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Bioclimatology and climatophilous vegetation of Gran Canaria (Canary Islands)

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The bioclimates, ombrotypes, thermotypes, bioclimatic belts, climatophilous vegetation seres and potential natural vegetation of Gran Canaria were established and mapped. Due to salic substrates in the SW of the island, the potential natural vegetation map shows significant differences from the climatophilous seres map. Phytosociological tables of the terminal communities of each climatophilous sere are shown. The new association *Pistacio lentisci–Oleetum cerasiformis* is described.

Keywords: phytosociology, symphytosociology, syntaxonomy, vegetation maps, vegetation seres

Introduction

Bioclimatological studies allow a better understanding of the physical environment and its relation to plant communities. Lately, bioclimatology has made great progress and given rise to numerous publications. Applying the criteria of Rivas-Martínez (1995, 1997), we undertook a study of the Canary Islands and some surrounding areas, producing papers on Tenerife, Hierro, La Palma and Lanzarote (Rivas-Martínez *et al.* 1993a, Del-Arco *et al.* 1996, 1999a, Reyes-Betancort *et al.* 2001). A contribution on Fuerteventura (Rodríguez *et al.* 2002) is forthcoming. This paper presents a similar study for Gran Canaria.

The overall phytosociological study of the vegetation of Gran Canaria was partially approached by Sunding (1972). The present paper, following the lines of our previous contributions, attempts to fulfill the need for a general study incorporating bioclimatic aspects.

Material and methods

This study was performed according to the bioclimatic criteria of Rivas-Martínez (1995, 1997),

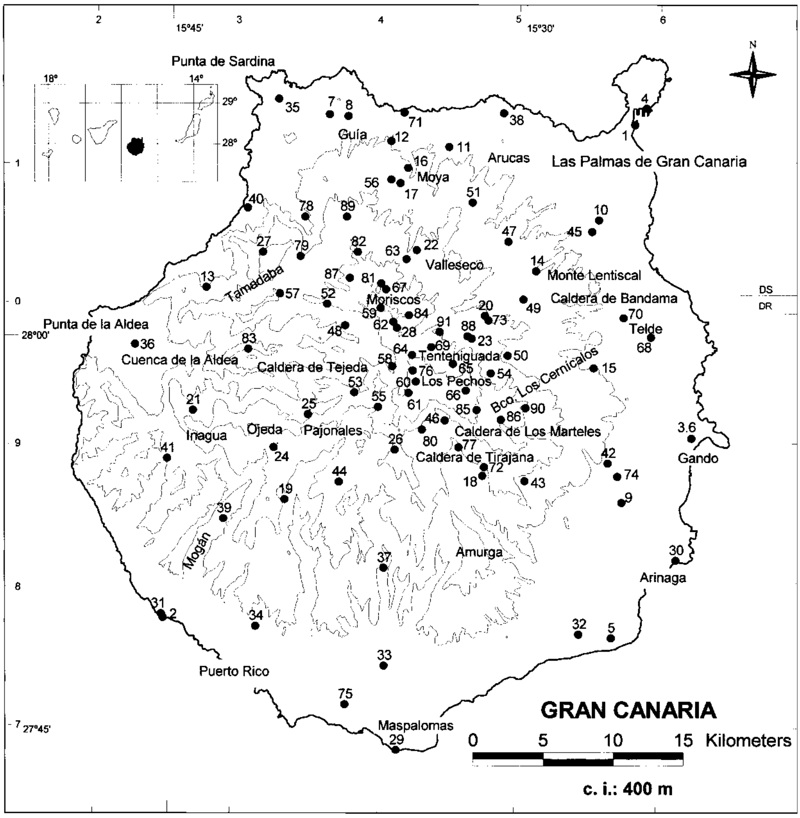


Fig. 1. Toponymic map and location of meteorological stations on Gran Canaria. Numbers refer to those of Table 1 and 2.

with data from 28 thermopluviometric and 73 pluviometric meteorological stations which constitute the most complete official register for the island (Fig. 1 and Tables 1–4). Thermopluviometric diagrams were drawn for some stations selected as most representative of the different bioclimatic situations (Fig. 2).

According to the World Bioclimatic Classification System (Rivas-Martínez 1995) the Canary Islands fit within the Mediterranean macrobioclimate, which is an extratropical macrobioclime characterised by aridity ($P < 2T$) at least two months after the summer solstice, among other features. Only three of the seven bioclimates within the Mediterranean macrobioclimate can be recognised in the Canary Islands: oceanic-desertic, oceanic-xeric and oceanic-pluviseasonal. To define them, Ci (continentality index), Oi (ombrothermic index) and $P > 2T$ ratio are used. This classification provides a basis for establishing the bioclimatic belts of any territory by using a combination of thermotype, bioclimate and ombrotype. Thermotypes constitute thermic spaces within an CTi (compensated thermal index) gradient. Ombrotypes constitute ombric spaces within an Oi gradient. Bioclimatic belts are defined as the successive types or groups of physical media along an altitudinal or latitudinal clisere. They are not the same as vegetation belts, which are the plant community complexes or vegetation seres along an altitudinal cliseries.

In addition to the combination of thermotype, bioclimate and ombrotype used in the bioclimatic belt formula we include the presence or absence of clouds (Del-Arco *et al.* 1999a) to refine the characterisation of bioclimatic belts. This allows apparently similar belts on north facing slopes under the influence of trade-wind clouds to be differentiated from those on dry south facing slopes.

A few simple indices are used to establish thermotypes, bioclimates and ombrotypes. CTi, used to establish thermotypes, is defined as

Table 1. Climatic and bioclimatic data from the 28 thermopluviometric stations studied (Gran Canaria). T = Mean annual temperature in °C; T_{max} = Mean maximum temperature of the coldest month; T_{min} = Mean minimum temperature of the coldest month; Ti = Thermal index; Ci = Continentality index; CTi = Compensated thermal index; Tp = Positive temperature; Tv = Summer temperature; P = Annual rainfall in mm; Pv = Summer rainfall; $P > 4T$ = Months in which the rainfall value (in mm) is greater than four times the temperature value (in °C); $4T > P > 2T$ = Months in which the rainfall value is between twice and four times the temperature value; $2T > P > T$ = Months in which the rainfall value is greater than the temperature value, but smaller than two times this value; $P < T$ = Months in which the rainfall value is smaller than the temperature value; Oi = Ombrothermic index; Ovi = Summer ombrothermic index; T–P = Recording period of T and P (years). * Anomalous figure according to data of stations 42 and 74.

No.	Thermopluviometric stations	Height	T	T_{max}	T_{min}	Ti	Ci	CTi	Tp	Tv	P	Pv	$P > 4T$	$4T > P > 2T$	$2T > P > T$	$P < T$	Oi	Ovi	T–P	B.B.[1]
1	Las Palmas de G.C-La Luz	6	21	20.8	15.6	574	5.7	541	2520	713	145	10	0	0	2	10	0.58	0.14	40–40	2
2	Mogán-Puerto de Mogán	10	20.9	21.8	14.4	571	6.3	544	2508	719									3–0	
3	Telde-Gando	10	20	20.1	13.6	537	6.8	515	2400	720	171	15	0	0	4	8	0.71	0.21	30–30	2
4	Las Palmas de G.C.- J.O.P.	15	21	20.1	16.3	574	6.1	545	2520	711	110.7	5.37	0	0	2	10	0.44	0.08	27–10	2
5	S.B. Tirajana-El Matorral	15	20.6	20.9	14	555	7.3	538	2472	733									2–2	
6	Telde-Aeropuerto de Gran Canaria	24	20.8	20.7	14.7	562	6.6	538	2496	721	146	15.2	0	0	4	8	0.58	0.21	18–16	2
7	Gáldar-Casco	110	19.6	19.9	13.6	531	5.9	500	2352	671	222.7	8.8	0	3	3	6	0.95	0.13	33–33	3
8	Guía-Instituto	190	19.5	19.2	13.9	526	6.6	502	2340	667	195	12.5	0	0	4	8	0.83	0.19	10–6	2
9	Agüímes	265	18.4	18.5	11.1	480	7.8	468	2208	666	288.3*								13–15	
10	Las Palmas de G.C.-Tafira CMT	269	18.6	18.4	12.7	497	6.2	469	2232	643									4–2	
11	Firgas-Itara	280	18.6	19.1	12	497	6.6	473	2232	653									5–3	
12	Guía-Tres Palmas	310	18.4	19.1	12.6	501	5.5	466	2208	626	289.9	9.1	0	3	3	6	1.31	0.15	10–22	3
13	Agaete-Suerte Alta	360	19.1	18.9	12.1	500	8.4	494	2292	691									4–5	
14	Santa Brígida-El Tejar	390	19.2	19.6	11.8	506	7.9	495	2304	698	391.5	22.5	2	4	1	5	1.70	0.32	12–12	4
15	Telde-Centro Forestal Doramas	400	19.2	18.3	12	495	8.6	491	2304	689									2–2	
16	Moya-Casco	485	17.9	18.4	9.9	462	8.3	455	2148	640	449.9	36.5	3	3	1	5	2.09	0.57	12–21	5
17	Moya-Los Tilos	525	16.6	16.7	8.4	417	7.5	402	1992	591									1–2	
18	Santa Lucía-El Casco	690	19.4	18.6	10.1	481	12	481	2328	748									2–1	
19	Mogán-Barranquillo Andrés	715	18.8	17.7	10.9	474	10.3	474	2256	706	282.8	4.8	1	4	1	6	1.25	0.07	1–29	3
20	San Mateo-Colegio	835	15.3	15.1	7.2	376	9.8	376	1836	604									5–5	
21	Mogán-Inagua	940	17.8	15.6	10.1	435	13.5	435	2136	742	317.3	8.4	2	2	3	5	1.49	0.11	19–27	7
22	Valleseco-Casco	980	14.4	14.4	5.9	347	10.2	347	1728	589	736.6	36.5	6	1	2	3	4.26	0.62	28–33	15
23	San Mateo- La Lechucilla	980	15.1	13.3	7.8	362	11.1	362	1812	608									4–2	
24	Tejeda-Vivero de Ñameritas	1040	14	14.4	5	334	12.8	334	1680	640	374.3	8.1	5	0	2	5	2.23	0.13	12–31	14
25	Tejeda-Pinar de Pajonales	1190	16.4	14.9	7.6	389	12.9	389	1968	686	455.1	6	5	1	1	5	2.31	0.09	15–20	9(s)
26	S.B. Tirajana-Cuevas del Pinar	1240	16.4	14.8	7.4	386	13.1	386	1968	693	473.7	7.2	5	1	1	5	2.41	0.10	12–25	9(s)
27	Agaete-Pinar de Tamadaba	1255	15.6	13.8	7.1	365	13.3	365	1872	664	606.4	30	5	2	2	3	3.24	0.45	16–20	11(s)
28	Tejeda-Cruz de Tejeda	1514	14	10.9	6.1	310	13.6	310	1680	616									5–5	

[1] Bioclimatic belt according to Table 5. (s) = Potential natural vegetation differing of climatophilous vegetation because of salic nature of rocks. Source: National Meteorological Institute, except: 1 and 3 (Rivas-Martínez, 1996); 7, 9, 12, 16 and 21 (De-León *et al.*, 1991; Alt. station no. 9 corrected). Pluviometric data of stations with less than 5 years of recording are not considered. In order to arrive at reliable conclusions, pluviometric data are taken from the nearest stations with widest recording period. The table below shows the correlation between TP stations and P stations.

TP station No.	P station No.	TP station No.	P station No.	TP station No.	P station No.	TP station No.	P station No.
2	31	11	12	17	56	23	73
5	32	13	78	18	72	28	62
10	45	15	47	20	73		

Table 2. Rainfall stations (Gran Canaria).

