CONTRIBUTIONS TO THE KNOWLEDGE OF THE VEGETATION OF THE CANARY ISLANDS

(TENERIFFE AND GRAN CANARIA)

BY

F. BØRGESEN

WITH AN APPENDIX

LICHENES TENERIFFENSES

SCRIPSIT

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D. KGL. DANSKE VIDENSK. SELSK. SKRIFTER, NATURVIDENSK. OG MATHEM. AFD., 8. RÆKKE, VI. 3.

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BIANCO LUNOS BOGTRYKKERI

1924

Memoriæ

delectissimi magistri demortui

EUGENII WARMING

qui primus studio oecologiæ plantarum operam dedit

pio animo hoc opusculum dicatur.

During the winter of 1921 I stayed on the Canary Islands from January to April.

After a brief sojourn in Las Palmas I went to Teneriffe, where I remained from the beginning of January till the end of February, then I went back to Gran Canaria, where I stayed until I left the islands in the middle of April.

During my stay in Teneriffe I lived for some length of time at Puerto Orotava and Santa Cruz.

From the former place, besides shorter excursions in the immediate neighbourhood, I made longer trips to the laurel wood near Agua Garcia, to the pine wood round Agua Mansa, and along the north side of the island to Icod de los Vinos, Buenavista and El Palmar.

From Santa Cruz I made excursions to the laurel wood of Las Mercedes.

During my stay in Gran Canaria I especially visited the hill-sides between Las Palmas and Puerto de la Luz, the Isleta, and the neighbourhood south of Las Palmas as far as Telde. Among longer excursions must be mentioned a trip to Moya on the north side of the islands made in order to find, if possible, remains of the old laurel wood which formerly covered a large area here. For a week or so I stayed up in Monte, from whence I visited the surrounding country and made an expedition up to the mountain village of Lagunetas.

The main object of my journey was to make collections of Algæ along the coasts. But the peculiar and extremely varied vegetation of the islands soon aroused my interest, the consequence being that I began to examine this also.

However, as the time which remained for this was very short, and during my visit I was so unfortunate as to bring on myself an attack of dysentery, which lessened my working-power, the following account is necessarily fragmentary, since I only managed to visit a few places. Similarly the lists of the flora from these localities must not be considered as more than approximately complete. In this connection it must also be remarked that the winter and spring of 1920—21 were very dry, and many species, especially therophytes, were badly developed or not at all.

In order to obtain the best possible results under these circumstances my method has been to examine the flora of a comparatively small district as thoroughly

as possible, trying to collect all the species growing there, and to decide their life form according RAUNKIÆR'S system.

I have only examined parts of the vegetation of the lower subtropical region, and the laurel wood and the pine-wood together with the maqui of the montanic region.

Magister K. GRAM hast most kindly determined my collection of flowering plants just as I have also discussed the life forms of some of the species with him. The keeper of the Botanical Museum, CARL CHRISTENSEN, has named the ferns etc.

Regarding the synonymy the names used in PITARD and PROUST'S work: »Les îles Canaries. Flore de l'archipel« have also been employed here.

Furthermore I must give my cordial thanks to Professor BROTHERUS, who has identified the mosses that I collected, and to Professor VAINIO, who has determined the lichens. As several new species were to be found among these, Professor VAINIO has sent me a description of them which appears as an appendix to this treatise.

Finally I owe a great debt of gratitude to Prof. RAUNKIÆR for the interest he has shown my work, just as we, according to his wish, have compared our determinations of the life forms of the Canarian flora, as Prof. RAUNKIÆR had already earlier determined these.

The drawings are made partly by mag. sc. O. HAGERUP, partly by mag. sc. O. ROSTRUP.

To the Military Governor of the Canary Islands, His Excellency General MONTE VERDE and to Colonel JESUS FERRER GIMENO I here want to express my sincerest thanks for the permission to explore the Isleta of which the military authorities have taken possession and which is closed to foreigners.

I should also like to convey my warmest thanks the former minister of foreign affairs, captain C. M. T. COLD, in 1920 Director of the United Steam Pacquet Company, Copenhagen, for his valuable assistance with regard to the dispatch of my scientific luggage.

Finally I am much indebted to the Trustees of the Carlsberg Foundation and the Rask-Ørsted Foundation for grants respectively to the drawings and figures and to the translation into English.

