.7</td>
<td>538</td>
<td>2484</td>
<td>713</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>San Sebastián-Playa Cabrito</td>
<td>15.2</td>
<td>0</td>
<td>2.1</td>
<td>0.1</td>
<td>13.2</td>
<td>551</td>
<td>7.7</td>
<td>538</td>
<td>2496</td>
<td>724</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Alajeró-Playa Santiago</td>
<td>14.7</td>
<td>0</td>
<td>2.0</td>
<td>0.0</td>
<td>14.7</td>
<td>539</td>
<td>5.4</td>
<td>503</td>
<td>2364</td>
<td>679</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Vallehermoso</td>
<td>21.2</td>
<td>0</td>
<td>1.8</td>
<td>0.8</td>
<td>19.2</td>
<td>513</td>
<td>6</td>
<td>483</td>
<td>2256</td>
<td>656</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Vallehermoso-Dama</td>
<td>22.5</td>
<td>0</td>
<td>2.0</td>
<td>0.0</td>
<td>14.3</td>
<td>553</td>
<td>6.2</td>
<td>525</td>
<td>2448</td>
<td>696</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>San Sebastián-Chejelipes Presa</td>
<td>28.0</td>
<td>0</td>
<td>1.9</td>
<td>0.0</td>
<td>12.8</td>
<td>512</td>
<td>7.8</td>
<td>500</td>
<td>2328</td>
<td>683</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>Agulo-Juego Bolas</td>
<td>73.5</td>
<td>0</td>
<td>1.5</td>
<td>0.1</td>
<td>10.2</td>
<td>408</td>
<td>6.5</td>
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<td>1860</td>
<td>561</td>
<td>0</td>
<td>0</td>
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<tr>
<td>8</td>
<td>Alajeró</td>
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<td>0</td>
<td>1.7</td>
<td>0.1</td>
<td>16.1</td>
<td>444</td>
<td>10.4</td>
<td>444</td>
<td>2124</td>
<td>686</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>Valle Gran Rey-Ayudantía de Marina</td>
<td>84.9</td>
<td>0</td>
<td>1.4</td>
<td>0.7</td>
<td>13.6</td>
<td>408</td>
<td>6.5</td>
<td>383</td>
<td>1860</td>
<td>561</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>Agulo-Merina Vivero</td>
<td>84.0</td>
<td>0</td>
<td>1.3</td>
<td>0.2</td>
<td>10.9</td>
<td>360</td>
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<td>609</td>
<td>0</td>
<td>0</td>
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<tr>
<td>11</td>
<td>Hermigua-Cedro Icona</td>
<td>96.0</td>
<td>0</td>
<td>1.3</td>
<td>0.3</td>
<td>7.5</td>
<td>350</td>
<td>7.8</td>
<td>338</td>
<td>1688</td>
<td>532</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>Vallehermoso-Chipude C.F.</td>
<td>121.5</td>
<td>0</td>
<td>1.4</td>
<td>0.4</td>
<td>6.6</td>
<td>336</td>
<td>12.7</td>
<td>336</td>
<td>1740</td>
<td>622</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>San Sebastián-Montaña Tajaqué</td>
<td>122.5</td>
<td>0</td>
<td>1.3</td>
<td>0.2</td>
<td>7.5</td>
<td>296</td>
<td>12.5</td>
<td>296</td>
<td>1596</td>
<td>573</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>Vallehermoso-Laguna Grande</td>
<td>127.5</td>
<td>0</td>
<td>1.3</td>
<td>0.2</td>
<td>6.7</td>
<td>298</td>
<td>12.6</td>
<td>298</td>
<td>1572</td>
<td>586</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

where $P_p$ (positive rainfall) is the annual rainfall in mm, taking into account only the months with mean temperature higher than 0 °C. Since this is the case for all the thermopluviometric weather stations on the island, $P_p$ has the same value as $P$; $T_p$ (positive temperature) is the value in tenths of degrees resulting from the sum of the monthly means above 0 °C. The $I_o$ is one of the indices that best fit the altitudinal limits of the vegetation series. Further explanation can be found in Rivas-Martínez (1995, 1997, 2007) and Del-Arco et al. (1996, 1999a, 2002, 2006a).
The bioclimatic maps (Figs. 3–5) were drawn according to the indices obtained for the meteorological stations, and the threshold values of the indices which delimit thermotype, bioclimate and ombrotype (Table 2).

The curves showing the key values of change in these were then traced from the appropriate gradients on the different slopes (Tables 3 and 4). The bioclimatic-belt map was made by overlapping the thermotype, bioclimate and ombrotype maps, and considering the area influenced by t.w.c. (Huetz de Lemps 1969, Arozena 1991). In any subsequent colouring of the maps the criteria of Del-Arco et al. (1999b) should preferably be followed.

To identify the potential and other vegetation units we have used the phytosociological method of Braun-Blanquet (1979), and consequently phytosociological tables have been constructed using his abundance-cover scale [(+) = species not in the sampled area but present in the surrounding, + = species sparsely or very sparsely present; cover very small, 1 = plentiful but small cover value, 2 = very numerous, or covering at least 5% of the area, 3 = any number of individuals covering 25%–50% of the area, 4 = any number of individuals covering 50%–75% of the area, 5 = covering more than 75% of the area]. Vegetation series were characterized according to the criteria laid down by Géhu and Rivas-Martínez (1981). The terms climatophilous, edaphoxerophilous, and edaphohygrophilous are used throughout the text according to definitions by Rivas-Martínez (1995).

### Statistical analysis

Ordination techniques aid in explaining community variation (Gauch 1982), and they can be used...
Fig. 2. Climatic, bioclimatic, and symphytosociological data from some representative meteorological stations. Years: periods when temperature and rainfall were recorded. T = Mean annual temperature (°C); M = Mean maximum temperature of the coldest month (°C); m = Mean minimum temperature of the coldest month (°C); It = Ther- micity index; Itc = Compensated thermicity index; Tp = Positive temperature; Tv = Summer temperature; Ic = Conti- nentality index; Io = Ombrothermic index; Iov = Summer ombrothermic index; P > 4T = Months in which the rainfall value (in mm) is greater than four times the temperature value; 4T > P > 2T = Months in which the rainfall value is between four and two times the temperature value; 2T > P > T = Months in which the rainfall value is greater than temperature value but smaller than two times this value; P < T = Months in which the rainfall value is smaller than the temperature value; P = Annual rainfall in mm; Pp = Positive rainfall; Pv = Summer rainfall; H = Frost period; white = frost-free period (m > 0 °C); black = frost (m ≤ 0 °C); hatched = probable frost (m' ≤ 0 °C); m; monthly mean daily minimum temperature; m'; monthly mean absolute minimum temperature.

to evaluate trends through time as well as space (ter Braak & Šmilauer 2002). We used Principal Components Analysis (PCA, applying CANOCO; ter Braak & Šmilauer 2002) to examine the relationships among the altitude, climatic and bioclimatic parameters of the meteorological stations, and bioclimatic belts and vegetation series.

We used Detrended Correspondence Analysis (DCA; Hill & Gauch 1980) to examine how sample plots are grouped into the main gradients, in accordance with the different bioclimatic belts.
Fig. 2. Continued.
Nomenclature

The phytosociological nomenclature follows Rivas-Martínez et al. (2001, 2002); below association level, Rodríguez-Delgado et al. (1998) may be consulted. The taxonomic nomenclature
is mainly according to Acebes et al. (2004). Common names (Perera López 2005) of the taxa are mentioned the first time they appear.