No.	Location	Height m a.s.l.	Rainfall mm	Recording period	Gradient. Thermopluviometric reference stations	Estimated mean annual temperature °C	Tp	Estimated Oi
29	Maspalomas-Faro	12	68.06	55–90 (35)	2–9	20.9	2508	0.27
30	Arinaga-Faro	13	75.75	51–90 (39)	3–9	20.0	2400	0.32
31	Mogán-Playa	5	89.51	50–90 (40)	2–19	20.9	2508	0.36
32	Juan Grande	42	92.78	71–90 (19)	5–9	20.3	2436	0.38
33	Ayagaure-Data	125	113.78	51–90 (39)	19–26	21.5	2579	0.44
34	Barranco Lechugal	157	119.27	69–90 (21)	2–21	20.5	2460	0.48
35	Sardina del Norte	90	122.99	67–90 (23)	7–12	19.7	2364	0.52
36	San Nicolás	75	156.80	50–90 (40)	2–21	20.7	2484	0.63
37	Ayagaure-Presa	325	168.43	50–90 (40)	19–26	20.6	2472	0.68
38	Trasmontaña	105	175.83	51–90 (39)	4–11	20.2	2424	0.73
39	Mogán-Pueblo	265	189.91	50–90 (40)	2–19	20.0	2400	0.79
40	Guayedra	90	213.39	67–90 (23)	13–27	20.2	2424	0.88
41	Tasarte-Pueblo	400	216.54	50–90 (40)	2–19	19.5	2340	0.93
42	Ingenio-Pueblo	340	207.47	50–90 (40)	9–18	18.2	2184	0.95
43	Temisas	680	301.40	51–90 (39)	9–18	17.4	2088	1.44
44	Chira-Presa	912	288.30	69–90 (21)	19–26	17.9	2148	1.34
45	Tafira-Vivero	337	330.56	50–90 (40)	10–14	18.9	2268	1.45
46	Culata Risco Blanco	985	381.63	63–90 (27)	18–26	17.8	2136	1.79
47	Acebuchal	510	442.90	62–90 (28)	15–23	18.4	2208	2.01
48	Guardaya	830	434.60	51–90 (27)	19–27	18.1	2172	2.00
49	Madroñal	595	502.70	50–90 (40)	14–20	17.4	2088	2.41
50	Tenteniguada	745	528.29	50–90 (49)	15–23	16.8	2016	2.62
51	Palmar-Dña.Pino	545	529.13	67–90 (23)	11–22	17.0	2040	2.59
52	Artenara	1235	498.18	50–90 (40)	27–28	15.5	1860	2.68
53	Cruz del Carpio	1365	494.20	51–90 (30)	25–28	15.1	1812	2.73
54	Rincón-Tenteniguada	1025	485.60	70–90 (20)	15–23	14.8	1776	2.73
55	Ayacata	1305	545.90	50–90 (40)	26–28	15.8	1896	2.88
56	Santa Cristina	645	533.76	52–90 (38)	17–22	16.0	1920	2.78
57	Cruz de María	1270	565.07	53–90 (35)	27–19	15.5	1860	3.04
58	Culata de Tejeda	1195	600.59	50–90 (40)	25–28	16.4	1968	3.05

59	Moriscos	1770	604.37	81–90 (9)	22–28	13.8	1656	3.65
60	Cortijo Huertas	1700	643.25	57–90 (32)	25–28	12.6	1512	4.25
61	Hornos-Presa	1625	702.00	51–90 (39)	26–28	13.0	1560	4.50
62	Cruz de Tejeda	1520	747.50	50–90 (37)	28	14.0	1680	4.45
63	Valsendero	875	800.15	50–90 (40)	17–22	14.9	1788	4.48
64	Mesas de Ana López	1548	764.50	62–90 (28)	20–28	13.9	1668	4.58
65	Hoya del Gamonal	1365	828.45	50–90 (40)	20–28	14.3	1716	4.83
66	Cuevas Blancas	1690	899.67	50–90 (40)	23–28	13.6	1632	5.51
67	Retamilla	1370	987.82	50–90 (40)	20–28	14.3	1716	5.76
68	Telde Narea	135	183.67	50–90 (40)	6–15	20.3	2436	0.75
69	Cueva Grande	1335	829.65	51–90 (39)	20–28	14.3	1716	4.83
70	Higuera Canaria	200	227.41	51–90 (30)	6–15	20.1	2412	0.94
71	San Felipe	16	167.92	51–90 (39)	8–11	21.2	2544	0.66
72	Santa Lucía	715	300.44	50–90 (40)	18–26	19.3	2316	1.30
73	San Mateo	830	551.30	50–90 (39)	20	15.3	1836	3.00
74	Adeje	265	164.31	61–83 (22)	9–18	18.4	2208	0.74
75	Nasa-Espacial	155	95.70	69–90 (21)	5–9	19.4	2324	0.41
76	Mesas-Forestal	1680	889.71	82–90 (8)	20–28	13.7	1644	5.41
77	Taidia	815	341.69	51–90 (39)	19–25	18.3	2196	1.56
78	Berrazales	340	397.15	50–90 (40)	7–13	19.1	2292	1.73
79	Pérez-Presa	850	358.95	55–90 (35)	13–27	17.2	2064	1.74
80	Agua Latente	1145	461.22	76–90 (14)	18–26	16.9	2028	2.27
81	Montañón	1456	777.11	78–90 (12)	22–28	14.0	1680	4.63
82	Cortijo Pavón	1165	664.71	63–90 (27)	22–28	14.3	1716	3.87
83	Parralillo-Presa	360	187.97	65–66 (23)	13	19.1	2292	0.82
84	Radio Atlántico	1595	640.28	77–90 (13)	22–28	13.9	1668	3.84
85	Cortijo Lorian	1480	695.85	69–90 (21)	23–28	14.1	1692	4.11
86	Hoya de la Perra	1425	564.14	50–90 (40)	23–28	14.2	1704	3.31
87	Hoya de Morón	1305	662.44	67–90 (23)	27–28	15.3	1836	3.61
88	Lomo Aljorradero	1075	627.57	50–90 (40)	23–28	14.9	1788	3.51
89	Cortijo La Solapilla	950	618.84	69–90 (21)	17–22	14.5	1740	3.56
90	El Moreno	1120	476.60	67–90 (23)	15–23	14.1	1692	2.82
91	Antona-Gañanías	1110	746.22	50–90 (40)	20–28	14.8	1776	4.20

Table 3. References for constructing the bioclimatic maps (Gran Canaria).

Station reference	Height difference (m)	Oi difference	Height (m) of transition between bioclimates					
			Desertic-Xeric (Oi = 0.9)			Xeric-Pluviseasonal (Oi = 2)		
			Upper height (m) of ombrotype					
			Hyperarid (Oi = 0.3)	Arid (Oi = 0.9)	Lower-Semiarid (Oi = 1.45)	Upper-Semiarid (Oi = 2)	Dry (Oi = 3)	Subhumid (Oi = 5.5)
35-7	20	0.43	80	108				
29-75	143	0.14	42					
29-33	113	0.17	32					
29-32	30	0.11	20					
40-27	1165	2.36		100	371	643	1137	
36-21	865	0.86		346	900			
39-41	135	0.14		371				
41-21	540	0.69		371	807			
39-19	450	0.46		373				
37-44	587	0.66		521				
37-72	390	0.62		463				
30-72	702	0.88		476				
74-42	75	0.21		319				
68-70	65	0.19		186				
45-14	53	0.25		220		453		
38-51	440	1.86		145				
38-12	205	0.58		165				
71-12	294	0.65		124				
8-12	120	0.48		208				
7-78	230	0.78			257			
40-78	250	0.85			257			
83-48	470	1.18			610			
19-24	325	0.98			781	963		
44-26	328	1.07			946	1114		
72-46	270	0.49			797			
72-77	100	0.26			773			
42-90	780	1.87			548	776		
70-50	545	1.68			365	544		
70-47	310	1.07			348	507		
38-45	232	0.95			281			
38-51	440	1.86			275	405		
12-16	175	0.78			341	465		
79-52	385	0.76				956		
79-27	405	1.5				920		
21-24	100	0.61				1002		
46-80	160	0.48				1045		
57-27	15	0.2					1267	
48-58	365	1.05					1178	
53-58	170	0.32					1168	
55-61	320	1.62					1329	
80-86	280	1.04					1342	
90-86	305	0.49					1232	
54-66	665	2.78					1089	
49-73	235	0.57					830	
47-22	470	2.25					717	
51-22	435	1.67					652	
56-63	230	1.7					675	
56-89	305	0.78					731	
87-67	65	2.15						1362
73-76	850	2.42						1712
61-76	55	0.91						1685
65-66	325	0.6						1685
85-66	210	1.38						1689
81-67	595	1.13						1538
63-67	495	1.28						1269

follows: CTi = Ti ± C, given that Ti (thermal index) = $(T + T_{min} + T_{max}) \times 10$, where T = mean annual temperature, and T_{min} and T_{max} are the mean minimum and mean maximum temperature in the coldest month. C is the compensation value: when the continentality index (Ci = difference between mean temperatures of the warmest and coldest months of the year) is less than 9 (oceanic) or more than 18 (continental), a compensation value (C) is subtracted or added to the Ti value to obtain CTi. 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 cold of highly continental territories or the extra winter warmth in highly oceanic ones, so that the resulting compensated thermal index (CTi) is comparable all around the Earth. In the territory studied, only compensations for values of C smaller than 9 were made. This compensation value is obtained from: $C = (9.0 - \text{Ci}) \times 10$. Oi, used to establish bioclimates and ombrotypes, is defined as follows: Oi = (Pp/Tp) × 10, where Pp (positive precipitation, i.e. summarised rainfall in months with mean temperature higher than 0 °C) is the annual rainfall in mm. Since this is always the case on the island, Pp has the same value as P; Tp (positive temperature) is the value in tenths of degrees resulting from the sum of the mean temperatures of the months with a mean higher than 0 °C. The Oi is the index that best fits with the altitudinal limits of the vegetation seres. Further explanation can be found in Rivas-Martínez (1995, 1997) and Del-Arco *et al.* (1996, 1999a).

The bioclimatic maps (Figs. 3–5) were made according to the indices obtained for the meteorological stations, and the threshold values of the indices delimiting thermotype, bioclimate and ombrotype. The curves showing the key values of change in these were then traced from the appropriate gradients on the different slopes. The bioclimatic belt map was made by overlapping the thermotype, bioclimate and ombrotype maps, considering the area influenced by trade-wind clouds. In any subsequent colouring of the maps the criteria of Del-Arco *et al.* (1999b) should preferably be followed.

To study the vegetation, phytosociological relevés were compiled following the Zürich-Montpellier School protocol (Braun-Blanquet 1979). Vegetation seres were characterised according to the criteria laid down by Géhu &

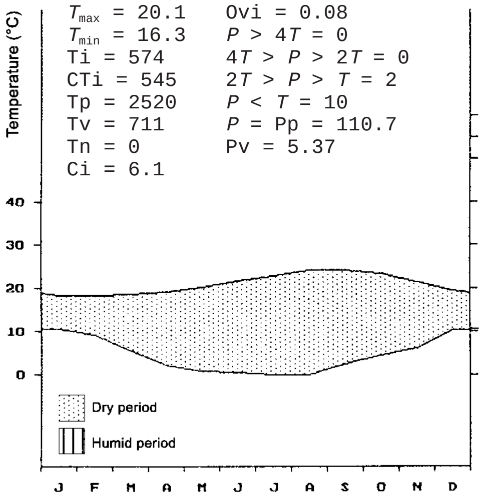
Table 4. References for constructing the bioclimatic maps (Gran Canaria).

Station references	Height (m) difference	CTi difference	Height (m) of transition between thermotypes			
			Infra-Thermo (CTi = 450)	Thermo-Meso (CTi = 350)	Lower-Meso-Upper-Meso (CTi = 280)	Meso-Supra (CTi = 210)
13-27	895	129	665	1359		
13-25	830	105	707	1498		
13-21	580	59	793			
19-24	325	140	770	1003		
19-26	525	88	858		1837	
18-26	550	95	869	1448	1853	
15-23	580	129	584			
14-20	445	119	558			
16-17	40	53	489			
27-28	259	55		1326	1655	1985
25-28	324	79		1349	1637	1924
26-28	274	76		1370	1622	1875
23-28	534	52		1103	1822	
20-28	679	66		1102	1822	
20-22	145	29		965		
17-22	455	55		955		
22-28	534	37		936	1946	

4. Las Palmas de Gran Canaria. J.O.P.

15 m
27/10* years 1965–1996/1978–1994

T = 21	Oi = 0.44
T_{max} = 20.1	Ovi = 0.08
T_{min} = 16.3	$P > 4T$ = 0
Ti = 574	$4T > P > 2T$ = 0
CTi = 545	$2T > P > T$ = 2
Tp = 2520	$P < T$ = 10
Tv = 711	P = Pp = 110.7
Tn = 0	Pv = 5.37
Ci = 6.1	



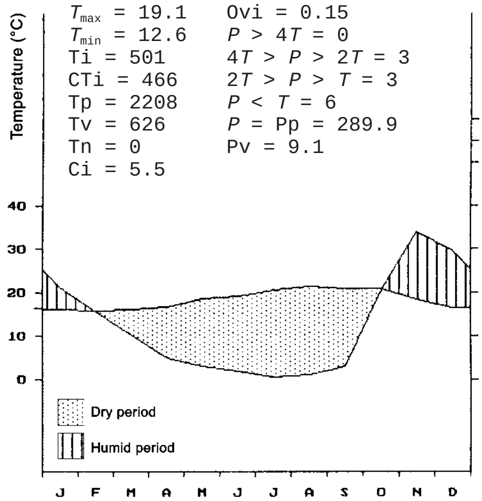
Arid Oceanic-Desertic Inframediterranean

Euphorbio balsamiferae sigmetum

12. Guía Tres Palmas

310 m
10/22* years 1954–1969/1949–1970

T = 18.4	Oi = 1.31
T_{max} = 19.1	Ovi = 0.15
T_{min} = 12.6	$P > 4T$ = 0
Ti = 501	$4T > P > 2T$ = 3
CTi = 466	$2T > P > T$ = 3
Tp = 2208	$P < T$ = 6
Tv = 626	P = Pp = 289.9
Tn = 0	Pv = 9.1
Ci = 5.5	