I.

The Low Land Region.

In the account of the vegetation of this region I have dealt with the following associations: The sandy beach, the dunes, the rocky shore, the dry flats and hills, the lava torrents and the rocky slopes.

The Sandy Beach Vegetation.

On the steep and very exposed rocky coasts of the two islands which I visited, Teneriffe and Gran Canaria, sandy beaches are only to be found in a few places.

As a rule deep inlets and bays, in which the sand can accumulate, are lacking and as furthermore the islands rise from the depths of the ocean without having any surrounding plateau where the water is shallow, this is, of course, to a great extent the cause of the rapid removal and disappearance into the sea of all loose material.

On Teneriffe I have only met with a sandy beach in the little bay east of Puerto Orotava where the sand being sheltered by the torrent of lava which has come down from the Montaña de las Arenas has been allowed to accumulate. Here the sand is black, being derived chiefly from fine-grained lava or basalt.

On Gran Canaria there is more sand. The little peninsula Isleta, on the north side of Gran Canaria, provides shelter and on the whole good conditions for the formation of sand. In Bahia del Confital, where the waves of the Atlantic rush inshore with tremendous force, great masses of sand are constantly cast ashore to such an extent that there is sufficient material for the formation of the huge moving dunes that cover the long tongue of land between the Isleta and the main island and over which the sand is again carried into the sea on the opposite side by the wind. The sand is here yellowish and rather fine.

However, no particularly rich sand-flora is developed in these places. Thus I do not remember seeing a single phanerogam plant on the broad plage at the interior of Bahia del Confital. The reason for this may be that the place is too exposed. At high water and in heavy seas nearly the whole beach is covered by the waves so that there is no time of rest in which the vegetation can gain a hold. But neither was there any particularly rich sandy beach vegetation on the other

side of the tongue. What one mostly met with here where ruderal plants. The great amount of house building here, together with the filling up and the erection of piers etc. are also, of course, an increasing hindrance to the vegetation.

In a more sheltered place on the north side of Bahia del Confital a small sandy beach locality was found with a rather rich vegetation. Here the sand was coarser and more compact, and consisted in great measure of calcareous shells and calcareous algæ etc.

South of Las Palmas and further south down towards Telde sandy beaches are to be found in places. I have seen them from the road, but I have not had the opportunity of examining these places more closely. However, there does not seem to be very much vegetation, the shore being too much exposed. Greater masses of sand are also said to be found at the south point of Gran Canaria, but I did not get so far.

Fig. 1. Growth of *Tamarix Gallica* var. *Canariensis* on the sandy beach near Puerto Orotava.

On the eastern islands, Lanzarote and Fuertaventura, there is a more extensive sand and dune formation with a considerably richer and more characteristic sand flora. Bolle[1] (l. c. 1892/3, p. 253) having especially studied the flora of these islands, mentions a whole series of species not to be found on the stretches of sand which I have seen.

Now I shall first mention the vegetation of the little bit of sandy beach near Orotava. The loose sand nearest to the sea is quite without vegetation; only where one comes to the stretches of sand that are not reached by the waves and therefore firmer, the vegetation begins. Here *Plantago Coronopus* was growing in abundance with rosettes as much as 20 cm. in width. Moreover *Aizoon Canariense* is common, forming great, wide-spread growths flatly pressed to the ground. The spatulate leaves are densely covered with waterfilled epidermal bladders (Volkens, l. c., p. 53, tab. XIII, figs. 6, 7, 8). The plant is annual and lives as long as the conditions are suf-

[1] For literature quoted here and in the following see list of literature.

ficiently favourable for it. VOLKENS (l. c. p. 123) writes that its supply of water is often not consumed till August.