### Results

**Thermotypes, bioclimates, and ombrotypes.**

Three thermotypes (Inframediterranean, Thermo-mediterranean and Mesomediterranean; Fig. 3), three bioclimates (oceanic-desertic, oceanic-xeric and oceanic-pluviseasonal; Fig. 4), and five ombrotypes (hyperarid, arid, semiarid, dry and subhumid; Fig. 4), were present on the island.

**Bioclimatic belts and vegetation series**

Upon overlapping the thermotype, bioclimatic, and ombrotype and taking into account the absence or presence of t.w.e., 19 bioclimatic belts were demarcated (Fig. 5) as hosts to the seven climatophilous vegetation series found on the island (Fig. 6 and Table 5).

### Table 2. Threshold values for thermotypes, bioclimates and ombrotypes according to Rivas-Martínez (1997).

<table>
<thead>
<tr>
<th>Thermotype</th>
<th>Ltc</th>
<th>Tp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inframediterranean</td>
<td>450–580</td>
<td>&gt;2450</td>
</tr>
<tr>
<td>Thermomediterranean</td>
<td>350–450</td>
<td>2150–2450</td>
</tr>
<tr>
<td>Mesomediterranean</td>
<td>210–350</td>
<td>1500–2150</td>
</tr>
<tr>
<td>Supramediterranean</td>
<td>80–210</td>
<td>900–1500</td>
</tr>
<tr>
<td>Oromediterranean</td>
<td>–</td>
<td>450–900</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bioclimate</th>
<th>Io</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceanic-desertic</td>
<td>0.1–0.9</td>
</tr>
<tr>
<td>Oceanic-xeric</td>
<td>0.9–2.0</td>
</tr>
<tr>
<td>Oceanic-pluviseasonal</td>
<td>&gt;2.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ombrotype</th>
<th>Io</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperarid</td>
<td>0.1–0.3</td>
</tr>
<tr>
<td>Arid</td>
<td>0.3–0.9</td>
</tr>
<tr>
<td>Semiarid</td>
<td>0.9–2.0</td>
</tr>
<tr>
<td>Dry</td>
<td>2.0–3.0</td>
</tr>
<tr>
<td>Subhumid</td>
<td>3.0–5.5</td>
</tr>
<tr>
<td>Humid</td>
<td>5.5–11</td>
</tr>
</tbody>
</table>
Ordination of the climatic and bioclimatic data with PCA revealed that those parameters discriminate two main tendencies (Fig. 7). The most important parameters are related to temperature variations in relation to altitude. These parameters are closely related to axis 1, which separates bioclimatic belts (especially B2 and B19) and vegetation series (especially those located in the Infra-Mediterranean and Mesomediterranean).

Differences mainly conditioned by rainfall and humidity (mist precipitation) are ordinated by axis 2, where bioclimatic belts and vegetation series are separated according to the different ombrotypes. Three main groups of variables and belts can be distinguished. Infra-Mediterranean belts are correlated with highest temperatures (upper left area of the graph), while Mesomediterranean belts (right area) are related with highest altitude. The Mesomediterranean belts without clouds or outside the influence of clouds in summer, are correlated with altitude, continentality index, and frost probability. Finally, a third group, in the lower right area of the graph, corresponds with Thermomediterranean and Mesomediterranean bioclimatic belts. These belts differ in mist, PP, Ppv, Iov, and Io.

DCA (Fig. 8) was also very consistent in discriminating the bioclimatic belts. Along axis 1,
plots were discriminated into different belts (Inframediterranean, Thermomediterranean, and Mesomediterranean) according to altitude and temperature parameters \( (T, M, m, I_t, I_{tc}, T_p, T_v) \). Sample scores of axis 1 were correlated with these parameters \( (p < 0.001) \). Axis 2 separates different plot groups within each mentioned bioclimatic belt, according to precipitation parameters \( (P_p, P_v, I_v, I_{ov}, \text{Mist}) \). Sample scores of axis 2 were correlated with these parameters.

### Table 3. References for constructing the bioclimatic maps: thermotypes.

<table>
<thead>
<tr>
<th>Stations</th>
<th>Height (m) difference between stations</th>
<th>Itc difference between stations</th>
<th>Altitude (m) of transition between thermotypes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Infra-thermo ((I_{tc} = 450))</td>
</tr>
<tr>
<td>4–10</td>
<td>628</td>
<td>156</td>
<td>345</td>
</tr>
<tr>
<td>4–7</td>
<td>518</td>
<td>100</td>
<td>383</td>
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<tr>
<td>1–6</td>
<td>265</td>
<td>61</td>
<td>497</td>
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<td>2–6</td>
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<td>38</td>
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<td>2–8</td>
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<td>767</td>
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<td>6–13</td>
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<td>1009</td>
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<td>23–24</td>
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<td>112</td>
<td>754</td>
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<td>12–14</td>
<td>60</td>
<td>38</td>
<td>1303</td>
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</table>

### Table 4. References for constructing the bioclimatic maps: bioclimates and ombrotypes.

<table>
<thead>
<tr>
<th>Altitude (m) of transition between bioclimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desertic-xeric ((I_o = 0.9))</td>
</tr>
<tr>
<td>Upper altitude (m) of ombotype</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stations</th>
<th>Height difference (m)</th>
<th>(I_o) difference</th>
<th>Hyperarid ((I_o = 0.3))</th>
<th>Arid ((I_o = 0.9))</th>
<th>Lower-semiarid ((I_o = 1.45))</th>
<th>Upper-semiarid ((I_o = 2))</th>
<th>Dry ((I_o = 3))</th>
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Along axis 2, humid bioclimatic belts are situated in the lower area of the graph, while the drier ones are located in the upper area.

Figure 9 shows the vegetation series differentiated by DCA. Three groups can be distinguished along axis 1. The first consists of the series Neochamaeleo–Euphorbio balsamiferae sigmetum and Euphorbio berthelotii–canariensis sigmetum; the latter appears in the lower part of the graph due to greater water requirements. The second group includes the Brachypodio arbusculae–Junipero canariensis sigmetum. The third group includes, from top to bottom, Cisto gomerae–Pino canariensis sigmetum, Violo-Myrico fayae sigmetum, Visneo mocanerae–Arbuto canariensis sigmetum, and Lauro novocanariensis–Perseo indicae sigmetum. All four sigmeta in this group are positioned according to humidity conditions.

Potential natural vegetation map

Several potential natural vegetation maps of Gomera have been produced, among them those by Ceballos and Ortuño (1951), Santos and Fernández (1980), Rivas-Martínez (1987), Santos (2000), and Del-Arco et al. (2006b) based on climatophilous macroseries.

As a complement to the climatophilous vegetation series map (Fig. 6), which represents a rather theoretical approach to vegetation distribution, we have drawn a potential natural vegetation map. The influence of topographic, geomorphic, edaphic, and geological factors (Carracedo 1980, Rodríguez-Losada & Martínez-Frias 2004) (Fig. 10) affecting the expansion of edaphophilous vegetation (edaphophilous series and permanent vegetation) makes other potential communities appear in the potential natural vegetation map (Fig. 11), although only the more representative potential communities at the map scale are displayed. These two maps show differences and several improvements on the previously mentioned maps.