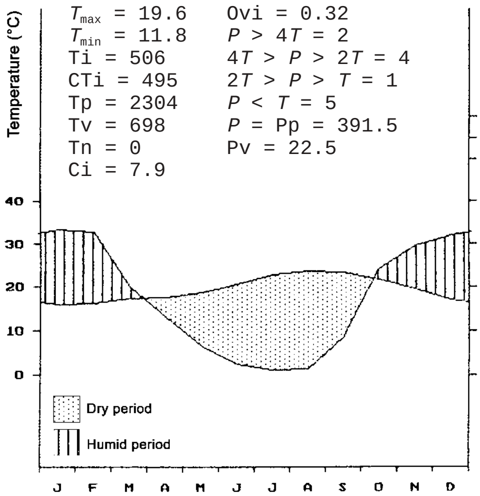
Lower-Semiarid Oceanic-Xeric Inframediterranean

Aeonio percarnei-Euphorbio canariensis sigmetum

14. Santa Brigida. El Tejar

390 m
12/12* years 1979–1996/1979–1995

T = 19.2	Oi = 1.7
T_{max} = 19.6	Ovi = 0.32
T_{min} = 11.8	$P > 4T$ = 2
Ti = 506	$4T > P > 2T$ = 4
CTi = 495	$2T > P > T$ = 1
Tp = 2304	$P < T$ = 5
Tv = 698	P = Pp = 391.5
Tn = 0	Pv = 22.5
Ci = 7.9	



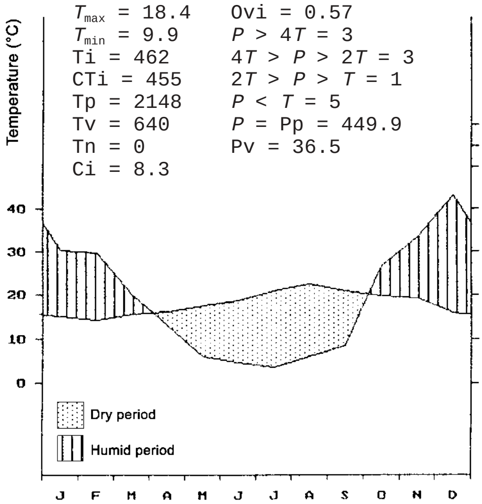
Upper-Semiarid Oceanic-Xeric Inframediterranean

Pistacio lentisci-Oleo cerasiformis sigmetum

16. Moya. Casco

485 m
12/21* years 1953–1977/1949–1978

T = 17.9	Oi = 2.09
T_{max} = 18.4	Ovi = 0.57
T_{min} = 9.9	$P > 4T$ = 3
Ti = 462	$4T > P > 2T$ = 3
CTi = 455	$2T > P > T$ = 1
Tp = 2148	$P < T$ = 5
Tv = 640	P = Pp = 449.9
Tn = 0	Pv = 36.5
Ci = 8.3	



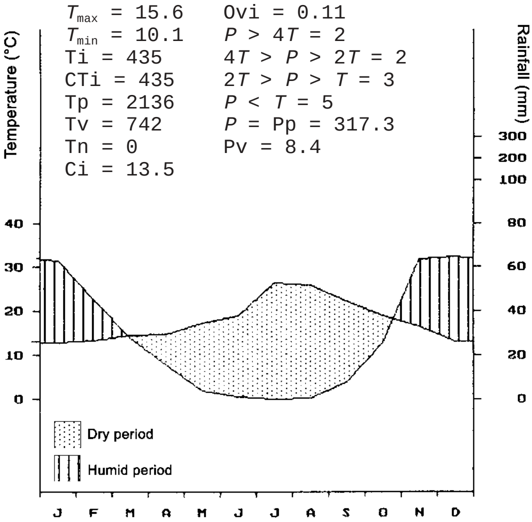
Dry Oceanic-Pluviseasonal Inframediterranean
(with trade-wind clouds)
Visneo mocanerae-Arbuto canariensis sigmetum

Rivas-Martínez (1981). The terms climatophilous, edaphoxerophilous and edaphohygrophilous are used throughout the text according to Rivas-Martínez (1995). The climax represents the final stage of balance in the geobotanic succesion. It may be recognized as the final

21. Mogán. Inagua

940 m
19/27* years 1951–1974/1949–1980

T = 17.8	Oi = 1.49
T_{max} = 15.6	Ovi = 0.11
T_{min} = 10.1	$P > 4T$ = 2
Ti = 435	$4T > P > 2T$ = 2
CTi = 435	$2T > P > T$ = 3
Tp = 2136	$P < T$ = 5
Tv = 742	P = Pp = 317.3
Tn = 0	Pv = 8.4
Ci = 13.5	

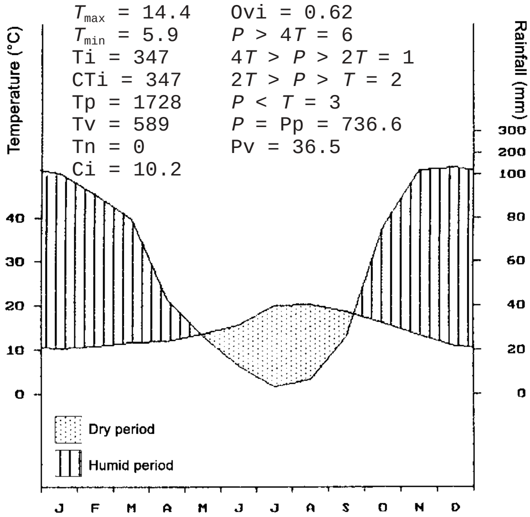


Upper-Semiarid Oceanic-Xeric Thermomediterranean
Pistacio lentisci-Oleo cerasiformis sigmetum (climatophilous series)
Pino canariensis sigmetum (edaphophilous, in salic territories)

22. Vallesco. Casco

980 m
28/33* years 1960–1996/1960–1995

T = 14.4	Oi = 4.26
T_{max} = 14.4	Ovi = 0.62
T_{min} = 5.9	$P > 4T$ = 6
Ti = 347	$4T > P > 2T$ = 1
CTi = 347	$2T > P > T$ = 2
Tp = 1728	$P < T$ = 3
Tv = 589	P = Pp = 736.6
Tn = 0	Pv = 36.5
Ci = 10.2	

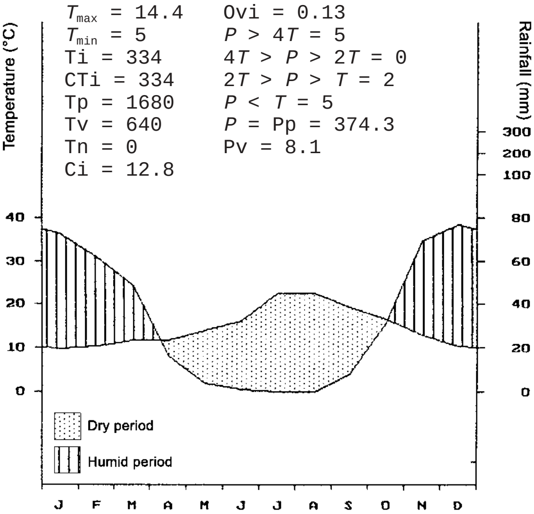


Subhumid Oceanic-Pluviseasonal Lower-Mesomediterranean
(with trade-wind clouds)
Lauro azoricae-Perseo indicae sigmetum

24. Tejeda. Vivero de Ñameritas

1040 m
12/31* years 1960–1996/1961–1995

T = 14	Oi = 2.23
T_{max} = 14.4	Ovi = 0.13
T_{min} = 5	$P > 4T$ = 5
Ti = 334	$4T > P > 2T$ = 0
CTi = 334	$2T > P > T$ = 2
Tp = 1680	$P < T$ = 5
Tv = 640	P = Pp = 374.3
Tn = 0	Pv = 8.1
Ci = 12.8	



Dry Oceanic-Pluviseasonal Lower-Mesomediterranean
(without trade-wind clouds)
Pino canariensis sigmetum

Fig. 2. Climatic, bioclimatic and symphytosociological data of some representative meteorological stations studied for Gran Canaria. * Numbers indicate annual available data in the mentioned period. Second number refers to a recording of a different period of rainfall; T = Mean annual temperature in °C; T_{max} = Mean maximum temperature of the coldest month; T_{min} = Mean minimum temperature of the coldest month; Ti = Thermicity index; CTi = Compensated thermicity index; Tp = Positive temperature; Tv = Summer temperature; Tn = Negative temperature; Ci = Continentality index; Oi = Ombrothermic index; Ovi = Summer ombrothermic index; $P > 4T$ = Months in which the rainfall value (in mm) is greater than four times the temperature value (in °C); $4T > P > 2T$ = Months in which the rainfall value is between twice and four times the temperature value; $2T > P > T$ = Months in which the rainfall value is greater than the 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. [T_{min} > 2 °C throughout the entire period at all the stations].

stage or stable association of a vegetation sere. At least three seres may be recognized depending on the amount of water in the soil, which comes mainly from rain. The zonal climatophilous sere is in accordance with ombroclimate. The edaphohygrophilous sere is wetter because

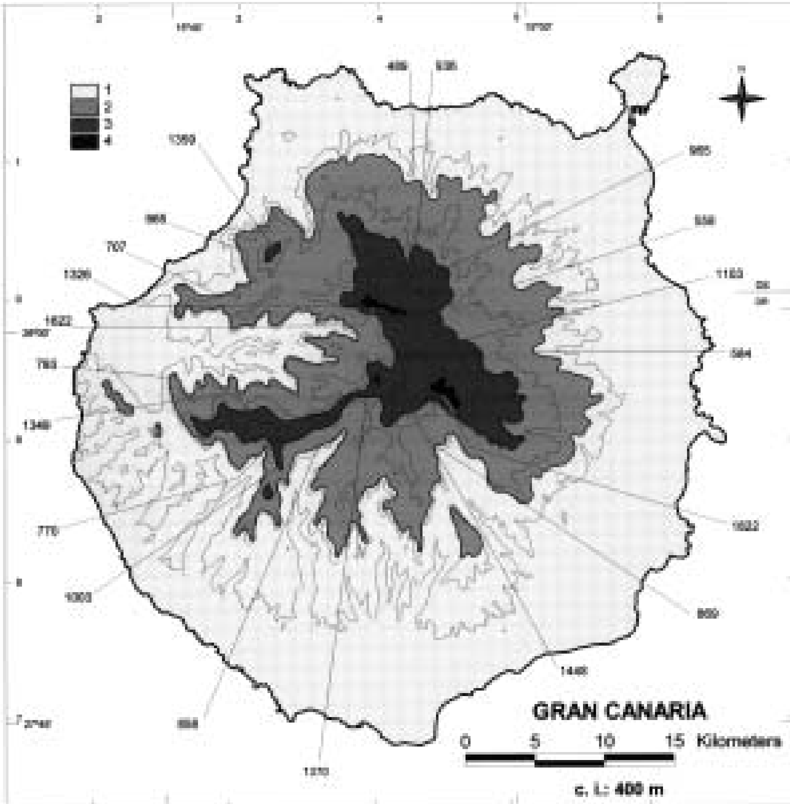


Fig. 3. Thermotype map of Gran Canaria. — **1**: Inframediterranean; — **2**: Thermomediterranean; — **3**: Lower-mesomediterranean; — **4**: Upper-mesomediterranean. Numbers indicate altitude in m a.s.l.

of percolation or run-off. The edaphoxerophilous sere is drier for topographic and lithic reasons.

The phytosociological nomenclature follows Rodríguez *et al.* (1998), and the taxonomy, in general, follows Hansen and Sunding (1993).

Study area

Gran Canaria is situated 27°43´–28°11´N and 15°21´–15°48´W, 210 km off the African continent, in the middle of the Canary Archipelago. Its surface area is 1560 km^2, and N–S and W–E diameters are 49 and 48 km, respectively. It has a roughly round shape, and a largely steep coastline 236 km long, with some long sandy beaches to the E and S. Its highest altitude is at its centre (Los Pechos, 1950 m a.s.l.) (Martín & Díaz 1988, Del-Arco *et al.* 1996, Afonso 1997). The island is subject to a tradewinds regime generating clouds over its N half (Huetz de Lemps 1969, Fernandopullé 1976, Marzol 1988). Like the rest of the Canaries, it is a volcanic oceanic island, whose oldest datings are 13.9 Ma. Two clear zones can be differentiated according to their geological age: the NE half, known as "Neocanaria", which was rejuvenated through eruptions in the Pliocene and Pleistocene, and the SW half, known as "Paleocanaria", with an almost exclusive dominance of Miocene substrates. Erosion was intense in the latter and its geomorphology is strongly marked with gigantic landforms (spectacular gorges, pitons, calderas, etc.). Its current flora has a high degree of Canary endemism (22%), though the Mediterranean influence dominates (La-Roche & Rodríguez-Piñero 1994, Wells & Lindacher 1994). From the biogeographical point of view, Gran Canaria is one sector of the Western Canary Province (Canary subregion, Mediterranean region) (Rivas-Martínez *et al.* 1993a).