The only plant with subterranean rhizomes which I have found here is *Heliotropium erosum*; it is a perennial plant of a greyish green hue, and densely covered with long hairs. *Alternanthera achyrantha* forms great mats with its shoots creeping along the surface of the ground. The stems are densely hairy and on the small, oval leaves scattered hairs are to be found. *Beta patellaris* has long stems lying along the ground. *Frankenia ericifolia* var. *latifolia* and *Polycarpaea Teneriffæ* form small, low compact tufts. Both have very strong main-roots. *Frankenia* has linear, fleshy leaves with densely placed hairs giving the plant a greyish-green hue. *Mesembryanthemum nodiflorum* forms small low tufts with its branches lying along the ground; its linear, fleshy, terete leaves are 5—6 cm. long with bladder-shaped hairs and a water storage tissue in the middle of the leaf. VOLKENS gives (l. c., pl. XIII, fig. 3) a transverse section of the leaf. Now and then a few small rosettes of *Polycarpon tetraphyllum* were to be found; they were of a fresh green colour with small, spatulate leaves. Of grasses *Penisetum cenchroides* was found, but just as is the case with several of the above mentioned species, one can hardly call this grass especially characteristic of the sandy beach alone. Finally on the side nearest to the land there was a small growth of *Tamarix Gallica* var. *Canariensis* (Fig. 1). The trees reached a height of about 4 to 6 m., as a rule one was just able to pass erect under them. The stems, their diameters reaching 20—30 cm. or more, were crooked and twisted, and the crowns spread themselves far out and grew into each other.

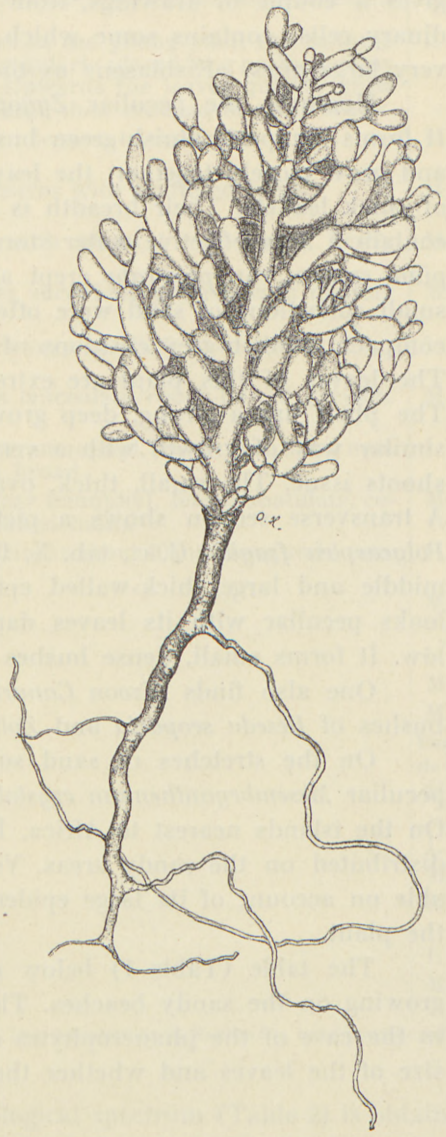

Fig. 2. *Zygophyllum Fontanesii* Webb. et Berth. A young plant.

The stretch of sand on the Isleta north of Bahia del Confital harboured a somewhat different flora. First of all the small, grey, annual *Oligomeris subulata* was conspicuous. It seldom grows higher than 20 cm. The branches are stiff, extending on all sides. The greyish leaves are linear to spatulate, rather fleshy, about two cm. long. VOLKENS (l. c.) has examined the plant and on plate VII, figs. 3—4

gives a couple of drawings, from which it appears that the epidermis, besides ordinary cells, contains some which are filled with mucilage and further more some very large ones, »Eisblasen« as they are called by VOLKENS.

Moreover the peculiar *Zygophyllum Fontanesii* was rather common (Fig. 2). It forms compact, bluish-green bushes about one foot high. The branches are erect and grow closely together, the leaves are opposite, with thick petioles and a couple of thick leaflets. Their breadth is somewhat greater than their thickness, and they contain a very effective water storage-tissue composed of thin-walled cells. *Heliotropium erosum* var. *prostrata* crept along in the sand, and behind its dense cushions small collections of sand were often present. Spread among this vegetation smaller, compact, whitish-grey cushions of *Frankenia lævis*, var. *capitata*, were to be found. The leaves of this plant are extremely small, often no more than 2—3 mm. long. The plant has a strong, deep growing, main root. *Polycarpœa candida* has quite a similar way of growth with a very thick, rugged main root from wich new, short shoots issue. The small, thick, oval leaves, about $^1/_2$ cm. long, are of a greyish hue. A transverse section shows a picture almost similar to the one VOLKENS gives of *Polycarpœa fragilis* (l. c., tab. X, fig. 1), namely roundish water-filled cells in the middle and large thick-walled epidermal cells. Finally *Senecio flavus* occurred; it looks peculiar with its leaves dark green on the upper side and deep purple below. It forms small, dense bushes about 20 cm. high.