Climatophilous vegetation series

There is a clear correspondence between the climatophilous series map, obtained from the bio-
Fig. 6. Map of climatophilous vegetation series.

Fig. 7. Principal Component Analysis of all variables of the plots. Eigenvalues axis 1: 0.933 (93.3% of the cumulative percentage of variance), axis 2: 0.044 (97.7% of the cumulative percentage of variance). B = Bioclimatic belt., S = Vegetation series (S1 = Neochamaeleo pulverulentae-Euphorbio balsamiferae sigmetum, S2 = Euphorbio berthelotii-canariensis sigmetum, S3 = Brachypodio arbusculae-Junipero canariensis sigmetum, S4 = Visneo mocanerae-Arubbo canariensis sigmetum, S5 = Lauro novocanariensis-Perseo indicae sigmetum, S6 = Violo rivinianae-Myrico fayae sigmetum, S7 = Cisto gomerae-Pino canariensis sigmetum). T = mean annual temperature, M = mean maximum temperature of the coldest month, m = mean minimum temperature of the coldest month, It = thermicity index, Ic = continentality index, Itc = compensated thermicity index, Tp = positive temperature, Tv = summer temperature, Pf = frost period, P = annual rainfall (mm), Pp = Positive rainfall, Pv = Summer rainfall, Io = Ombrothermic index, Iov = Summer ombrothermic index. B = Bioclimatic belts according to Table 5.
This sweet-spurge scrub is an association endemic to Gomera (Table 6). Its structure and physiognomy are those of a crassicaule desertic scrub, terminal community of the hyperarid and arid desertic Inframediterranean climatophilous series of the sweet spurge (Euphorbia balsamifera) on Gomera: Neochamaeleo pulverulentae–Euphorbio balsamiferae sigmetum.

It is a community with few species, where besides Euphorbia balsamifera the following are common among others: Kleinia neriifolia ("verode"), Euphorbia berthelotii ("tabaiba picuda"), Neochamaelea pulverulenta ("leña buena"), Campylanthus salsoloides ("romero marino") and Launaea arborescens ("ahulaga"). Its potential area is confined to the hyperarid and arid desertic Inframediterranean bioclimatic belts. The hyperarid occupies a short and narrow SSW coastal strip between Punta del Becerro and Punta de Iguala; the arid extends in an arc at low altitude on the E, S and W slopes, from San Sebastian, in the E, to Taguluche, in the W. Along this area it borders with Frankenio-Astydamietum latifoliae (Table 7) (rocky cost halophilous belt) in the SE, with Euphorbieta bertheloti–canariensis (cardón scrub) at a certain altitude, with Atriplici-Tamaricetum canariensis ("tarajal") (Table 7) in some ravine mouths, climatic belts map, and the distribution of their remnants, their serial substitute communities and distribution of bioindicative species. These are evidence of the reciprocal correspondence between climatophilous series and bioclimatic belts. Seven climatophilous vegetation series are recognizable.

Although this paper attempts to characterize the climatophilous series and their relation to bioclimatic belts, we comment on the other potential communities, since they are in special locations of their general area, and also show some illustrative relevés. We also describe some substitutional communities.
Fig. 10. Main factors related to the expansion of edaphophilous potential natural vegetation.

Fig. 11. Map of potential natural vegetation.
### Table 6. Euphorbietum aphyllae stat. nov. (1–6); Neocamaeleo pulverulentae-Euphorbietum balsamiferae ass. nov. (7–11); Euphorbietum berthelotii-canariensis (12–15); Plocametum pendulae subass. euphorbietosum berthelotti (16).

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#### Character taxa

- **Euphorbia aphylla**
- **Euphorbia balsamifera**
- **Euphorbia canariensis**
- **Plocama pendula**
- **Kleinia nerifolia**
- **Periploca laevigata**
- **Euphorbia berthelotii**
- **Rubia frutcosa**
- **Echium aculeatum**
- **Neochamaeleo pulverulentae**
- **Asphodelus ramosus**
- **Ajuga iva**
- **Lotus emeroides**
- **Aeonium castello-paivae**
- **Brachypodium arbuscula**
- **Aristida adscensionis**
- **Aeonium decorum**
- **Lavandula canariensis**
- **Schizogyne sericea**
- **Asparagus arborescens**
- **Campylianthus salsoloides**
- **Kickxia scoparia**
- **Vicia cirrhosa**
- **Ceropegia dichotoma**
- **subsp. krainzii**
- **Hyparrhenia sinaica**
- **Launaea arborescens**
- **Aeonium viscatum**
- **Microcera varia**
- **Asparagus arborescens**
- **Campylianthus salsoloides**
- **Kickxia scoparia**
- **Vicia cirrhosa**
- **Ceropegia dichotoma**
- **subsp. krainzii**

#### Companion taxa

- **Hyparrhenia sinaica**
- **Launaea arborescens**
- **Aeonium viscatum**
- **Microcera varia**
- **Asparagus arborescens**
- **Campylianthus salsoloides**
- **Kickxia scoparia**
- **Vicia cirrhosa**
- **Ceropegia dichotoma**

#### Number of taxa/relevés

- **Area (m²)**
- **Cover (%)**
- **Altitude (m. a.s.l.)**
- **Slope (°)**
- **Aspect**
- **Relevé**

---

**Other taxa** (relevé): (1) *Patellifolia webbiana* +; (4) *Juniperus turbinata* subsp. *canariensis 3, Phoenix canariensis* (plant.) 1, *Juncus acutus 1, Retama rhodorhizoides 1, Globularia salicina 1*; (6) *Volutaria canariensis +, Pinus halepensis* (pl.) 1, *Seseli webbii 1*; (8) *Polycarpaea divaricata 2, Reseda scoparia 1, Convolvulus floridus 1*; (9) *Ceballosia frutcosa +; (10) Sonchus ortunoi 2, Atalanthus sp. +; (11) *Artemisia thomas 1; (12) Cistus monspeliensis 1, Piptatherum caerulescens +, Cosentinia vellea subsp. *bivalens +; (13) Scilla haemorrhoidalis 1*; (15) *Todaroa aurea subsp. suaveolens 1, Heteropogon contortus +; (16) Nictiana glauca II, *Lotus sessilifolius II, Rumex vesicarius II, Calendula arvensis I, Patellifolia patellaris I, Reichardia ligulata I, Astydiamia latifolia I*.

with Plocametum pendulae subass. euphorbietosum berthelotii ("balera") in the arid and semiarid alluvial ravine beds ("ramblas") (Table 6, and with a finicolous representation of Tragan moquinii sigmetum (Table 7) on the sand of Playa del Inglés, in the W.

Nowadays the community has a scarce, fragmented distribution within its potential area and its best nuclei are in the SW, between Punta del Becerro and Punta Calera. A facies of Plocama pendula ("balo") is common in the SE, between Punta Gorda and Punta Gaviona. The substitutional shrubby nitrophilous community Lau-naeo arborescentis–Schizogynetum sericeae has a wide distribution over disturbed areas of the sweet-spurge scrub potential territory, as has the halonitrophilous herbaceous community Mesembryanthemetum crystallinum.

**Euphorbietum berthelotii-canariensis**

Rivas-Martinez et al. 1993

Common name: Gomera cardón scrub.