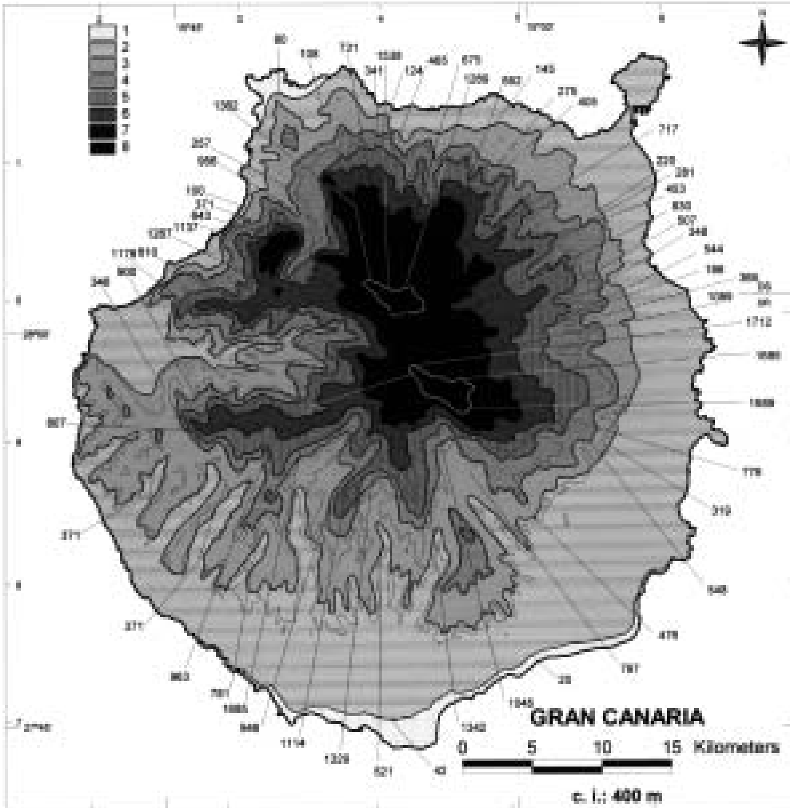


Fig. 4. Ombrotype and bioclimate map of Gran Canaria. — **1**: Hyperarid; — **2**: Arid; — **3**: Lower-semiarid; — **4**: Upper-semiarid; — **5**: Lower-dry; — **6**: Upper-dry; — **7**: Subhumid; — **8**: Humid. **1**–**2** Desertic; **3**–**4** Xeric; **5**–**8** Pluviseasonal. Numbers indicate altitude in m a.s.l.

Results

Thermotypes

Three thermotypes were found to be present on the island: Inframediterranean, Thermomediterranean, and Mesomediterranean (Fig. 3). The Inframediterranean thermotype surrounds the island from sea-level up to where thermal index (CTi) values of 450 are reached, with an altitudinal limit varying from 450 m in the north (above Guía), 800 m in the west (Cuenca de la Aldea–Cuenca de Tejeda), and near 850 m in the south (above Maspalomas). Above it the Thermomediterranean encircles the island up to a value of CTi 350. Its lowest upper limit is located around Valleseco, Centre-N, at about 950 m, reaching 1448 m in the S (Caldera de Tirajana) and 1600 m in the W (Caldera de Tejeda). Then, the Mesomediterranean extends up to the summit (1950 m). The upper and lower horizons of the Mesomediterranean are shown on the map. This limit is in general useful in other higher islands to distinguish the climatophilous areas of evergreen laurel forest and pine woodland on the N slopes influenced by clouds.

The map shows that the Inframediterranean territories are the largest (1081 km^2), followed in size by the Thermomediterranean (362 km^2) and Mesomediterranean (117 km^2) areas. These horizontal projection surface areas should be considered very approximate because of the steep relief of the island.

Bioclimates

Three types of bioclimates are found: oceanic-desertic, oceanic-xeric and oceanic-pluviseasonal (Fig. 4). They were delimited by their ombrothermic index (Oi) value. Territories with Oi < 0.9

Fig. 5. Bioclimatic belts of Gran Canaria. Grey areas indicate territories with trade-wind clouds, including lower overcast areas below mist level. Numbers refer to Table 5.

are included in the desertic bioclimate which surrounds the island from sea-level up to 100–200 m on the N slope, to over 400 m on the W and S slope. Above it, the xeric bioclimate extends up to Oi = 2. It is a wide ring with its upper limit around 400 m on the less arid northern areas around Valleseco, up to about 900 m on the W slope and more than 1000 m at the S tip of the island. The pluviseasonal bioclimate caps the summit.

Ombrotypes

Six ombrotypes were differentiated according to Oi values (Fig. 4). The hyperarid ombrotype appears on the S coast as well as on the NW cape (Punta de Sardina), in territories with an Oi < 0.3 with a narrow altitudinal range, in general less than 50 m. Next, the arid ombrotype extends upwards, sharing its upper limit with the desertic bioclimate. The semiarid ombrotype coincides with the xeric bioclimate; it has been divided into a lower and upper horizon to separate potential territories of "cardón scrub" sere and "thermophilic woodland" sere respectively. Above it the dry ombrotype continues until Oi = 3 is reached at about 700 m in the N above Moya. It gradually ascends on the E slope up to about 1200 m around Caldera de Los Marteles, keeping to a more or less similar altitude on the S and W slopes. The map shows the lower and upper horizons, which are used to delimit some vegetation seres. The highest territories are almost exclusively of subhumid ombrotype, only substituted on the N slopes by the humid ombrotype where Oi = 5.5 around Moriscos and Los Pechos, in general above 1500 m with a N exposure.

Bioclimatic belts

Upon considering the thermotype, bioclimate and ombrotype, and the presence or absence of trade-wind clouds, twenty bioclimatic belts were demarcated (Fig. 5), host to the six climatophilous vegetation seres found on the island (Table 5).

Climatophilous vegetation seres

Several potential natural vegetation maps of the island already exist (Ceballos & Ortuño 1951, Sunding 1972, Bramwell *et al*. 1986, Rivas-Martínez 1987). None of them is based on climatophilous vegetation seres. Only the Rivas-Martínez (1987) map based on climatophilous macroseres uses similar criteria to ours. To elaborate our map (Fig. 6) the distribution of remnants of the potential natural vegetation, its substitute communities and bio-indicative species were taken into account. Once the distribution patterns of communities and species became known, bioclimatic data and indices were used to objectify the map. Six climatophilous vegetation seres are recognisable. Their terminal communities are described below.

Euphorbietum balsamiferae Sunding 1972

[*Lectotypus*: Sunding (1972), t. 11, rel. no. 2; chosen here].

This sweet spurge scrub (“tabaibal dulce”) is an association endemic to Gran Canaria (Table 6), whose potential area corresponds to the hyperarid and arid desertic Inframediterranean belts. It is an oligospecific association, physiognomically characterised by the pachycaule species *Euphorbia balsamifera* (“tabaiba dulce”).

It corresponds to the terminal community of the hyperarid and arid desertic Inframediterranean climatophilous sere of the sweet spurge (*Eu-*

Table 5. Correspondence between bioclimatic belts and climatophilous vegetation seres in Gran Canaria.

Bioclimatic belt	Climatophilous vegetation seres
1. Hyperarid desertic Inframediterranean	*Euphorbio balsamiferae sigmetum*
2. Arid desertic Inframediterranean	*Euphorbio balsamiferae sigmetum*
3. Lower-semiarid xeric Inframediterranean	*Aeonio percarnei–Euphorbio canariensis sigmetum*
4. Upper-semiarid xeric Inframediterranean	*Pistacio–Oleo cerasiformis sigmetum*
5. Dry pluviseasonal Inframediterranean (with trade-wind clouds)	*Visneo mocanerae–Arbuto canariensis sigmetum*
6. Lower-semiarid xeric Thermomediterranean	*Pistacio–Oleo cerasiformis sigmetum*
7. Upper-semiarid xeric Thermomediterranean	*Pistacio–Oleo cerasiformis sigmetum*
8. Dry pluviseasonal Thermomediterranean (with trade-wind clouds)	*Visneo mocanerae–Arbuto canariensis sigmetum*
9. Lower-dry pluviseasonal Thermomediterranean (without trade-wind clouds)	*Pistacio–Oleo cerasiformis sigmetum*
10. Upper-dry pluviseasonal Thermomediterranean (without trade-wind clouds)	*Pino canariensis sigmetum*
11. Subhumid pluviseasonal Thermomediterranean (with trade-wind clouds)	*Lauro azoricae–Perseo indicae sigmetum*
12. Subhumid pluviseasonal Thermomediterranean (without trade-wind clouds)	*Pino canariensis sigmetum*
13. Upper-dry pluviseasonal lower-Mesomediterranean (with trade-wind clouds)	*Visneo mocanerae–Arbuto canariensis sigmetum*
14. Dry pluviseasonal lower-Mesomediterranean (without trade-wind clouds)	*Pino canariensis sigmetum*
15. Subhumid pluviseasonal lower-Mesomediterranean (with trade-wind clouds)	*Lauro–Perseo indicae sigmetum*
16. Subhumid pluviseasonal lower-Mesomediterranean (without trade-wind clouds)	*Pino canariensis sigmetum*
17. Humid pluviseasonal lower-Mesomediterranean (with trade-wind clouds)	*Lauro azoricae–Perseo indicae sigmetum*
18. Humid pluviseasonal lower-Mesomediterranean (without trade-wind clouds)	*Pino canariensis sigmetum*
19. Subhumid pluviseasonal upper-Mesomediterranean (without trade-wind clouds)	*Pino canariensis sigmetum*
20. Humid pluviseasonal upper-Mesomediterranean (without trade-wind clouds)	*Pino canariensis sigmetum*

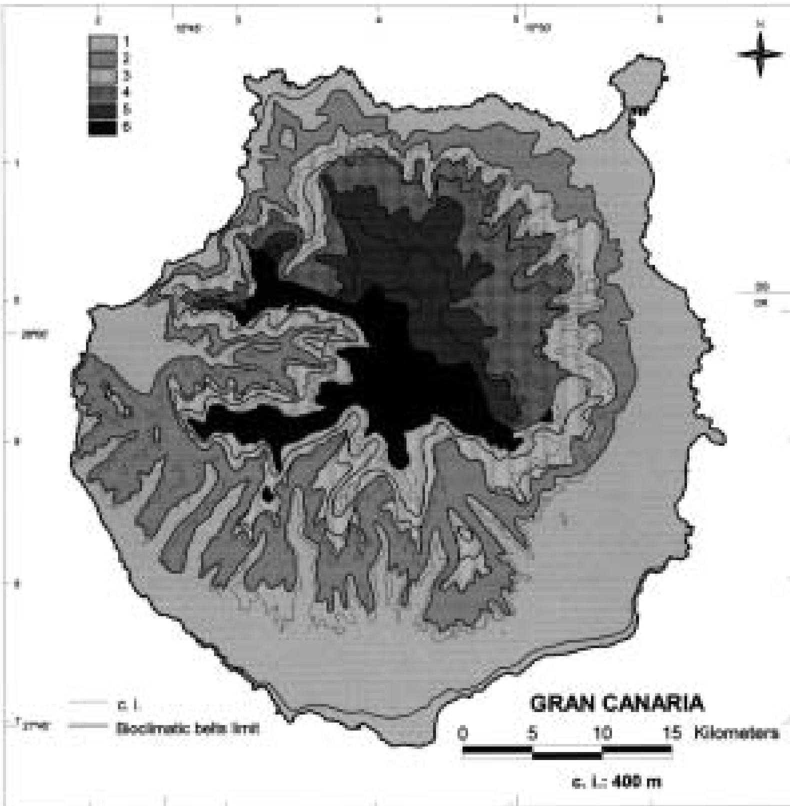


Fig. 6. Map of climatophilous vegetation series. — **1**: *Euphorbio balsamiferae sigmetum*; — **2**: *Aeonio percarnei-Euphorbio canariensis sigmetum*; — **3**: *Pistacio lentisci-Oleo cerasiformis sigmetum*; — **4**: *Visneo mocanerae-Arbuto canariensis sigmetum*; — **5**: *Lauro azoricae-Perseo indicae sigmetum*; — **6**: *Pino canariensis sigmetum*.

phorbia balsamifera) in Gran Canaria (*Euphorbio balsamiferae sigmetum*), which surrounds the island. Occupying a narrow band on the N and NW cliffs where it can reach up to 100–200 m a.s.l., it broadens to the E, and in the S can even exceed 500 m (Fig. 6). It also shows a great penetration inland in the Cuenca de la Aldea in the W. On N and NW slopes, a good part of its potential area is occupied by the edaphoxerophilous sere of "tolda" (*Euphorbia aphylla*): *Astydamio–Euphorbio aphyllae sigmetum* (Table 7) [*Lectotypus* ass.: Rivas-Goday & Esteve (1965): 271, t. 4, rel. 1. In: Rivas-Martínez *et al*. (1993b): 194]. On E and S slopes, the edaphophilous sabulicolous Inframediterranean western Canary *geosigmetum* extends over sandy ground; in addition, the cardón scrub (*Aeonio percarnei–Euphorbio canariensis sigmetum*) is found as an edaphophilous sere on the lava flows of the Amurga massif on the S slope, within the Paleocanaria geological zone (Fig. 7). The remaining territory corresponds to the potential area of *Euphorbietum balsamiferae* (Fig. 8 and Table 6).