One also finds *Aizoon Canariense* pretty frequently and more casually a few bushes of *Reseda scoparia* and *Zollikoferia spinosa*.

On the stretches of sand south of Puerto de la Luz large specimens of the peculiar *Mesembryanthemum crystallinum* were here and there growing on the beach. On the islands nearest to Africa, Lanzarote and Fuertaventura, this plant is widely distributed on the sandy areas. VOLKENS has examined it. It is especially remarkable on account of its large epidermal bladders, which cover all the green parts of the plant.

The table (Table 1) below gives a general view of the species I have found growing on the sandy beaches. They are arranged according to their life form and, in the case of the phanerophytes and chamaephytes, information is given as to the size of the leaves and whether these are succulent, hairy etc.

Table 1. Plants from the sandy shore arranged according to their life forms.

1) from Martianez, Puerto Orotava, Teneriffe (M.).
2) from Bahia Confital, Isleta, Gran Canaria (I.).

1 M.	Tamarix Gallica L.	Leptophyl. About 5—6 m. high tree.	M.
1 N.	Schizogyne sericea Schultz Bip.	Leptophyl. Leaves linear, abt. 15 mm. long and 1 mm. broad covered with long white hairs. Often a chamæphyte only.	I.

2 N.	Zollikoferia spinosa Boiss.	The ground leaves in the young plant two to three cm. long with irregularly placed long prolongations on both sides. Upwards the leaves quickly grow smaller, first linear then reduced to small scales.	I.
3 N.	Zygophyllum Fontanesii Webb et Berth.	Bifoliate, succulent leaves, nanophyl[1].	I.
1 Ch.	Alternanthera achyrantha R. Br.	Nanophyl; oval leaves with scattered hairs.	M.
2 Ch.	Argyranthemum frutescens Schultz Bip.	Laciniate leaves with about 1 mm. broad, fleshy lobes.	M.
3 Ch.	Frankenia ericifolia Chr. Sm. var. latifolia Webb.	Leptophyl. Leaves succulent, greyish with densely placed hairs.	M.
4 Ch.	Frankenia laevis L. var. capitata Webb.	Leptophyl. Leaves very small, 2—3 mm. long only; greyish.	I.
5 Ch.	Heliotropium erosum Lehm.	Nanophyl. Leaves lanceolate, rough-haired, greyish.	M. I.
6 Ch.	Polycarpæa candida Webb et Berth.	Leptophyl, but near nanophyl, leaves oval, abt. 6 mm. long and 4 mm. broad.	I.
7 Ch.	Polycarpæa Teneriffæ Lam.	Leptophyl, but near nanophyl, leaves spatulate, covered with air-filled hairs.	M.
8 Ch.	Reseda scoparia Brouss.	Nanophyl; leaves linear about 40 mm. long and 1 mm. broad.	I.
1 H.	Pennisetum cenchroides Rich.		M.
1 Th.	Aizoon Canariense L.		M. I.
2 Th.	Beta patellaris Moq.		M.
3 Th.	Coronopus didymus Sm.		M.
4 Th.	Mesembryanthemum crystallinum L.		Puerta de Luz
5 Th.	Mesembryanthemum nodiflorum L.		M. I.
6 Th.	Oligomeris subulata Boiss.		I.
7 Th.	Plantago Coronopus L.		M.
8 Th.	Polycarpon tetraphyllum L.		M.
9 Th.	Senecio flavus Schultz Bip.		I.
10 Th.	Stellaria media Will.		M.

[1] Regarding the compound leaf I must point out that I, in contradiction to RAUNKIÆR, have considered the leaflets as a biological unit juxtaposed the undivided leaf.

On the basis of this list the following biological spectrum (Table 2) is obtained.

Table 2. Biological spectrum of the sandy beach vegetation.