This is an endemic association to Gomera (Table 6), representative of the cardón scrub of the lower-semiarid xeric Inframediterranean bioclimatic belt. Its potential area rings the island; in the southern half above the climatophilous area of Neochamaeleo pulverulentae–Euphorbietum balsamiferae, and in the northern half from near sea level, above Frankenio-Astydamietum latifoliae or Euphorbietum aphylleae (potential edaphophilous community of windward promontories and cliffs; Table 6), until it reaches the potential area of Brachypodio-Juniperetum canariensis (juniper woodland). It can enter the climatophilous area of the latter as edaphoxerophilous potential vegetation on steep rocky places with scarce soil.

Its structure and physiognomy are those of a xeric crassicaule association, terminal community of the lower-semiarid xeric Inframediterranean climatophilous, and lower-semiarid and dry (without t.w.c.) Infra-Thermomediterranean edaphoxerophilous series of cardón (Euphorbia canariensis) on Gomera: Euphorbio berthelotii-canariensis sigmetum.

The main species apart from Euphorbia canariensis are among the others: Kleinia nerii-folia, Euphorbia berthelotii, Rubia fruticosa ("tasaigo"), Periploca laevigata ("corínca"), and Plocama pendula. The cardón scrub has substantially lost area and nowadays can only be observed in isolated, cleared, and sheltered steep places, throughout its potential area. The best remnants of the subass. typicum are commoner in the E of the island. The subass. euphorbietosum balsamiferae (northern sweet-spurge scrub) is frequent in particular xeric conditions favoured by rocky substrates on the N and NE slopes; the abundance of Euphorbia balsamifera gives a particular sweet-spurge scrub physiognomy to the association.

There is a facies of Periploca laevigata that develops on slope debris very close to the potential area of Brachypodio-Juniperetum canariensis. The facies of Plocama pendula is to a physiognomonic appearance of the community on very fragmented, eroded and porous old lava substrates, particularly developed on the NE, E, SE and NW sides of the island.

**Table 7.** Frankenio ericifoliae-Astydamietum latifoliae (1); Traganetum moquinii (2); Atriplici ifniensis-Tamaria cetum canariensis (3–4).

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**Character taxa**

- Astydamia latifolia
- Frankenia ericifolia
- Zygophyllum fontanesii
- Traganum moquinii
- Salsola divaricata
- Tamarix canariensis
- Companion taxa
- Lycium intricatum
- Schizogyne sericea
- Launaea arborescens

**Other taxa** (relevé): (1) Argyranthemum frutescens, Neochamaelea pulverulentia, Micromeria varia, Periploca laevigata, Plocama pendula, Phagnalon saxatile +; (2) Phoenix dactylifera, Nicotiana glauca +.

**Localities:** 1 = Playa de Alojera, 1.V.1987; 2 = Charco del Cieno (Del-Arco & Wildpret 1990: inv. 12, p. 106); 3 = Charco del Conde (Valle Gran Rey), 7.IV.1994; 4 = Mouth of Barranco de Vallehermoso, 7.IV.1994.
The main substitutional scrub is *Euphorbietum berthelotii* (“tabaibal amargo”), bitter-spurge scrub widely distributed over the potential area of the cardón scrub. Its floristic composition differs little from the latter but there is an impoverishment in species and the absence of *Euphorbia canariensis* is striking. The nitrophilous scrub *Artemisio thusculae–Rumicetum lunariae* (“inciensal-vinagreral”) is also common in anthropic areas, as are the nitrophilous herba-cous communities of *Echio-Galactition*.


Common name: Juniper woodland.

This is an association endemic to Gomera (Table 8), the Infra-Thermomediterranean juniper woodland. Its climatophilous area rings the island above the climatophilous area of *Euphorbio berthelotii-canariensis* and below that of *Visneo mocanerae–Arbutetum canariensis* (dry evergreen laurel forest) on the slopes under the influence of the t.w.c., and the climatophilous area of *Cisto gomerae–Pinetum canariensis* (pine woodland) on the southern slope. It can also develop upwards as an edaphoxerophilous community.

Its structure and physiognomy are those of a xeric, open woodland, terminal community of upper-semiarid xeric Infra-Thermomediterranean, dry pluviseasonal Inframediterranean (without t.w.c.), and lower-dry pluviseasonal Thermomediterranean (without t.w.c.) climatophilous series of juniper (*Juniperus turbinata subsp. canariensis*) on Gomera: *Brachypodio arbusculae-Junipero canariensis* sigmetum.

Apart from *Juniperus turbinata subsp. canariensis* (“sabina”), the most characteristic species among others are: *Olea cerasiformis* (“acebuche”), *Pistacia atlantica* (“almácigo”), *Rubia fruticosa*, *Euphorbia berthelotii*, *Kleinia nerifolia*, *Jasminum odoratissimum* (“jazmín silvestre”), *Asparagus umbellatus* (“esparraguera”), *Rhamnus crenulata* (“espinero”) and *Brachypodium arbuscula* (“cebadilla”).

A facies of *Periplora laevigata* can be distinguished on slope debris in the Hermigua Valley and a *Plocama pendula* facies develops over myocene pyroclasts in several places on the island.

Besides subass. *typicum*, we recognize the subass. *ericetosum arboreae* Del-Arco, O. Rodríguez, Acebes, García-Gallo, Pérez-de-Paz, J.M. González, R. González & V. Garzón subass. *nov. hoc loco* (Table 8, holotype rel. no. 7) which grows in contact with the dry evergreen laurel forest. Their differential species are *Erica arbo-rea* (“brezo”), *Myrica faya* (“faya”) and *Visnea mocanera* (“mocán”).

Within its potential area, the most characteristic substitutional scrubs are *Micromerio gome-rensis–Cistetum monspeliensis* (rockrose scrub, “jaral”) and *Euphorbietsm berthelotii*, both widely spread on the island’s S slope, and *Artemisio thusculae–Rumicetum lunariae* in anthropic places. *Rhamno crenulatae–Hypericetum canariensis* (“espinal-granadillal”) is the substitutional scrub found mostly in disturbed places within the potential area of the humid juniper woodland (subass. *ericetosum arboreae*), which shows a notable presence of the Canary endemism *Spar-tocytisus filipes* (“escobonero”).

*Euphorbio berthelotii–Retamatetum rho-drhizoidis* (white broom scrub), a characteristic community growing on dry slope debris, reaches its optimum within the territory of juniper woodland, and can also extend as a substitution favoured by grazing and fires. The Canary Palm (*Phoenix canariensis*) community (*Periploco lae-vigatae–Phoenixetum canariensis* — “palmeral”) (Table 8) has its main potential territory on humid colluvial slopes within this climatophilous area. It reaches its maximum current representation on this island and Gran Canaria. The azonal Canary willow community (*Rubo-Salicetum canariensis* — “sauzal”), which grows at a wide range of altitudes along ravine edges and beds with running water a large part of the year and on dripping rock faces, is also well represented here (Rivas-Martínez et al. 1993, Rodríguez et al. 1986).

In Vallehermoso (Garabato and surroundings), in a small proportion of its climatophilous area, there is an especially low altitude pine woodland community with participation of elements of the juniper woodland (*Cisto gomerae–Pinetum canariensis* subass. *juniperetosum canariensis*) on salic plugs.
The Gomera juniper woodland is today largely an open community, but impoverished as a result of human action. Its biotope was the preferred habitat in which to establish urban nuclei, to grow crops and to graze animals, because of its favourable orographic and climatic conditions. The juniper woodland is nowadays dispersed into several patches on the island, but some important nuclei like those of Hermigua, Agulo, Vallehermoso and Tazo still persist.