Nowadays the community has greatly retreated, as a consequence of agricultural, urban and industrial expansion around the island's lowland periphery. The best remnants are located on the SW slope between Puerto Rico and Punta de la Aldea. The main substitutional scrubs belong to *Launaeo–Schizogynion*, made up of *Launaea arborescens*, *Schizogyne glaberrima*, *S. sericea*, *Artemisia ramosa* etc., and to the nitrohalophilous *Chenoleo tomentosae–Suaedetum vermiculatae*.

Aeonio percarnei-Euphorbietum canariensis (Rivas-Goday & Esteve 1965) Sunding 1972

Nomenclatural note: *Aeonio percarnei–Euphorbietum canariense* Rivas-Goday & Esteve 1965 is a valid name but illegitimate (Art. 34, Barkman *et al*. 1986, CPN) because the epithet "*canariense*" was used by the authors in reference to the "Canary region". It was also used for the three associations they described: *Rubio–Euphorbie-*

Table 6. *Euphorbietum balsamiferae* Sunding 1972 (*Aeonio–Euphorbion canariensis*, *Kleinio–Euphorbietalia canariensis*, *Kleinio–Euphorbietea canariensis*).

Relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Altitude m a.s.l.	195	320	200	150	145	75	205	110	145	135	170	160	160	140	150
Slope (°)	30	45	45	30	40	20	5	20	20	45	35	30	15	30	30
Exposure	SW	SW	N	W	E	NW	SW	N	SE	S	SE	SE	SW	E	E
Area (m^2)	100	200	100	150	150	200	100	100	200	100	100	200	400	100	100
Cover (%)	80	60	75	75	80	70	90	60	60	80	80	70	60	55	70
Reference	630M	636M	635M	628M	629M	640M	631M	632M	639M	633M	634M	638M	726P	637M	253S
Number of species	15	19	17	16	19	18	13	17	17	9	8	6	8	5	12
Character taxa															
Euphorbia balsamifera	5	4	5	5	5	4	5	4	4	5	5	4	4	4	4
Euphorbia regis-jubae	1	2	1	2	2	2	1	2	2	2	1	1	2	–	–
Kleinia neriifolia	1	2	2	2	2	2	2	+	2	2	2	–	–	–	2
Rubia fruticosa	1	+	1	1	2	1	2	2	–	–	–	–	–	–	–
Scilla haemorrhoidalis	2	–	2	2	2	1	1	2	–	–	–	–	–	–	–
Plocama pendula	–	+	1	–	–	1	–	–	–	–	–	1	1	1	–
Kickxia scoparia	+	2	1	–	–	2	–	–	2	–	–	–	–	–	–
Neochamaelea pulverulenta	–	+	–	–	–	–	–	–	1	–	–	2	2	2	–
Asparagus pastorianus	1	–	2	+	2	–	–	–	–	–	–	–	–	–	–
Ceropegia fusca	1	+	–	–	–	–	2	–	1	–	–	–	–	–	–
Periploca laevigata	1	+	–	–	–	–	+	–	1	–	–	–	–	–	–
Euphorbia canariensis	–	–	–	2	1	1	–	–	–	–	–	–	–	–	–
Helianthemum canariense	–	–	–	–	–	–	–	+	–	–	–	–	–	–	3
Asparagus umbellatus	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pancratium canariense	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Atalanthus pinnatus	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–
Campylanthus salsoloides	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–
Reseda scoparia	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Companion taxa															
Launaea arborescens	2	+	2	2	1	2	1	1	1	2	+	2	+	2	2
Hyparrhenia sinaica	2	2	2	2	2	1	2	2	–	1	2	–	–	–	–
Lycium intricatum	–	–	+	1	+	2	+	2	–	–	1	1	2	–	1
Opuntia dillenii	2	+	–	2	+	–	2	2	–	2	1	–	–	–	–
Aristida adscensionis subsp. *caerulescens*	1	2	–	2	1	–	–	2	1	–	–	–	–	–	–
Cenchrus ciliaris	1	2	–	1	–	–	–	–	–	–	2	–	–	–	1
Fagonia cretica	.	1	–	1	–	2	–	–	+	–	–	–	–	–	2
Asphodelus ramosus	–	1	–	2	2	–	2	–	–	–	–	–	–	–	–
Arisarum vulgare subsp. *subexertum*	–	–	–	2	2	–	1	2	–	–	–	–	–	–	–
Lavandula minutolii	–	+	–	–	–	2	–	–	+	–	–	–	–	–	–
Salvia aegyptiaca	–	–	–	–	–	+	–	–	+	–	–	–	–	–	1
Schizogyne sericea	–	–	–	–	–	–	–	+	–	–	–	–	1	–	2
Tetrapogon villosus	–	–	–	–	–	–	–	+	2	–	–	–	–	+	–
Tricholaena teneriffae	–	+	–	–	–	–	–	–	–	1	–	–	–	–	–
Artemisia ramosa	–	+	–	–	–	–	–	–	1	–	–	–	–	–	–
Asparagus plocamoides	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–
Lotus cf. *glaucus*	–	–	–	–	+	–	–	+	–	–	–	–	–	–	–
Dichanthium insculptum	–	–	–	–	–	1	–	–	–	+	–	–	–	–	–
Schizogyne glaberrima	.	–	–	–	–	+	–	–	– +	–	–	–	–	–	–

Other taxa. — in 3: *Digitaria nodosa* 1; *Micromeria varia* subsp. *meridialis* +, *Dipcadi serotinum* +, *Echium decaisnei* +; — in 5: *Ononis angustissima* 1; *Micromeria varia* subsp. *canariensis* +, *Pennisetum setaceum* +; — in 6: *Argyranthemum filifolium* 1, *Vicia filicaulis* +; — in 8: *Asparagus scoparius* +, *Frankenia capitata* +; — in 9: *Aeonium percarneum* +; in 15: *Artemisia reptans* 2, *Ajuga iva* var. *pseudiva* +, *Ononis diffusa* 1. Localities (Gran Canaria). — 1 (630M) & 7 (631M). Barranco Hondo. Galdar. 28RDS3309 (17.II.2000); — 2 (636M). Barranco de Fataga. 28RDR4275 (18.II.2000); — 3 (635M). Barranco de Tirajana. 28RDR5280 (18.II.2000); — 4 (628M) & 5 (629M). Piso Firme. Agaete. 28RDS3208 (17.II.2000); — 6 (640M). Barranco de Mogán. 28RDR2578 (18.II.2000); — 8 (632M). Lomo Gualapa. Towards Puerto Sardina. 28RDS3111 (17.II.2000); — 9 (639M). Barranco de Arguineguín. 28RDR3475 (18.II.2000); — 10 (633M). El Morro de Cabo Verde. Moya. 28RDS4312 (17.II.2000); — 11 (634M). Barranco Guayadeque. El Carrizal. 28RDR5887 (18.II.2000); — 12 (638M) & 14 (637M). Above Balito. Arguineguín. 28RDR3073 (18.II.2000); — 13 (726P). Punta de la Aldea. 28RDR1998 (3.IV.1995); — 15 (253S). Lomo del Polvo. Las Palmas. (26.III.1996).

Table 7. *Astydamio–Euphorbietum aphyllae* (Rivas-Goday & Esteve 1965) Sunding 1972 (*Aeonio–Euphorbion canariensis, Kleinio–Euhorbietalia canariensis, Kleinio-Euphorbietea canariensis*).

Relevé	1	2	3	4	5	6	7	8	9
Altitude m a.s.l.	100	180	175	225	75	10	75	115	600
Slope (°)	20	25	30	20	35	30	30	30	70
Exposure	N	E	N	N	NE	N	NE	N	NE
Area (m^2)	100	100	100	100	100	100	100	100	50
Cover (%)	50	65	70	60	70	60	50	60	60
Reference	626M	624M	627M	HAB3	625M	289S	724P	623M	723P
Number of species	14	19	13	19	17	14	8	12	7
Character taxa									
Euphorbia aphylla	2	4	4	3	3	3	3	4	4
Rubia fruticosa	+	+	+	+	+	1	2	–	1
Euphorbia balsamifera	+	2	3	3	3	2	2	–	–
Kleinia neriifolia	+	1	–	1	+	–	1	+	2
Astydamia latifolia	3	–	2	1	3	3	–	–	–
Helianthemum canariense	1	1	2	2	–	–	–	2	–
Scilla haemorrhoidalis	–	+	1	–	–	–	–	1	–
Ceropegia fusca	2	+	–	–	–	–	–	–	–
Kickxia scoparia	–	+	–	–	–	–	–	1	–
Atalanthus pinnatus	–	–	–	1	–	–	–	–	–
Echium decaisnei	–	–	–	+	–	–	–	–	–
Periploca laevigata	–	–	–	–	+	–	–	–	–
Campylanthus salsoloides	–	–	–	–	1	–	–	–	–
Plocama pendula	–	–	–	–	–	–	1	–	–
Euphorbia regis-jubae	–	–	–	–	–	–	–	2	–
Seseli webbii	–	–	–	–	–	–	–	–	1
Companion taxa									
Lycium intricatum	+	2	–	+	+	–	2	1	2
Schizogyne sericea	1	+	1	–	+	1	–	+	–
Launaea arborescens	+	1	–	1	–	–	2	2	–
Fagonia cretica	1	+	–	–	+	–	–	1	–
Opuntia dillenii	1	+	–	1	1	–	–	–	–
Lavandula canariensis	–	+	2	+	–	2	–	–	–
Argyranthemum frutescens	–	–	1	2	2	2	–	–	–
Hyparrhenia sinaica	–	–	–	1	+	1	–	1	–
Limonium pectinatum	+	–	–	2	–	2	–	–	–
Frankenia capitata	+	–	1	–	–	–	–	–	–
Asphodelus ramosus	–	+	–	1	–	–	–	–	–
Arisarum vulgare subsp*. subexertum*	–	1	–	–	–	–	–	2	–
Aeonium percarneum	–	–	–	1	1	–	–	–	–
Micromeria tenuis subsp. *linkii*	–	–	–	+	1	–	–	–	–
Salsola divaricata	–	–	–	–	1	1	–	–	–
Reichardia ligulata	–	–	–	–	–	1	–	–	2

Other taxa. — in 2: *Paronychia capitata* subsp. *canariensis*+, *Atriplex semibaccata* +, *Tetrapogon villosus* +; — in 3: *Senecio flavus* 1, *Plocama pendula* 2; *Reseda scoparia* +; — in 4: *Sonchus acaulis* +; — in 5: *Aeonium virgineum*+; — in 6: *Frankenia ericifolia* 1, *Lotus glaucus* 1, *Aspalthium bituminosum* +; — in 7: *Asteriscus graveolens* subsp. *stenophyllus* 2; in 9: *Ononis angustissima* 1. Localities (Gran Canaria). — 1 (626M) & 3 (627M). Above Tinoca. 28RDS5112 (17.II.2000); — 2 (624M). Skirts of Montaña de Amagro. Sardina. 28RDS3312 (17.II.2000); — 4 (HAB3). Road from Guía to San Felipe (12.X.1994); — 5 (625M). San Felipe. 28RDS4113 (17.II.2000); — 6 (289S). San Felipe. 28RDS4112 (1.VI.1996); — 7 (724P). Punta de La Aldea. 28RDR1998 (3.IV.1995); — 8 (623M). Above Agaete. 28RDS3109 (17.II.2000); — 9 (723P). Mirador del Balcón. 28RDR2399 (3.IV.1995).

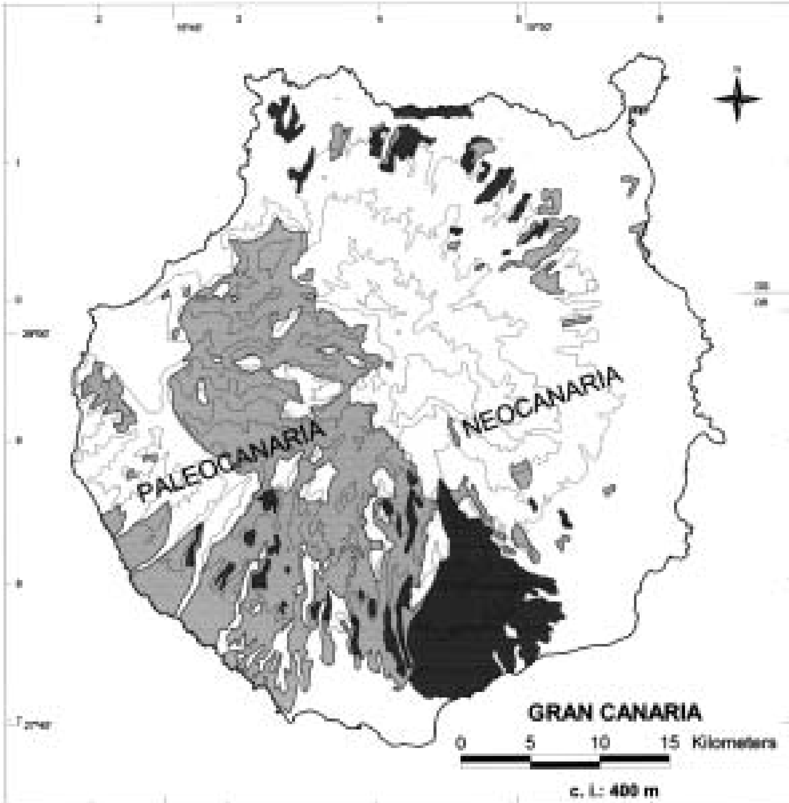


Fig. 7. Salic territories of Gran Canaria (Fuster *et al.* 1968, modified). Darkest areas = solid lava flows.

tum canariense, *Aeonio–Euphorbietum canariense* and *Astydamio–Euphorbietum canariense*. Sunding (1972) legitimates the Rivas-Goday & Esteve name, and now, according to Art. 39, we have chosen Rivas-Goday & Esteve (1965): 262, t. 3, relevé no. 1 as *lectotypus* of the association.