	Number of species	Percentage of species under each life form									
		S	E	M M	M	N	Ch	H	G	H H	Th
Sandy beach.....	23	..	..	..	4	13	35	4	..	..	44
Normal spectrum.... (after RAUNKIÆR)	1000	2	3	8	18	15	9	26	4	2	13

From this it appears that the therophyte % reaches 44 % or more than three times that of the normal spectrum; the high therophyte % is on the whole characteristic of the Canarian lowland vegetation. Next to them are the chamæphytes with 35 %, the phanerophytes reach 17 % (4 % M. and 13 % N.), and finally there are only 4 % of the hemicryptophytes.

When *Argyranthemum frutescens* is left out of consideration on account of its laciniate leaves, and when again *Zollikoferia spinosa* is looked upon as leptophyllous, because its large ground-leaves soon die away, 7 of 11 phanerophytes and chamaephytes have leptophyllous leaves and 4 nanophyllous. The size of the leaves in the perennial species is thus very small.

Moreover in several species the leaves are protected by densely-placed hairs.

Succulency is much developed in *Zygophyllum Fontanesii*, it is less so in *Frankenia*, *Argyranthemum* etc.

The Vegetation of the Dunes.

I have only had the oportunity of seeing actual dune formation in one place, namely on the tongue of land connecting the Isleta on the north side of Gran Canaria with the main island. Here there is a great shifting mass of dunes which

Fig. 3. Part of the dunes near Las Palmas. In the background the highland of Gran Canaria.

slowly moves across the tongue mostly in a south-easterly direction. But if one expects a rich flora here, one is soon disappointed, the dunes being almost entirely without vegetation (Fig. 3). Only at their south-eastern end is there a fall (Fig. 4) carrying a comparatively luxuriant vegetation.

As everywhere in the environs of Las Palmas the vegetation here also bore witness to the heavy rainfall of the year before, which was in strong contrast with the very dry year of 1921. This was especially evident in the fact that numerous,

Fig. 4. View of the dune-vegetation. Bushes of *Salsola Kali* at the left and behind; most of these (all the large ones) are from the year before and now dead. In the middle *Lycium Afrum*. The rounded mountains of the Isleta are seen in the back-ground.

large, dead, year-old specimens, more than a metre high, were to be found of the annual *Salsola Kali* (Fig. 4), whereas this year's plants were quite small, seldom a foot high and most of them much smaller. And already they were in full bloom and would scarcely become much larger. The year before this plant had formed the main mass of the vegetation; now it was far behind both in size and number.

Of plants with subterranean creeping stems *Cynodon Dactylon* was common. It has long but not especially deep running rhizomes, from which here and there tufts grew up. Moreover the coarse *Galilæa mucronata* crept in the sand. It is a greyish-green, stiff plant with long and deep-going runners forming rosettes here and there above the sand, which are surrounded underneath by brown sheaths. The leaves are a foot long, more or less involute and falcate; from the centre of the

rosetts rises a stiff, straight axis bearing the inflorescence. *Euphorbia Paralias* has long, spreading, subterranean runners but it was only present in a small area. *Heliotropium erosum* was rather common, forming here and there greyish tufts arising from the rhizomes.

Ononis Natrix forms large compact bushes reaching a height of about two feet. It is a thorny, greyish-felted bush, with small leaves, the single leaflets of which are dentated along their margins and sticky like the whole plant. Up the main branches short shoots are developed, bearing leaves at their base and flowers towards the top, and when the latter fall off, the flowerstalks, 3—4 cm. long and covered thickly with glandular hairs, remain and contribute to give the plant a peculiar, unpleasant appearance.

Ononis serrata is another, somewhat smaller and greener bush, which is not prickly. It is very hairy and sticky consequently covered with grains of sand.

Here and there *Beta patellaris* covered the sand with its long shoots lying along the ground.

Then there were large bushes of the very thorny and therefore very disagreable *Lycium Afrum*, which is not, however, without a certain beauty, since its branches bend gracefully to the ground in large curves (compare Fig. 4). The branches bear a number of short, stiff, pointed thorn-shoots. The leaves are small, grey-felted, linear-lanceolate and thick. The flowers are dark purple, and the fruit of a magnificent coral red colour.

Finally a few large bushes of *Plocama pendula* were to be found, one of which was strongly attacked by *Cuscuta Epithymum*. Likewise there were a few bushes of *Zollikoferia spinosa*. Both must however be considered as chance comers on the dunes.