**Visnea mocanerae—Arbutetum canariensis** Rivas-Martínez et al. 1993

Common name: Dry evergreen laurel forest.

**Table 8.** Brachypodio arbusculae-Juniperetum canariensis subass. typicum (1–3); subass. ericetosum arboreae subass. nov. (4–7); Periploco laevigatae-Phoenicetum canariensis (8). [Mayteno-Juniperion, Rhamno-Oleeta, Rhamno-Oleetea].

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This is a western Canary association (Table 9), the more thermophilous and resistant to the xeric conditions of the other types of evergreen laurel forest. It grows at the lower levels of areas affected by NE t.w.c., NW sheltered slopes of the cloud area where it reaches its highest altitudes, and the upper part of some southern thermomediterranean slopes influenced by overflowing clouds. It is a dense forest of medium size trees present in all the western Canary Islands.

Its climatophilous area extends over the slopes under the influence of NE trade-winds over the potential area of thermosclerophilous forest (Brachypodio arbusculae-Juniperetum canariensis) and extends to reach the area of dominance of the subhumid ombrotypes, around 800 m a.s.l., where the area of the humid evergreen laurel forest (Lauro novocanariensis–Perseetum indicae) starts. In a small proportion of its climatophilous area above Vallehermoso, a particular community with Canary pine and elements of the dry evergreen laurel forest is found over salic outcrops (Cisto gomerae-Pinetum canariensis subass. juniperetosum canariensis).

Its structure and physiognomy are those of dense xerophilous forest, terminal community of upper-semiarid xeric Thermomediterranean (with t.w.c.), dry pluviseasonal Infra-Thermo-Mesomediterranean (with t.w.c.) and subhumid pluviseasonal Thermomediterranean (with overflowing t.w.c.) of the Canary strawberry tree (Arbutus canariensis) on Gomera: Visneo-mocanerae–Arbuto canariensis sigmetum.

The trees Visnea mocanera, Arbutus canariensis (“madroño”), Apollonias barbujana (“barbusano”), Picconia excelsa (“palo blanco”), Ilex canariensis (“acebino”), Heberdenia excelsa (“adermo”), Myrica faya, and Erica arborea are common in the association. The shrubs Hypericum canariense (“granadillo”), Jasminum odo-ratissimum (“jazmín”), Daphne gnidium (“trovisca”), and Spartocytisus filipes, among others, are frequent at forest edges and in sustitutional scrubs.

Nowadays the association is found fragmented over steep areas like ravine cornices and high ledges in the middle part of the N, mainly in the Hermigua and Vallehermoso basins. Common in the lower two thirds of the potential area of the association is the substitutional scrub Rhamno-Hypericetum canariensis, and in the upper third, Myrico fayae–Ericetum arboreae (“fayal-brezal”). The nitrophilous scrub Artemisio thusculae-Rumicetum lunariae is also widespread.

Lauro novocanariensis–Perseetum indicae Oberdorfer ex Rivas-Martínez et al. 1977, corr. Rivas-Martínez et al. 2002

Common name: Humid evergreen laurel forest.

A western Canary association (Table 9) of Thermo- and Mesomediterranean belts affected by t.w.c. It is a tall, dense, floristically diverse forest at its optimum. Its climatophilous area is on the northern slopes under the influence of NE t.w.c., from 800 m a.s.l., above the potential area of Visneo-Arbutetum canariensis to about 1250 m a.s.l., where it reaches the climatophilous area of cold evergreen laurel forest (Violo rivinianae-Myricetum fayae).

Its structure and physiognomy correspond to mesophytic forest, terminal community of the subhumid pluviseasonal Thermo- and Mesomediterranean with t.w.c., climatophilous series of “viñátigo” (Persea indica): Lauro novocanariensis-Perseo indicae sigmetum.

The most common laurifolious trees making up the forest matrix are Laurus novocanariensis (“laurel”), Ilex canariensis, and Myrica faya. Persea indica (“viñátigo”), although present, is more common in edaphohygrophilous positions; Picconia excelsa, is mostly present at low altitude. Prunus lusitanica subsp. hixa (“hija”), very rare, was recently discovered there as native to the island. Besides these, the needleleaved Erica arborea is common. Among the small trees are Viburnum rigidum (“follao”) and Sambucus pala-mensis (“sauco”) — the latter very rare. Accompanying them are a number of shrubs, lianas, herbs, and ferns.

Two plant communities are common on the ridge crests within the potential area of this association: Ilici canariensis–Ericetum platycodonis at altitudes below 1100 m and is year-round under the influence of clouds; and Micromerio lepidae–Ericetum arboreae above 1100 m a.s.l., which is drier due to the lower frequency of t.w.c.
### Table 9. Visnea mocanerae–Arbutetum canariensis (1 and 2); Lauro novocanariensis–Perseetum indicae (3–5); Diplazio caudati–Ocoteetum foetentis (6 and 7); Rubo-Salicetum canariensis (8 and 9). [Pruno-Lauretea].

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#### Other taxa (relevé): (1) Rhamnus crenulata 2, Pericallis steezti 1, Spartocytisus filipes 1, Hypericum canariense 1, Globularia salicina 1; (2) Bystropogon canariensis 1, Smilax aspera 1, Bystropogon organifolius 1, Aeonium subplanum 1, Micromeris varia 1, Andryala pinnaflosa 1; (3) Vandenboschia speciosa 1, Tradescantia iluminensis 1; (4) Ixanthus viscosus II, Heberdenia excelsa I, Parietaria debilis I; (5) Davallia canariensis I, Polypodium maca-ronesicum I, Pericallis cf. tussilaginis I, Gennaria diphylla I; (6) Woodwardia radicans 2, Hedera canariensis 1, Cystopteris grex diaphana 1, Iris cf. foetidissima I; (7) Carex canariensis 1; (8) Juncus effusus III, Adiantum capillus-veneris III, Polygonum salicifolium II, Apium nodiflorum II, Pericallis cruenta I, Mentha longifolia I, Epilobium parviflorum I, Scirpus holoschoenus I, Mentha spicata I, Nasturtium officinale I, Samolus valerandi I, Commelina diffusa I, Equisetum ramosissimum I, Equisetum arvense I.

#### Localities and sources

at those altitudes in summer. Also, in ravine beds and on very humid slopes year-round, there are remnants of the typical edaphohygrophilous broad-leaved evergreen community *Diplazio caudati-Ocoteetum foentensis* within the potential territory of *Lauro-Perseetum indicae*.

Although in the past this community was damaged by felling trees for human use, Gomera hosts the Canaries’ best remnants of Tertiary Mediterranean evergreen laurel forest (Fernández López 1992, Fernández López & Moreno 2004, Santos 1990). Nowadays *Lauro novocanariensis–Perseetum indicae* shows an excellent state of conservation since the vast majority of its potential territory belongs to the Garajonay National Park, created in 1981 and a UNESCO World Heritage site since 1986 (Del Arco et al. 2009, Pérez-de-Paz et al. 1990, Romero Manrique 1987). In marginal locations within the park, the most common substitutional scrub is *Myrico fayae–Ericetum arboreae*, mainly as a consequence of past felling and later exploitation of the new growth for charcoal production, and as a source of vineyard stakes and poles for horticultural use. The *Adenocarpus foliolosus* scrub is also important, especially in the southern cloud overflow area of the summit, common in a repeatedly burnt territory in mixed patches together with *Micromerio gomerensis–Cistetum monspeliensis*. The *Teline stenopetala* subsp. *microphylla* (“jirdana”) community (*Telino-Adenocarpion*), found as a mantle of broom shrubland at the fringes of the forest, is also noteworthy. Bramble patches of *Rubus ulmifolius* (“zarzal”) (*Rubo-Rubion*), bracken areas of *Pteridium aquilinum*, hemicyryptophytic meadows of *Piptathero miliacei-Foeniculetum vulgaris* (“hinojal”) and nitrophilous meadows of *Echium-Galactition* are often signs of human disturbance.