This is an association endemic to Gran Canaria (Table 8), at its optimum with the physiognomy of cardón (*Euphorbia canariensis*) scrub — "cardonal"; or when impoverished or degraded, with the physiognomy of bitter spurge (*Euphorbia regis-jubae*, *sensu* Molero & Rovira 1998) scrub — "tabaibal amargo", typical of the lower-semiarid xeric Inframediterranean belt.

Its structure and physiognomy correspond to xeric crassicaule scrubland, which is the terminal community of (a) the lower-semiarid xeric Inframediterranean climatophilous sere; (b) the upper-semiarid xeric Infra- and Thermomediterranean edaphophilous rupicolous sere on ridges; and (c) the arid desertic Inframediterranean edaphohygrophilous sere on lava flows ("malpaíses"), of the cardón in Gran Canaria (*Aeonio percarnei–Euphorbio canariensis sigmetum*).

Its climatophilous area (Fig. 6) encircles the island directly above the area of *Euphorbietum balsamiferae*. Its upper limit is with the upper semiarid ombrotype, the area of the climatophilous sere of *Pistacio lentisci–Oleo cerasiformis sigmetum*, at heights between 250–350 m a.s.l. in the N and 800–950 m in the S. However, frequently on the SW slopes because of the prevailing salic substrates, the altitudinal succession between these two communities is not clear and a transition area can be observed between the cardón scrub sere and the Canary pine sere (*Pino canariensis sigmetum*) favoured on this substrate (Fig. 8).

The cardón scrub has retreated greatly and is now confined to steep rocky slopes and scarps. The best remnants are sheltered on the W slope, mainly in the SW quadrant. Bitter spurge scrub

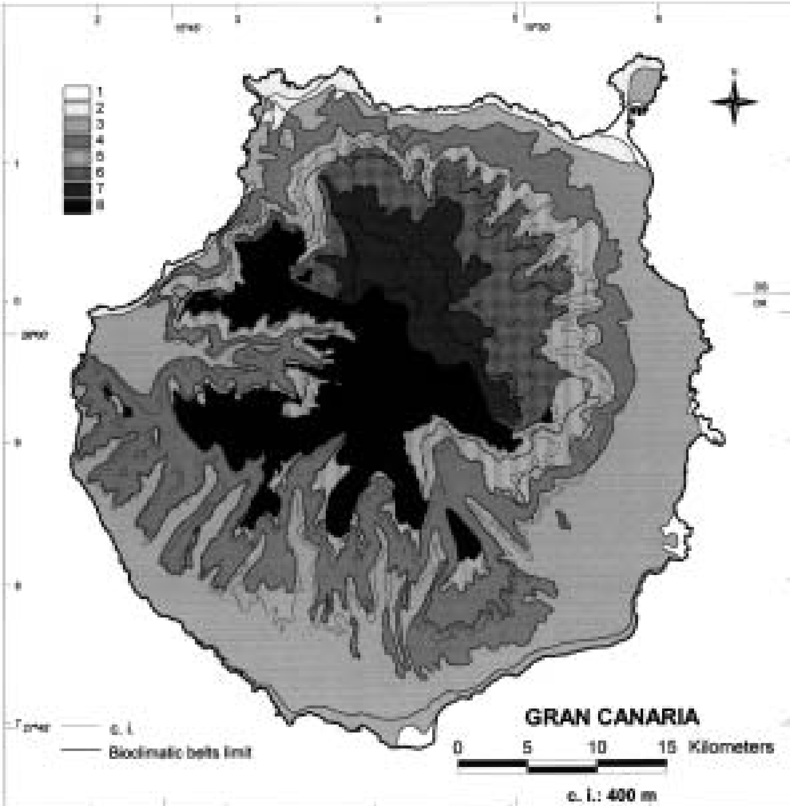


Fig. 8. Map of potential natural vegetation. — **1**: Edaphophilous sabulicolous inframediterranean Western Canary *geosigmetum*. — **2**: *Astydamio-Euphorbio aphyllae sigmetum*; — **3**: *Euphorbio balsamiferae sigmetum*; — **4**: *Aeonio percarnei-Euphorbio canariensis sigmetum*; — **5**: *Pistacio lentisci-Oleo cerasiformis sigmetum*; — **6**: *Visneo mocanerae-Arbuto canariensis sigmetum*; — **7**: *Lauro azoricae-Perseo indicae sigmetum*; — **8**: *Pino canariensis sigmetum*.

is widely spread within the climatophilous area of the association; to a great extent it represents an impoverished phase of *Aeonio percarnei-Euphorbietum canariensis* without cardón, with abundant *Euphorbia regis-jubae*.

At the lower altitude levels of the community there is a noticeable increase in sweet spurge, which marks the change to *Euphorbietum balsamiferae*.

The descent of "cardonal" to Inframediterranean desertic territories in the Amurga massif on phonolithic lava flows is not attributed to this salic substratum, because it is not regularly observed within the same bioclimatic belt in similar S and W salic territories of the island. It seems however to be directly related to substrate texture. The largely solid lava flows (Fig. 7) produce a shield effect decreasing the evaporation rate from the underlying soil, and maintain a favourable water balance, thus allowing the edaphohygrophilous descent of *Aeonio percarnei-Euphorbietum canariensis* into the climatophilous domain of *Euphorbietum balsamiferae* (Fig. 8). This descent also occurs on debris at the foot of bare cliffs that collect water.

Aeonio–Euphorbietum canariensis subass. *pistacietosum* Sunding 1972, seems to enclose cardón scrub with thermophilous elements and thermophilous woodland as well. We choose rel. no. 30, t. 12 (Sunding 1972) as *lectotypus* of subass. *pistacietosum* Sunding 1972; restricting the subassociation to cardón scrub with thermophilous elements, generally found growing on ridges as edaphophilous within the climatophilous area of thermophilous woodland (*Pistacio lentisci–Oleetum cerasiformis*).

Pistacio lentisci–Oleetum cerasiformis ass. nov.

[*Holotypus*: Table 9, rel. 1 (169S)].

Syn. *Aeonio percarnei–Euphorbietum canariense* (Rivas-Goday & Esteve 1965) Sunding 1972 subass. *pistacietosum lentisci* Sunding 1972 *p.p.*

Table 8. *Aeonio percarnei-Euphorbietum canariensis* (Rivas-Goday & Esteve 1965) Sunding 1972, and subass. *pistacietosum lentisci* Sunding 1972 *emend.* (*Aeonio–Euphorbion canariensis, Kleinio–Euphorbietalia canariensis, Kleinio–Euphorbietea canariensis*).

Relevé	1	2	3	4	5	6	7	8	9	10	11	12	13
Altitude m a.s.l.	315	430	185	115	125	400	240	400	450	300	275	600	500
Slope (°)	45	35	5	40	15	30	30	30	45	20	20	20	20
Exposure	S	NW	SW	NE	SE	SE	E	W	S	W	NW	SW	NE
Area (m^2)	100	200	200	200	200	200	200	1000	1000	400	400	100	100
Cover (%)	80	90	90	80	85	70	90	60	70	60	80	80	80
Reference	642M	644M	641M	643M	645M	173S	304S	166S	162S	HAB1	HAB2	720P	733P
Number of species	18	12	11	11	9	11	13	13	8	13	16	6	8
Character taxa													
Euphorbia canariensis	3	5	5	5	5	4	4	3	4	3	4	4	4
Periploca laevigata	3	1	3	3	3	2	2	2	2	2	3	2	2
Euphorbia regis-jubae	2	2	1	1	1	2	1	1	1	1	1	1	2
Rubia fruticosa	1	2	3	2	3	1	3	+	–	2	–	2	2
Kleinia neriifolia	1	1	2	1	2	–	–	–	–	1	3	2	2
Aeonium percarneum	2	2	–	–	–	1	2	2	+	–	3	–	–
Echium decaisnei	1	2	–	1	–	–	–	–	–	2	–	1	1
Asparagus umbellatus	1	–	2	–	–	+	–	–	–	–	1	–	–
Scilla haemorrhoidalis	1	+	1	–	–	–	–	–	–	–	–	–	–
Atalanthus pinnatus	2	–	–	–	–	–	1	–	–	–	2	–	–
Neochamaelea pulverulenta	–	–	–	2	+	–	–	–	–	–	–	–	1
Asparagus pastorianus	–	–	–	–	–	1	–	–	–	2	1	–	–
Campylanthus salsoloides	1	–	–	–	–	–	–	–	1	–	–	–	–
Convolvulus floridus	2	–	–	–	–	–	1	–	–	–	–	–	–
Ceropegia fusca	+	1	–	–	–	–	–	–	–	–	–	–	–
Plocama pendula	–	–	–	1	2	–	–	–	–	–	–	–	–
Euphorbia balsamifera	–	–	1	–	–	–	–	–	–	–	–	–	–
Parolinia ornata	–	–	–	–	1	–	–	–	–	–	–	–	–
Differential of subass. *pistacietosum lentisci*													
Olea europaea subsp. *cerasiformis*	–	–	–	–	–	1	4	3	–	–	–	–	–
Pistacia lentiscus	–	–	–	–	–	–	–	2	2	–	–	–	–
Pistacia atlantica	–	–	–	–	–	–	–	–	–	1	2	–	–
Phoenix canariensis	–	–	–	–	–	–	+	–	–	–	–	–	–
Companion taxa													
Lavandula canariensis	2	–	–	–	–	–	1	+	+	–	2	–	–
Asparagus plocamoides	–	2	–	1	2	–	–	1	–	–	–	–	+
Opuntia dillenii	1	–	–	–	–	2	–	–	–	1	2	–	–
Hyparrhenia sinaica	2	–	–	–	–	4	–	–	–	3	2	–	–
Opuntia ficus-indica	2	–	–	–	–	–	2	2	–	–	1	–	–
Rumex lunaria	–	–	–	–	–	1	–	1	+	–	1	–	–
Asphodelus ramosus	–	1	–	+	–	–	–	–	–	–	–	–	–
Lycium intricatum	–	–	1	+	–	–	–	–	–	–	–	–	–
Aeonium manriqueorum	–	–	–	–	–	–	1	1	–	–	–	–	–
Artemisia thuscula	–	–	–	–	–	–	+	–	–	1	–	–	–

Other species. — in 1: *Dichanthium insculptum* 1; — in 2: *Lavandula minutolii* 1; — in 3: *Launaea arborescens* +, *Arisarum vulgare* subsp. s*ubexertum* 2; — in 8: *Agave americana* 1; — in 10: *Juncus acutus* 2, *Pennisetum setaceum* +; — in 11: *Messerschmidia fruticosa* 3, *Foeniculum vulgare* 2. Localities (Gran Canaria). — 1 (642M). Los Dragos. Moya. 28RDS4410 (17.02.2000); — 2 (644M). Barranco Fataga. 28RDR4377 (18.II.2000); — 3 (641M). Barranco Hondo. Gáldar. 28RDS3309 (17.II.2000); — 4 (643M). Barranco Berriel. Amurga. 28RDR4974 (18.II.2000); — 5 (645M). Barranco de Arguineguín. 28RDR3475 (18.II.2000); — 6 (173S). Montaña San Gregorio. Tamaraceite. 28RDS5206 (6.VIII.1994); — 7 (304S). Bandama. 28RDS5500 (27.VIII.1996); — 8 (166S). Barranco de las Goteras. 28RDR5499 (14.VII.1994); — 9 (162S). Caldera de Bandama. 28RDS5500 (8.VII.1994); — 10 (HAB1). Above La Gaza. Galdar. 28RDS3509 (14.X.1994); — 11 (HAB2). Barranco del Brezal, near Tres Palmas. Guía. 28RDS4111 (13.X.1994); — 12 (720P). Between Andén Verde and San Nicolás. 28RDR2298 (3.IV.1995); — 13(733P). Slopes of Hogarzales El Cedro. 28RDR2192 (5.IV.1995).