Here and there a smaller plant, *Lobularia Lybica* occurred; it is a greyish, thickly felted plant, almost a foot high, with small, erect, linear-lanceolate leaves.

This is all that was to be found on the dunes. Altogether it was a rather poor flora but, taking into consideration that most of the dunes had no vegetation at all, nevertheless rather much. I have wandered over the dunes in several directions and have found nothing. Only in one place on the east side at the road to Las Palmas, a few plants of a small variety of *Ononis serrata* were to be found, namely the variety *prostrata* Boiss.

In the following survey (Table 3) the species are arranged according to their life forms.

Table 3. Plants from the dune, Las Palmas.

1 N.	Lycium Afrum L.	Leptophyl, leaves about 10 mm. long and 2 mm. broad.
2 N.	Ononis Natrix L. var. ramosissima Rchb.	Nanophyl; perhaps sometimes a chamaephyte only.
3 N.	Plocama pendula Ait.	Nanophyl. Only two specimens seen.
4 N.	Zollikoferia spinosa Boiss.	Leptophyl (see remarks p. 291) like Plocama casual.

1 Ch.	Heliotropium erosum Lehm.	Nanophyl, leaves 10—12 mm. long and 4—5 mm. broad, densely covered with rough hairs.
2 Ch.	Euphorbia Paralias L.	Nanophyl.
1 H.	Cynodon Dactylon Rich.	
1 G.	Galilea mucronata Parl.	
1 Th.	Beta patellaris Moq.	
2 Th.	Cuscuta Episonchum Webb et Berth.	On Zollikoferia spinosa.
3 Th.	Cuscuta Epithymum Murr.	On Plocama.
4 Th.	Lobularia Lybica Webb.	
5 Th.	Ononis serrata Forsk.	BATTANDIER et TRABUT consider this plant as ⊙ and I refer to it here in that way although I suppose that it might at times be an hemicryptophyte in the Canary Islands.
6 Th.	Salsola Kali L.	

On the basis of this list the following biological spectrum (Table 4) is obtained.

Table 4. Biological spectrum of the dune-vegetation.

	Number of species	Percentage of species under each life form									
		S	E	M M	M	N	Ch	H	G	H H	Th
Dunes at Las Palmas.	14	..	..	..	..	29	14	7	7	..	43
Normal spectrum....	1000	2	3	8	18	15	9	24	4	2	13

Just as in the flora of the sandy beach, the therophytes predominate, reaching 43 %, about the same percentage that we find there; then follow the nanophanerophytes with 29 %, the chamaephytes with 14 % and finally the hemicryptophytes and the geophytes, each with 7 %.

The size of the leaves here also is small. Of the 6 species of nanophanerophytes and chamaephytes 2 species are leptophyllous and 4 nanophyllous.

Three species are more or less strongly hairy. *Euphorbia Paralias* is glaucous; *Lycium* and *Plocama* have succulent leaves.

To be able to compare the Canarian sandy shore vegetation (beach and dune) with the sand vegetation from other climates I have in the scheme given below (Table 5) placed the biological spectrum of the Canarian vegetation together with one from the tropical zone and one from the temperate, both spectra being based upon the calculation of RAUNKIÆR (l. c., 1909, p. 59).

Table 5. Biological spectra of sandy shore vegetation from different climates.

	Number of species	Percentage of species under each life form									
		S	E	M M	M	N	Ch	H	G	H H	Th
St. Croix. Sandy Point	80	..	2.5	..	7.5	62	17	4	1	..	5
Can. Isl. Sandy beach and dunes.....	34	..	..	..	3	18	26	6	3	..	44
Denmark. Skallingen.	105	..	..	..	..	1	7	47	16	3	26
Normal spectrum....	1000	2	3	8	18	15	9	26	4	2	13

In that of the tropical zone based upon the vegetation of Sandy Point at the formerly Danish West Indian Island St. Croix, it is seen that the tropical Phanerophyteclima also stands out very clearly in the biological spectrum from the sandy shore even if the comparatively rather rough climate prevailing here makes the phanerophytic vegetation lower, making here several species nanophanerophytes which in more favourable localities are mesophanerophytes; the nanophanerophytes have the highest percentage with no less than 62 %, the mesophanerophytes have 7.5 and even the epiphytes are precent with a small percentage of 2.5 %.