The association (Table 10) caps the island. It is a dense, mid-height forest (10–5 m) whose climatophilous area starts at 1250–1300 m a.s.l., which is above humid evergreen laurel forest (*Lauro-Perseetum indicae*) on the N slopes, and above pine woodland (*Cisto gomerae–Pinetum canariensis*) on the dry S slope.

Its structure and physiognomy correspond to mesophytic forest, terminal community of the subhumid pluviseasonal Mesomediterranean (with t.w.c., except in summer), climatophilous series of “faya” (*Myrica faya*): *Violo rivinianae–Myrico fayae sigmetum*.

At its optimum the community is dominated by *Myrica faya*, accompanied by the most cold-tolerant species of the evergreen laurel forest: *Ilex canariensis* and *Erica arborea*, along with some *Laurus novocanariensis* mainly at low altitude.

The altitudinal transition from *Lauro-Perseetum indicae* is driven by the predominant absence of clouds in summer at the altitudes where the community grows, which involves an increase in solar radiation, temperature, and evaporation, causing an increase in continentality index (Ic) values to > 12.

The community, although transformed over the years, is in a relatively acceptable state of conservation in the northern half of its climatophilous area, where it shares the territory with the Canary tree-heath crest community (*Micromerio lepidae–Ericetum arboreae*, Table 10). But its southern area has been much more transformed by human use, and the substitutional scrubs *Myrico-Ericetum arboreae* and *Micromerio gomerensis–Cistetum monspeliensis* fill the territory, together with some *Pinus canariensis* and *Pinus radiata* plantation patches, which are today being eradicated.

### Violo rivinianae–Myricetum fayae

Fernández Galván ex Del-Arco, O. Rodríguez, Acebes, García-Gallo, Pérez-de-Paz, J.M. González, R. González & V. Garzón ass. nov. hoc loco

[Holotype: Table 10, rel. no. 6]

Common name: Cold evergreen laurel forest.

### Cisto gomerae–Pinetum canariensis

Del-Arco, O. Rodríguez, Acebes, García-Gallo, Pérez-de-Paz, J.M. González, R. González & V. Garzón ass. nov. hoc loco

[Holotype: Table 11, rel. no. 2]

Common name: Gomera pine woodland.

This is an association endemic to the island.
Table 10. Violo riviniana–Myricetum fayae ass. nov. (1–6); Micromerio lepidae–Ericetum arboreae (7); Ilici canariensis–Ericetum platycodonis (8–10). [Ixantho-Laurion, Pruno-Lauretalia, Pruno-Lauretea].

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</tbody>
</table>

**Character taxa**

- *Myrica faya*
- *Urtica morifolia*
- *Rubia peregrina subsp. agostinhoi*
- *Viola riviniana*
- *Erica arborea*
- *Micromeria lepida subsp. lepida*
- *Woodwardia radicans*
- *Luzula canariensis*
- *Erica platycodon*
- *Illex perado subsp. platyphylla*
- *Ixanthus viscousus*
- *Heberdenia excelsa*
- *Laurus novocanariensis*
- *Asplenium scindersum* • • • • • • II 2 1 1
- *Dryopteris oligodontia* + • + + I 1 1 2 2
- *Polystichum setiferum* • • • • • • IV 4 1 1
- *Davallia canariensis* + • • • • • • I 1 1
- *Brachypodium sylvaticum* + • • 1 + IV 3 1
- *Erica platycodon* • 4 4 3 3 3 V 3 1
- *Ilex canariensis* • + • • 1 • 1 1 1
- *Brachypodium sylvaticum* + • • • • • • III 1 1
- *Pteridium aquilinum* + • • • • • • IV 1 2 1
- *Phyllis nobla* • • • • • • I 3 1 2
- *Asplenium onopteris* 1 • 1 + 2 1 V 4 2 2
- *Ilex canariensis* + • • • • • • IV 4 1 1
- *Pteridium aquilinum* 1 2 • • • • IV 4 1 1
- *Davalla canariensis* • • • • • • I 3 1
- *Ocotea foetens* • • • • • • I 3 1
- *Blechnum spicant* 1 2 • • • • IV 1 1
- *Dryopteris oligodontia* + • • • • • • IV 1 1

**Companion taxa**

- *Ageratina adenophora* • + • 1 • 1 II • +
- *Myosotis latifolia* + 1 • • • • V • •
- *Achryson laxum* • • • • • • II 1 1
- *Cryptotaenia elegans* • • • • • • II 1 1
- *Adenocarpus foliolosus* • • • • • • II 1 1
- *Pericallis steezii* • • • • • • II • •
- *Sonchus ortunoi* • • • • • • I • •


Tabla 11. Cisto gomerae-Pinetum canariensis ass. nov.; subass. typicum (1–3); subass. juniperetosum canariensis subass. nov. (4–7). [Cisto-Pinion, Chamaecytiso-Pinetalia, Chamaecytiso-Pinetea].

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<td>SW</td>
<td>SW</td>
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<td>SW</td>
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<td>19</td>
<td>19</td>
<td>14</td>
<td>19</td>
<td>16</td>
</tr>
</tbody>
</table>

**Character taxa**

- Pinus canariensis
- Bystropogon origanifolius var. origanifolius
- Chamaecytisus proliferus subsp. angustifolius
- Cistus chinamadensis subsp. gomerae
- Erica arborea
- Juniperus turbinata subsp. canariensis
- Brachypodium arbuscula
- Illex canariensis
- Spartocytisus filipes
- Hypericum canariense
- Myrica faya
- Visnea mocanera

**Differential taxa of subass. juniperetosum canariensis**

- Erica arborea
- Juniperus turbinata subsp. canariensis
- Brachypodium arbuscula
- Illex canariensis
- Spartocytisus filipes
- Hypericum canariense
- Myrica faya
- Visnea mocanera

**Companion taxa**

- Cistus monspeliensis
- Opuntia maxima
- Kleinia neriifolia
- Dicrananthus plocamoides
- Aeonium castello-paivae
- Davallia canariensis
- Asphodelus ramosus subsp. distalis
- Euphorbia berthelotii
- Argyranthemum callichrysum
- Paronychia canariensis
- Atlantus pinnatus
- Leonurus rubrolineatus
- Hypericum reflexum
- Tolpis proustii
- Carlina salicifolia
- Micromeria varia subsp. varia
- Bituminaria bituminosa
- Sonchus hierrensis
- Agave americana
- Romulea columnae
- Todaroa aurea subsp. suaveolens
- Echium aculeatum
- Phoenix canariensis

**Other taxa** (relevé): (1) Cheilanthes pulchella 2, Greenovia aura 1, Micromeria lepida +, Lavandula canariensis +, Lobularia canariensis subsp. intermedia +, Vicia cf. disperma +; (2) Silene bourgeaui +, Sonchus ortunoi 1; (3) Sideritis lotsyi +; (4) Spartocytisus filipes 2, Teline stenopetala subsp. microphylla 1, Hyparrhenia sinaica 1, Globularia salicina +; (5) Adenocarpus foliolosus +, Andryala pinnatifida +; (7) Artemisia thuscula 1.