Table 9. *Pistacio lentisci–Oleetum cerasiformis* ass. nova (*Mayteno–Juniperion canariensis, Oleo–Rhamnetalia crenulatae, Kleinio–Euphorbietea canariensis*).

Relevé	1	2	3	4	5	6	7	8	9
Altitude m a.s.l.	400	450	300	490	340	370	350	640	310
Slope (°)	20	40	15	30	20	5	20	20	15
Exposure	W	W	W	NE	NE	N	NE	E	W
Area (m^2)	200	200	300	1000	1000	1000	1000	200	500
Cover (%)	90	80	80	80	80	80	80	80	70
Reference	169S	170S	292S	161S	164S	165S	167S	174S	291S
Number of species	11	11	8	11	9	10	14	9	12
Character taxa									
Olea europaea subsp. *cerasiformis*	3	4	2	3	4	4	4	4	–
Pistacia lentiscus	1	3	–	3	2	1	3	–	–
Euphorbia regis-jubae	+	1	1	2	–	–	–	1	1
Hypericum canariense	1	1	2	–	–	–	1	2	2
Pistacia atlantica	2	–	4	–	1	3	–	–	4
Atalanthus pinnatus	1	1	–	–	1	–	–	–	1
Periploca laevigata	1	2	–	–	+	–	2	–	–
Asparagus umbellatus	1	+	–	1	–	–	–	–	–
Rubia fruticosa	1	–	–	–	–	–	2	–	–
Convolvulus floridus	–	+	2	–	–	–	–	–	–
Asparagus plocamoides	–	–	+	–	–	–	–	–	+
Vicia cirrhosa	–	–	–	–	–	–	+	–	1
Phoenix canariensis	–	–	–	–	–	2	–	–	–
Retama rhodorhizoides	–	–	–	–	–	+	–	–	–
Tamus edulis	–	–	–	–	–	–	+	–	–
Jasminum odoratissimum	–	–	–	–	–	–	–	–	3
Companion taxa									
of *Aeonio–Euphorbion canariensis:*									
Euphorbia canariensis	–	1	–	–	–	–	–	–	–
of *Cisto–Micromerion hyssopifoliae:*									
Micromeria varia subsp. *canariensis*	–	–	–	–	–	–	+	1	–
Phagnalon umbelliforme	1	–	–	–	–	–	–	–	–
Paronychia capitata subsp. *canariensis*	.	–	–	–	–	–	1	–	–
Carlina salicifolia	–	–	–	–	–	–	–	–	1
of *Pegano–Salsoletea vermiculatae:*									
Rumex lunaria	–	–	–	1	2	1	–	–	–
Bosea yervamora	–	–	–	–	1	–	–	–	–
Echium decaisnei	–	–	–	–	–	–	+	–	–
Others									
Aeonium percarneum	–	1	1	+	–	–	–	1	1
Aeonium manriqueorum	–	–	–	1	2	2	2	2	–
Opuntia ficus-barbarica	–	–	1	+	1	–	–	–	2
Ferula linkii	–	–	–	1	–	–	1	–	+
Sonchus acaulis	–	–	–	1	–	–	+	1	–
Hyparrhenia sinaica	–	–	–	–	–	–	–	3	3
Teline microphylla	–	+	–	–	–	–	–	2	–

Other taxa. — in 1: *Rubus ulmifolius* 2; — in 4: *Lobularia canariensis* +; — in 6: *Ageratina adenophora* 1, *Arundo donax* 1, *Bryonia verrucosa* +; — in 7: *Pericallis webbii* 1. Localities (Gran Canaria). — 1 (169S) & 7 (167S). Barranco de las Goteras. 28RDR5499 & 28RDR5599 (14.VII.1994); — 2 (170S) & 8 (174S). La Solana de la Angostura. 28RDS5102 (23.VII.1994); — 3 (292S) & 9 (291S). Barranco de Galdar. 28RDS3811 (7.VII.1996); — 4 (161S). Pico de Bandama. 28RDS5500 (8.VII.1994); — 5 (164S). Lomo Mocanal. 28RDS5401 (8.VII.1994); — 6 (165S). Barranco Mondeal. 28RDS5301 (8.VII.1994).

This is an endemic association of Gran Canaria (Table 9), which includes stands of thermophilous juniper ("sabina"), wild olive ("acebuche"), and mastic ("almácigo" and "lentisco") woodlands, characteristic of the lower-semiarid xeric Thermomediterranean, upper-semiarid xeric Infra- and Thermomediterranean, and lower-dry pluviseasonal Thermomediterranean without trade-wind clouds. The last two occur on basaltic substrata (Fig. 6).

Its climatophilous area rings the island directly above the area of *Aeonio–Euphorbietum canariensis*, reaching the area of *Visneo–Arbutetum canariensis* at near 900 m a.s.l. in the NW, 500 m in the N and 600–700 m in the E. In the SW part of this band it borders the area of *Pinetum canariensis* on the narrow territories of the lower semiarid xeric Thermomediterranean belt independently of the salic or basaltic character of the substrate, and on the basaltic outcrops within the generally salic context of the zone (Fig. 8) where *Pinetum canariensis* subass. *juniperetosum canariensis* is widespread (Salas *et al*. 1998).

Its physiognomy depends on the dominant tree: wild olive woodland ("acebuchal") with dominance of *Olea europaea* subsp. *cerasiformis*; mastic-tree woodland ("almacigal") with dominance of *Pistacia atlantica*, and mastic-bush thicket ("lentiscal") with dominance of *Pistacia lentiscus*. Nowadays, juniper (*Juniperus turbinata* subsp. *canariensis*) woodland ("sabinar") is not found, as only isolated trees remain.

In its floristic group there is a dominance of the *Kleinio–Euphorbietea canariensis* shrubs (*Rubia fruticosa*, *Periploca laevigata*, *Asparagus umbellatus*, *Euphorbia regis-jubae*, *Kleinia neriifolia*, etc.), although there are some belonging to *Mayteno–Juniperion canariensis* (*Bupleurum salicifolium* subsp. *acyphyllum* and *Asparagus plocamoides*, among others).

The structure and physiognomy are those of open xeric woodland, the terminal community of the lower-semiarid xeric Thermomediterranean, upper-semiarid xeric Infra- and Thermomediterranean, and lower-dry pluviseasonal Thermomediterranean without trade-wind clouds; this is the climatophilous sere of mastic-bush (*Pistacia lentiscus*) and wild olive (*Olea europaea* subsp. *cerasiformis*) in Gran Canaria (*Pistacio lentisci–Oleo cerasiformis sigmetum*).

The current representation of the community is very scarce due to the radical transformation of its potential territory, mainly by farming and urban development. The best preserved remnants are: stands of wild olive, scattered over the whole NE, e.g. Barranco de los Cernícalos (Telde); mastic-bushes, also relegated to the NE, e.g. Caldera de Bandama–Monte Lentiscal; and mastic-tree groves, mainly spread over the NW, where the trees regenerate well at the valley bottoms, especially in La Aldea (Rodrigo & Montelongo 1986, Montelongo *et al*. 1986).

Among the substitution scrubs with a widespread area are rockrose scrub ("jaral"; *Euphorbio–Cistetum monspeliensis*); the nitrophilous scrub *Artemisio–Rumicetum lunariae*; the bitter spurge scrub ("tabaibal amargo"), sometimes as a facies of the latter and elsewhere as a recovering stage of the deforested woodland with dominance of its typical shrubs; and the perennial grassland of *Cenchro–Hyparrhenietum hirtae*. In the N, in adjacent areas to *Visneo–Arbutetum canariensis*, *Rhamno–Hypericetum canariensis* appears.

Visneo mocanerae-Arbutetum canariensis Rivas-Martínez, Wildpret, del-Arco, O. Rodríguez, P.Pérez, García-Gallo, Acebes, T.E.Díaz & Fern.Gonz. 1993

[*Holotypus*: Rivas-Martínez *et al*. (1993b): 216, t. 14, rel. 11].

This western Canary association (Table 10, rel. 1–3) is the dry evergreen laurel forest of the dry pluviseasonal Infra- and Thermomediterranean belts, affected by trade-wind clouds.

Its climatophilous territory (Fig. 6) is located on the N slopes of the island directly above the area of *Pistacio–Oleetum cerasiformis*, under the influence of NE trade-winds. These are occasionally deviated in direction due to the local topography, particularly in the NW (Marzol 1988: 59). This forest extends up to the domain of the subhumid ombrotype, at about 800 m in the N, where the area of *Lauro-*

Table 10. *Visneo mocanerae–Arbutetum canariensis* Rivas-Martínez *et al,* 1993; *Lauro azoricae–Perseetum indicae* Oberdorfer *ex* Rivas Martínez, Arnáiz, Barreno & Crespo 1977 (*Ixantho–Laurion azoricae, Pruno–Lauretalia azoricae, Pruno–Lauretea azoricae*).

Relevé	1	2	3	4
Altitude m a.s.l.	715	515	615	850
Slope (°)	70	15	25	40
Exposure	NE	W	NE	NE
Area (m^2)	200	400	400	300
Cover (%) trees	70	40	95	95
Cover (%) shrubs	80	70	–	–
Reference	647M	646M	329S	3036
Number of species	27	21	24	24
Character taxa				
of *Visneo–Arbutetum canariensis:*				
Apollonias barbujana	3	2	2	–
Visnea mocanera	1	–	–	–
Picconia excelsa	–	2	–	–
of *Lauro–Perseetum indicae:*				
Persea indica	–	–	–	3
Prunus lusitanica subsp. *hixa*	–	–	–	2
of Alliance, Order and Class:				
Laurus azorica	2	2	4	1
Canarina canariensis	2	2	1	1
Semele gayae	2	–	2	1
Viburnum rigidum	2	+	–	–
Convolvulus canariensis	2	–	+	–
Dryopteris oligodonta	+	–	1	–
Erica arborea	–	+	1	–
Ixanthus viscosus	+	–	–	–
Ocotea foetens	–	3	–	–
Myrica faya	–	–	2	–
Diplazium caudatum	–	–	–	1
Woodwardia radicans	–	–	–	1
Companion taxa				
Tamus edulis	+	2	+	1
Ageratina adenophora	1	2	+	1
Dracunculus canariensis	2	2	1	1
Rubia fruticosa subsp. *periclymenum*	1	2	+	–
Hypericum canariense	1	3	+	–
Rubus ulmifolius	1	1	–	2
Ferula linkii	+	+	–	1
Hypericum grandifolium	+	–	+	1
Vinca major	2	2	–	–
Bosea yervamora	1	2	–	–
Bystropogon canariensis	2	–	–	1
Geranium canariense	2	–	–	1
Gesnouinia arborea	1	–	–	1
Arisarum vulgare subsp. *subexertum*	–	–	2	1
Aichryson laxum	–	–	+	1
Aspalthium bituminosum	–	–	+	1

Other taxa. — In 1: *Bystropogon* x*serrulatus* +, *Bencomia caudata* 2, *Urtica stachyoides* +, *Aichryson punctatum* +, *Urtica morifolia* +; in 2: *Opuntia ficus indica* 2, *Euphorbia regis-jubae* 1, *Artemisia thuscula* +, *Phoenix cf. dactylifera* 1, *Oxalis pes-caprae* 3; in 3: *Pteridium aquilinum* 1, *Scrophularia calliantha* +, *Asparagus cf. plocamoides* +, *Davallia canariensis* +, *Polypodium macaronesicum* +, *Withania aristata* +, *Arundo donax* +; in 4: *Pericallis webbii* 1, *Brachypodium sylvaticum* 2, *Cedronella canariensis* 1, *Rumex pulcher* +, *Galium scabrum* 1. Localities (Gran Canaria). — 1 (647M). Barranco Oscuro. 28RDS4204 (17.II.2000); 2 (646M). Los Tiles de Moya. 28RDS4107 (17.II.2000); 3 (329S). Caidero Levantiscos. 28RDS4305 (6.XI.1999); 4 (3036). Barranco de la Virgen. NW de Valsendero (18.III.1967) [Sunding (1972; Tab. 25, rel. 1)].

Perseetum azoricae begins. Its potential area is reduced in the NW quadrant, on salic bedrock where the moist pine woodland (*Pinetum canariensis* subass. *ericetosum arboreae*) becomes dominant.

Its structure and physiognomy are those of dense xerophilous forest, terminal community of dry pluviseasonal Infra- and Thermomediterranean of the Canary strawberry-tree ("madroño canario", *Arbutus canariensis*) (*Visneo–Arbuto canariensis sigmetum*), in areas with trade-wind clouds. As happens in La Palma, due to the rareness of "madroño" on the island it would be preferable to refer the sere to other trees that, although scarce, are better represented, like "barbusano" (*Apollonias barbujana*), "mocán" (*Visnea mocanera*) or "paloblanco" (*Picconia excelsa*) (Marrero *et al*. 1989, Suárez 1994).

Nowadays only small fragments of the association persist on steep slopes. The substitution scrub *Rhamno–Hypericetum canariensis* allows the original domain of *Visneo–Arbutetum canariensis* to be recognised.