If now we compare the Canarian sandy shore vegetation with the tropical spectrum, we find that the phanerophyte % is very much reduced and the epiphytes have quite disappeared; to make up for this the chamaephyte % is increased a good deal, but it is the therophyte % which shows the largest increase, in accordance with not only the whole Canarian low land vegetation but upon the whole with all dry subtropical areas which, as shown by RAUNKIÆR, just are characterised by the large therophyte % (therophyteclima, RAUNKIÆR, 1908, p. 54).

If finally we consider the biological spectrum based upon the vegetation of the sandy coast in the temperate zone, namely from the peninsula Skallingen on the west coast of Jutland, it is seen that the hemicryptophyte % is now the most dominant, the therophyte % is very much reduced to not far from half of that in the subtropical zone; the chamaephytes are reduced very much. On the other hand the geophyte % has increased.

The Vegetation of the Rocky Shore.

On the steep rocky coasts of the Canary Islands which in most cases rise abruptly from the sea, there are almost always powerful breakers. Unbroken, the mighty Atlantic waves strike against the land with reverberations like thunder, and the spray and foam rise up on the coasts in mighty cascades, and are carried higher up by the wind. Up to what level the influence of the sea is noticeable, it is rather hard to say, but it is a fact that particles from the sea are carried up to a height of

several hundred feet. Therefore the rocky slopes along the sea shore have a vegetation which to a great extent receives its character from the sea. Several species are to be found here which gradually disappear higher up as the influence of the sea grows less.

I have had the opportunity of becoming specially acquainted with the vegetation of the rocky shore through repeated visits to the rocks of La Paz, east of Orotava. It is a very exposed piece of coast, consisting of a steep, rugged, rocky wall, full of holes and chinks against which the Atlantic swell is dashed and the showers of fine spray are carried by the wind high up the rocks. There are a couple of paths on the rocky sides along which one can pass and thereby get a glimpse of the vegetation.

The lowest, most exposed part of the rocks, being constantly sprinkled by the surf, is destitute of the higher plants. Here only algæ and lichens are to be found. The phanerogamous plants only appear at about 100 feet above the sea, the height varying of course according to the degree of exposure.

A whole series of plants is to be found here. First there are several species with long, decumbent stems hanging down the rocky walls and slopes. Among these *Salsola longifolia* must be mentioned, a bush with fleshy, terete, bluish-green leaves about $1^1/_2$ cm. long and 3—4 mm. thick. According to VOLKENS l. c. p. 59 and p. 139, pl. XII, fig. 4, the leaf has in its centre a thick water tissue. Further *Beta vulgaris* and *Beta procumbens*, both with long, decumbent stems and fleshy leaves. Then *Atriplex glauca* was found, with small, oblong, lanceolate, silver grey leaves, about $1^1/_2$ cm. long, and finally *Mesembryanthemum nodiflorum* already mentioned as growing on the sandy beach.

In the crevices the thick-leaved, bluish-green *Crithmum maritimum* was to be found here and there.

Artemisia Canariensis forms large, silver-white, strongly aromatic bushes and *Sisymbrium millefolium* with a somewhat similar appearance, although a good deal smaller, is endowed with elegant, finely-divided, silver-white leaves.

Lobularia Lybica and *Lobularia intermedia* form dense white flowered, small bushes which hang down from the rocks. While *L. intermedia* is a chamaephyte, *L. Lybica* is a therophyte only; both have small ovate-lanceolate leaves, thickly covered with silky hairs.

Linaria Graeca has decumbent branches; the leaves are broad, with hastate base, and scattered stiff hairs.

Here and there small bushes are to be found of *Statice pectinata*, only about 10 cm. high, with spatulate, bluish-green leaves about 2 cm. long, and of *Micromeria hyssopifolia* var. *hirta* a small ericoid bush forming dense, low cushions; the leaves are ovate, densely hairy and $1^1/_2$ cm. long.

Spergularia marginata is a little perennial bush with decumbent branches. The leaves are fleshy, terete, linear, and may be as much as 4 cm. long.