**Localities:** 1 = Roque de los Pinos de Imada (Alajeró) (Del-Arco et al. 1990: rel. 4, p. 38), 2 (holotype) and 3 = iibid. 4.XII.2007; 4 = Risco Blanco, Vallehermoso (4.XII.2007), 5 (holotype), 6 and 7 = El Andén, Barranco del Garabato (Vallehermoso), 11.XII.1987 (Del-Arco et al. 1990: table I, p. 35).
(Table 11) whose climatophilous area extends along a narrow southern strip lying between 1000–1200 (1250) m a.s.l., which is between the potential area of juniper woodland (Brachypodio–Juniperetum canariensis) and the summit evergreen laurel forest (Ixantho-Laurion novo-canariensis).

Its structure and physiognomy correspond to open woodland, the terminal community of dry and subhumid pluviseasonal Mesomediterranean (without t.w.c.) climatophilous series of Pinus canariensis on Gomera: Cisto gomerae–Pino canariensis sigmetum.

The most representative taxa apart from Pinus canariensis are: Bystropogon origanifolius var. origanifolius (“poleo”), Chamaecytisus proliferus subsp. angustifolius (“escobón”), and Cistus chinamadensis subsp. gomerae (“jara blanca”) (Demoly et al. 2006).

The only representative stand of the subassociation typicum is to be found in Imada (Del-Arco et al. 1990); although located on a salic substratum it is within a typical bioclimatic belt of climatophilous pine woodland (dry pluviseasonal lower Mesomediterranean). There are some xeric elements present, such as Kleinia neriifolia, Euphorbia berthelotii, Echium aculeatum (“tajinaste”), and Cistus monspeliensis (“jara”). These xero-thermophilous plants are differentials of thermophilous pine woodland, which is similar to those of the other Canary Islands low altitude southern pine woodland. Some humid elements like Erica arborea are to be found, due to the influence of nearby southward overflowing t.w.c. Probably in the narrow potential pine-woodland strip, dry and humid pine woodlands would have formed a mosaic depending on the exposure.

The Gomera pine woodland has become almost extinct and only a few remnants persist. The retreat of pine woodland was so strong, and probably occurred so early after the conquest of the island by the Spaniards that many authors have assumed the pre-contact absence of wild pine woodland. However, molecular analysis (Navascués et al. 2006, Vaxevanidou et al. 2006) and archaeological evidence (Navarro 1992, Rosario et al. 2002) support the existence of autochthonous Pinus canariensis on Gomera. Bioclimatic belts suitable for its development, the abundant presence of its substitutional and mantle community Adenocarpo foliolosi–Chamae cytisetum angustifolii, and old isolated individuals linked to salic outcrops and fragmentary little stands all support our thesis of accepting the potentiality of pine woodland on the island.

**Cisto gomerae-Pinetum canariensis**

**subass. juniperetosum canariensis**

Del-Arco, O. Rodríguez, Acebes, García-Gallo, Pérez-de-Paz, J.M. González, R. González & V. Garzón subass. nov. hoc loco

[Holotype: Table 11, rel. no. 5].

Common name: Gomera salic pine woodland.

This is an edaphophilous subassociation endemic to Gomera (Table 11) which potentially develops on salic outcrops of the Thermo- and Mesomediterranean belts within the general climatophilous area of juniper woodland (Brachypodio-Juniperetum canariensis) and evergreen laurel forest (Pruno-Lauretalia novocanariensis).

Its structure and physiognomy correspond to a mixed pine woodland, the terminal community of upper-semiarid xeric Thermomediterranean (without t.w.c.), lower-dry pluviseasonal Thermomediterranean (without t.w.c.), and upper-semiarid to subhumid Thermo- and Mesomediterranean (with t.w.c.) salic edaphophilous sub-series: Cisto gomerae–Pino canariensis faciation of Juniperus turbinata subsp. canariensis.

Its differential taxa are: Brachypodium arbuscula, Erica arborea, Hypericum canariense, Ilex canariensis, Juniperus turbinata subsp. canariensis, Myrica faya, Spartocytisus filipes, and Visnea mocanera.

Although there are many salic outcrops in the potential area (Rodríguez-Losada & Martínez-Frías 2004), only some support isolated pines or pine stands. For instance, on the the central salic rocks of the island (Agando, Ojila and La Zarzita), characteristic plants of pine woodland are present like Cistus chinamadensis subsp. gomerae and Chamae cytisus proli-
ferus subsp. angustifolius, but Pinus canariensis itself is only found at Agando. The community, although favoured by reforestation, nowadays has its best and only representation on crags at the northern locality of Garabato (Vallehermoso) (Del-Arco et al. 1990) at 300–500 (750) m a.s.l., within the general climatophilous area of humid juniper woodland (Brachypodio-Juniperetum canariensis subass. ericetosum arboresae) and dry evergreen laurel forest (Visneo-Arbutetum canariensis). In our map of potential natural vegetation (Fig. 11), we only show the community at Garabato, despite its possibly extending to other salic outcrops.

Other communities

We describe below some new communities mentioned in the text. The first two are the terminal communities of two edaphophilous series shown in the potential vegetation map, the others are serial or mantle communities.

**Euphorbietum aphyllae** (Rivas-Martínez et al. 1993) Del-Arco, O. Rodríguez, Acebes, García-Gallo, Pérez-de-Paz, J.M. González, R. González & V. Garzón stat. nov.

[Art. 27d; Weber et al. 2000].


Common name: Leafless spurge scrub.

This is a chamaephytic and low nanophanerophytic association endemic to Gomera (Table 6), characterized by *Euphorbia aphylla* (“tolda”). It grows on cliffs and rocky outcrops on the island’s N slope, under the steady influence of the prevailing NE trade-wind. It is an edaphophilous community in the climatophilous territory of *Euphorbio berthelotii–canariensis* sigmetum.

It corresponds to the terminal community of the semiarid xeric Infra-Thermomediterranean and dry pluviseasonal Infra-Thermomediterranean (without t.w.c.) edaphoxerophilous colluvial series of white broom (*Retama rhodorhizoides*) on Gomera: *Euphorbio berthelotii–Retamo rhodorhizoidis sigmetum*.

The association is physiognomically characterized by *Retama rhodorhizoides* (“retama blanca”), accompanied by widespread species from the more hotter belts of the island, like *Echium aculeatum*, *Euphorbia berthelotii*, *Kleinia neriifolia*, *Micromeria varia* subsp. *varia* (“tomillo”), *Neocharmaelea pulvurulenta* and *Rubia fruticosa*, among others.

The community is spread particularly over the NW sector of the island (Arguamul-Alojera-Taguluche), and is more localised in the W (Valle Gran Rey), N (Hermigua Valley) and S (Santiago Valley). Its expansion in the NW is largely anthropic, mainly due to fires and grazing.
**Micromerio gomerensis–Cistetum monspeliensis** Del-Arco, O. Rodríguez, Acebes, García-Gallo, Pérez-de-Paz, J.M. González, R. González & V. Garzón ass. nov. *hoc loco*

[Holotype: Table 13, rel. no. 2].

Common name: Gomera rockrose scrub.