Lauro azoricae-Perseetum indicae Oberdorfer ex Rivas-Martínez, Arnáiz, Barreno & Crespo 1977

[*Lectotypus*: Oberdorfer (1965): 70, t. 4, rel. 6. In: Rivas-Martínez *et al.* (1993b): 211].

Another western Canary association (Table 10, rel. 4), this is the humid evergreen laurel forest in the subhumid pluviseasonal Thermomediterranean, and humid and subhumid pluviseasonal lower-Mesomediterranean belts, with trade-wind clouds. Its climatophilous area (Fig. 6) is the area affected by more persistent trade-wind clouds on the island's N slope, above the area of *Visneo–Arbutetum canariensis* and below the altitude of the upper-Mesomediterranean thermotype, where pine woodland (*Pinetum canariensis*) begins its climatophilous area. Its potential area is also reduced in the NW of the island on salic bedrock where *Pinetum canariensis* subass. *ericetosum arboreae* develops.

Its structure and physiognomy are those of mesophytic forest, terminal community of the subhumid pluviseasonal Thermomediterranean, and subhumid and humid pluviseasonal lower-Mesomediterranean climatophilous sere of "viñatigo" (*Persea indica*) (*Lauro azoricae-Perseo indicae sigmetum*) in areas with trade-wind clouds.

This community is now practically absent from the island, because of massive tree-felling throughout centuries of human use. Only small impoverished relicts persist on some steep slopes and humid valleys (Suárez 1994). Even the typical substitutional scrub *Myrico–Ericetum arboreae* ("fayal-brezal") has a very reduced presence. Among the scrubs, those made up of *Chamaecytisus proliferus* subsp. *proliferus* var. *canariae* ("escobonal"), *Adenocarpus foliolosus* ("codesar"), and *Teline microphylla* ("retamar") (*Telino–Adenocarpion*) dominate, along with bramble patches of *Rubus ulmifolius* ("zarzal") (*Rubo–Rubion*). Also noteworthy are the bracken areas of *Pteridium aquilinum* and nitrophilous meadows of *Echio–Galactition*.

Pinetum canariensis Ceballos & Ortuño ex Sunding 1972

[*Lectotypus*: Sunding (1972): 122, t. 29, rel. 18. In: Rivas-Martínez *et al*. (1993b): 230].

Pine woodland of the Thermo- and Mesomediterranean belts is an association endemic to Gran Canaria (Table 11). Its climatophilous area caps the island above the humid evergreen laurel forest (*Lauro-Perseetum indicae*) on the N slope in the domain of the upper-Mesomediterranean thermotype, where there are frequent winter frosts and the influence of the dry NW wind prevails; and above the climatophilous area of thermophilous woodland in the South (Fig. 6). To the NW, local exposure favours the dry evergreen laurel forest (*Visneo-Arbutetum canariensis*) forming transition areas with pine woodland.

However, the potential area of the association is larger (Fig. 8) because pine woodland extends over salic substrate on the upper-semiarid xeric and upper-dry pluviseasonal Thermomediterranean belts of the SW half of the island, where *Pinetum canariensis* subass. *juniperetosum canariensis* is well developed (Figs. 7 and 8).

Table 11. *Pinetum canariensis* Ceballos & Ortuño *ex* Sunding 1972 (*Cisto–Pinion*, *Chamaecytiso–Pinetalia canariensis*, *Chamaecytiso–Pinetea canariensis*).

Number	1	2	3	4	5
Number of relevés	16	8	21	15	5
Character taxa					
Pinus canariensis (A)	V	V	V	V	V
Pinus canariensis (B)	II	V	V	V	V
Cistus symphytifolius var. *symphytifolius*	III	V	II	V	III
Chamaecytisus proliferus subsp. *meridionalis*	V	IV	V	IV	IV
Lotus holosericeus	III	II	r	II	–
Bystropogon origanifolius var. *canariae*	I	I	r	–	–
Cistus symphytifolius var*. leucophyllus*	II	–	–	–	–
Companion taxa					
of *Cisto–Micromerion hyssopifoliae* and higher syntaxa (*Cisto–Micromerietalia hyssopifoliae*, *Kleinio–Euphorbietea canariensis*):					
Euphorbia regis-jubae	II	III	III	V	IV
Cistus monspeliensis	III	V	III	IV	V
Micromeria benthamii	III	IV	III	IV	IV
Echium onosmifolium	I	I	II	III	I
Micromeria lanata	+	V	II	–	I
Kleinia neriifolia	I	–	I	II	–
Echium decaisnei	–	–	+	+	III
Micromeria varia subsp. *meridialis*	–	–	+	III	–
Ceropegia fusca	–	–	+	I	–
Carlina canariensis	–	–	I	–	II
Rubia fruticosa	–	–	r	–	I
Aeonium percarneum	–	–	–	I	I
Atalanthus pinnatus	–	–	–	II	–
Carlina texedae	–	–	–	I	–
Allagopappus dichotomus	–	–	–	I	–
Kickxia scoparia	–	–	–	I	–
Parolinia ornata	–	–	–	+	–
Micromeria benthamii x varia	–	–	–	+	–
of *Cenchro–Hyparrhenietum hirtae* (*Hyparrhenion hirtae*, *Hyparrhenietalia hirtae*, *Lygeo–Stipetea*):					
Asphodelus ramosus	III	III	III	IV	II
Aristida adscensionis subsp. *caerulescens*	–	I	r	III	II
Hyparrhenia hirta	–	I	r	II	II
Phagnalon saxatile	–	–	–	II	I
Others					
Teline microphylla	+	I	+	II	II
Dipcadi serotinum	I	I	I	I	I
Lavandula minutolii	I	–	II	II	II
Argyranthemum adauctum subsp. *canariense*	II	–	r	+	–
Adenocarpus foliolosus var. *villosus*	I	–	I	+	–
Sonchus acaulis	I	–	+	–	I
Prunus dulcis	+	–	+	+	–
Rumex lunaria	–	I	I	+	–
Descurainia preauxiana	–	–	r	II	II
Aeonium simsii	I	–	–	I	–
Salvia canariensis	–	–	+	II	–
Ferula linkii	–	–	–	I	I
Paronychia capitata subsp. *canariensis*	–	–	–	I	I
Hypericum reflexum	–	II	–	–	–
Artemisia thuscula	–	II	–	–	–
Phagnalon purpurascens	–	–	–	II	–
Launaea arborescens	–	–	–	II	–

Other taxa. — in 1: *Pinus pinea* (cult.) I; — in 2: *Cytinus hypocistis* I, *Agave americana* I; — in 3: *Juniperus turbinata* subsp. *canariensis* r, *Allagopappus viscosissimus* r, *Asparagus plocamoides* r, *Vicia filicaulis* r, *Phoenix canariensis* r, *Arundo donax* r, *Juncus acutus* +, *Dittrichia viscosa* r; — in 4: *Aspalthium bituminosum* I, *Micromeria helianthemifolia* +, *Cheilanthes pulchella* +, *Lobularia canariensis* +, *Piptatherum caerulescens* +; — in 5: *Vicia cirrhosa* I. Origin of relevés. — 1. Salas *et al.* 1998, Table 1, rel. 2–3, 5–6 & 9–20; — 2. Pérez-de-Paz *et al.* 1994, Table 8, rel. 1–7 & 10; — 3. Ibid., Table VI; — 4. Ibid. Table III; — 5. Ibid., Table V.

Its structure and physiognomy are those of oligospecific woodland, terminal community of the climatophilous sere of upper-dry and subhumid pluviseasonal Thermomediterranean, dry, subhumid and humid pluviseasonal lower-Mesomediterranean all without trade-wind clouds, and subhumid and humid pluviseasonal upper-Mesomediterranean; along with edaphophilous sere of salic upper-semiarid xeric and salic lower-dry pluviseasonal Thermomediterranean of the Canary pine (*Pinus canariensis*) in Gran Canaria (*Pino canariensis sigmetum*).

The Gran Canaria pine woodlands are the best-represented arboreal community on the island, although they have been favoured by afforestation. Those of Inagua, Ojeda, Pajonales and Tamadaba are outstanding examples (Pérez-de-Paz *et al*. 1994).

Within the potential area of pine woodland, the broom scrubs of *Teline microphylla* and *Adenocarpus foliolosus* var. *villosus* (*Telino–Adenocarpion*) are widely present, especially in the less arid N and summit areas. The broom scrub dominated by *Chamaecytisus proliferus* subsp. *meridionalis* ("escobonal") constitutes a noteworthy facies of pine woodland in the dry SE sector (Salas *et al*. 1998). The decapitate soils, above all in Thermomediterranean areas, are colonised by rockrose scrub ("jaral") (*Euphorbio regis-jubae–Cistetum monspeliensis*). The *Artemisio–Rumicion lunariae* scrub is widespread on nitrophilous soils (Pérez-de-Paz *et al*. 1994, Salas *et al*. 1998).

Discussion

From a bioclimatic viewpoint, the large territory under the desertic bioclimate strikes the attention. In the westernmost islands of La Palma and Hierro, this is limited to a narrow strip along the S and W shores, being absent from the N slopes (Del-Arco *et al*. 1996, 1999a). It shows itself clearly in Gran Canaria, surrounding the island, even containing hyperarid territories, which in the rest of the western islands have only a testimonial presence in S Tenerife (Marrero *et al*. 2001). This large desertic ombroclime (with hyperarid and arid ombrotypes) establishes a connection with the eastern islands Lanzarote (Reyes-Betancort *et al.* 2001) and Fuerteventura (Rodríguez-Delgado *et al.* 2002). The Canary Inframediterranean thermotype may be linked floristically with the coastal NW African territories, by means of the crassicaule communities of *Aeonio–Euphorbion* on the islands and similar Rand-Flora remnants on the African continent (Rivas-Goday & Esteve 1965, Wildpret & Del-Arco 1987, Quézel 1979, Médail & Quézel 1999).

The Canary Islands together with Madeira and the Salvage Islands constitute the Canary subregion within the Mediterranean region (Rivas-Martínez *et al.* 1993a). The SW Moroccan territory, despite showing some climatic and floristic similarities to the Canary Islands in its Infra- and Thermomediterranean belts, is still considered to belong to the Western Mediterranean subregion (Rivas-Martínez 1995). Although using a slightly different classification, Médail & Quézel (1999) justify their biogeographical division of the Mediterranean region into Macaronesian and Mediterranean subregions by the high percentage of indigenous Mediterranean phanerophytes and therophytes, along with the low level of adaptative radiation in the Moroccan territory.

The biogeographical classification of the Canary Islands is reaffirmed by the following climatic, bioclimatic, floristic and phytocoenological criteria:

1. Mediterranean climate,
2. the practical absence of the Inframediterranean thermotype in the continental European Mediterranean territory, widely represented in the islands,
3. high percentage of endemism in the flora,
4. high percentage of endemic communities, *Kleinio–Euphorbietea canariensis* and *Pruno–Lauretea azoricae* being outstanding for their residual character.

This study leads us to consider the lower-semiarid xeric Thermomediterranean belt identified in Gran Canaria as belonging to the thermophilic woodland climatophilous sere. Nowadays the area is covered by legume scrub ("escobonal") and rockrose scrub ("jaral"). The study also reaffirms, within Gran Canaria, the assignation of the upper-dry pluviseasonal Thermomediterranean territories to the Western Canary pine woodland macrosere (*Cisto–Pino canariensis sigmion*), and the pluviseasonal Infra-, Thermo- and Mesomediterranean with trade-wind clouds, to the domain of evergreen laurel forest ("monteverde") (*Ixantho–Lauro azoricae sigmion*).

The different geological compositions of the SW and NE halves of the island give rise to noteworthy differences between the climatophilous and potential natural vegetation (Figs. 6 and 8). These differences, also present in other islands of the archipelago, e.g. Tenerife (Ladera de Santa Úrsula, Icod), mean a great expansion in the area occupied by some vegetation seres to the detriment of others. It is worth pointing out that climatophilous character should be assigned according to the optimum vegetation in the average soil and relief conditions of the territory (Géhu & Rivas-Martínez 1981). Regarding substrate, basaltic rock (basic) is the most widespread in the western Canaries, including Gran Canaria. Salic bedrock (acidic) is the second most common, indicating a particular geological situation. This may be considered edaphophilous when communities spread out of their normal chorological framework on basaltic substrates. The descent of pine woodland into the upper-semiarid xeric and lower-dry pluviseasonal Thermomediterranean is due to the salic bedrock, which determines the edaphophilous condition of the pine woodland sere growing over it.

The altitudinal descent of the cardón sere (*Aeonio–Euphorbio canariensis*) into Inframediterranean territories on the S slopes is worthy of attention, due to its edaphohygrophilous behaviour. As we have pointed out, the salic bedrock and soil does not appear to be the determining factor, but rather the shielding effect of certain superficial lava flows (malpaíses) which lower the evaporation rate and as a consequence increase soil water retention.

The potential natural vegetation map (Fig. 8) shows obvious differences from the map by Sunding (1972), which derive from a finer phytosociological definition of the most characteristic potential natural vegetation units, along with advances in bioclimatic studies.

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