This is a scarcely or non-nitrophilous chamaephytic-nanophanerophytic association endemic to Gomera (Table 13), that grows on eroded stony or decapitated soils, mainly within the climatophilous area of juniper woodland (*Brachypodium-Juniperetum canariensis*) and pine woodland (*Cisto gomerae-Pinetum canariensis*), although it can also be found in the upper level of cardón

### Table 12. Euphorbia berthelotii-Retamatetum rhodorrhizoidis ass. nov. [Mayteno-Juniperion, Rhamno Oleetalia, Rhamno-Oleetea].

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<td>W</td>
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<td>SE</td>
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<td>18</td>
<td>23</td>
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<td>22</td>
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</table>

#### Character taxa

- *Retama rhodorrhizoides*
- *Kleinia nerifolia*
- *Euphorbia berthelotii*
- *Neoclimacaeae pulvulenta*
- *Micromeria varia subsp. varia*
- *Rubia fruticosa*
- *Echium aculeatum*
- *Perploca laevigata*
- *Juniperus turbinata subsp. canariensis*
- *Micromeria gomerensis* subsp. canariensis
- *Euphorbia balsamifera*

#### Companion taxa

- *Bituminaria bituminosa*
- *Artemisia thyscula*
- *Hyparrhenia sinaica*
- *Phagnalon saxatile*
- *Launaea arborescens*
- *Plocama pendula*
- *Schizogyne sericea*
- *Argyranthemum frutescens*
- *Romex lunaria*
- *Lobularia canariensis*
- *Aeonium holochrysum*
- *Opuntia ficus-indica*
- *Aeonium castello-paivae*
- *Lavandula canariensis*
- *Phagnalon rupestr*
- *Ajuga iva*
- *Aristida adscensionis*
- *Ferula linkii*
- *Todaroa aurea*


#### Localities (24.I.2003): 1 = Between Tazo and Arguamul (serial); 2 = Above Ermita de Santa Lucía, Tazo (serial); 3 = Tazo. 4 = Between Tazo and Alojera; 5 = Surroundings of Lomo del Balo, above Alojera; 6 = Between Risco de Alojera and Cabeza del Buey (holotype); 7 = El Palmarejo (Valle Gran Rey).
It is mainly characterized by Micromeria varia subsp. gomerensis ("tomillo"), Cistus monspeliensis and some widespread species of Kleinio-Euphorbietae canariensis such as Euphorbia berthelotii, and Echium aculeatum.

The subass. adenocarpetosum foliolosi Del-Arco, O. Rodríguez, Acebes, García-Gallo, Pérez-de-Paz, J.M. González, R. González & V. Garzón subass. nov. hoc loco (Table 13, holotype rel. no. 10) grows in the coldest area of the association, which corresponds to potential territories of evergreen laurel forest and pine woodland. Its differential species are Adenocarpus foliolosus ("codeso de monte") and Chamaecytisus proliferus subsp. angustifolius.

Table 13. Micromerio gomerensis–Cistetum monspeliensis ass. nov.; subass. typicum (1–5); subass. adenocarpetosum foliolosi subass. nov. (6–12). [Micromerio-Cistion, Micromerio-Cistetalia, Rhamno-Oleetea].

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<td>10</td>
<td>2</td>
<td>6</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

**Characteristic taxa**
- Cistus monspeliensis
- Euphorbia berthelotii
- Micromeria varia subsp. gomerensis
- Micromeria varia subsp. varia
- Echium aculeatum

**Differential taxa**
- Chamaecytisus proliferus ssp. angustifolius
- Adenocarpus foliolosus

**Companion taxa**
- Dittrichia viscosa
- Phagnalon saxatile
- Erica arborea
- Pericallis stetzi
- Asphodelus ramosus subsp. distalis
- Bituminaria bituminosa
- Lobularia canariensis

**Other taxa** (relevé): (1) Paronychia canariensis +; (2) Kleinia nerifolia +; (3) Hyparrhenia sinaica 1, Rubia fruticosa +; (5) Vicia disperma 1; (6) Myrica faya +; (8) Sonchus ortuno 1, Agave americana +, Phoenix canariensis +; (9) Sideritis lotsyi 1; (11) Descurainia millefolia 1, Artemisia thuscula +; (12) Ageratina adenophora +.


scrub (Euphorbio berthelotii-canariensis) and even within the potential territory of evergreen laurel forest (Pruno-Lauretalia). It is more abundant in the S sector of the island.
**Adenocarpo foliolosi–Chamaecytisetum angustifolii** Del-Arco, O. Rodríguez, Acebes, García-Gallo, Pérez-de-Paz, J.M. González, R. González & V. Garzón ass. nov. hoc loco

[Table 14, Holotype rel. no. 5].

Common name: “escobón” shrubland.

This is a nano-microphanerophytic community (Table 14) with a preference for ledges, cornices and rocky biotopes in the dry-subhumid Thermo-Mesomediterranean belts of the S sector of the island, within the potential territory of pine woodland and cold evergreen laurel forest.

It is floristically characterized by *Chamaecytisus proliferus* subsp. *angustifolius* (usually dominant), *Adenocarpus foliolosus*, and to a small extent by *Sideritis lotsyi* (“tajora”) and *Bystropogon origanifolius*. Apart from these, some dynamic plants belonging to *Cisto-Micromerietalia* and *Pruno-Lauretalia* are frequent by present.

Its expansion as a substitutional community in this S sector has probably been favoured by deforestation and fires, extending its area to the upper territories of juniper woodland and also to high territories of humid evergreen laurel forest on the central plateau of the island, and those of dry evergreen laurel forest in overflowing cloud areas. Today the community is also widely spread over abandoned agricultural areas.

**Acknowledgements**

We thank the “Centro Meteorológico Zonal de Santa Cruz de Tenerife” of the “Instituto Nacional de Meteorología” for providing us the basic climatic data. This paper has been supported by the project “Cartography of the Vegetation of the Canary Islands”, sponsored by “GRAFCAN S.A.” and

**Table 14.** *Adenocarpo foliolosi–Chamaecytisetum angustifolii* ass. nov. [*Cisto-Pinion, Chamaecytiso-Pinetalia, Chamaecytiso-Pinetea*].

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<th>5</th>
<th>6</th>
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<td>SW</td>
<td>SW</td>
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<td>100</td>
<td>100</td>
<td>90</td>
<td>90</td>
<td>100</td>
<td>90</td>
<td>95</td>
</tr>
<tr>
<td>Number of taxa</td>
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<td>7</td>
<td>9</td>
<td>10</td>
<td>12</td>
<td>6</td>
<td>6</td>
<td>4</td>
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</table>

**Character taxa**

*Chamaecytisus proliferus*

subsp. *angustifolius*

4 4 5 4 3 4 5 5

*Adenocarpus foliolosus*

1 • 1 2 3 2 • •

*Sideritis lotsyi*

• + 1 2 3 • • •

*Bystropogon origanifolius*

4 3 1 • • • • •

**Companion taxa**

*Cistus monspeliensis*

4 + 2 1 1 + 1 1

*Erica arborea*

1 • 1 3 • 1 1 +

*Pericallis steetzi*

• • • 1 • • 2 •

*Micropermia lepida*

• • • • 1 • 1 •

*Pteridium aquilinum*

• • • 1 + • • •

*Myrica faya*

• • • • 1 • •

*Plantago arborescens*

• • • • + • •


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**References**


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