On small terraces with some soil, *Andropogon hirtus* was common, and where it was damper *Cyperus fuscus* grew. Then some specimens were to be found of *Aeonium Lindleyi* with a very ramified stem, and thick, sticky, hairy leaves, gathered in rosettes at the end of the branches. Seen at some distance it may often remind

one a good deal of a small-leaved *Rhododendron*. And in such places several therophytes also occur: *Parietaria Judaica* with leaves 2 cm. long and 1 cm. broad and with scattered, stiff hairs, *Chenopodium murale*, *Aizoon Canariense* and the above mentioned *Beta* species, etc.

Quite low, dense tufts, reminding one strongly of those of *Saxifraga*, were

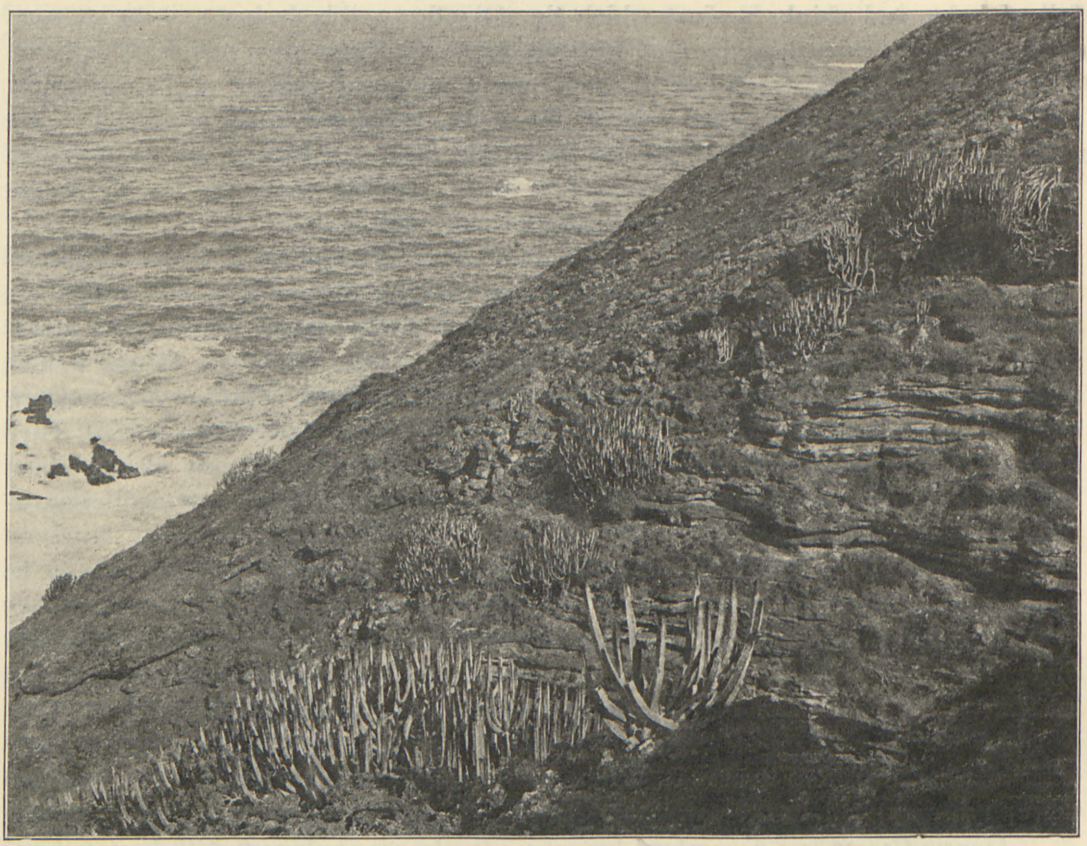

Fig. 5. Rocky slopes near La Paz at Puerto Orotava with *Euphorbia Canariensis*.

formed by the two small *Petrophyes*-species, *P. brachycaulon* and *P. polyphyllum*; they covered perpendicular rocky walls in caves and fissures.

In the narrow fissures of the rocks the thick shining foliage of *Asplenium marinum* protrude, and in similar but damper places *Adianthum capillus veneris* was common.

Here and there tufts of *Urginea Scilla* are seen and far down the rocks *Euphorbia Canariensis* (Fig. 5) grows and even *Euphorbia regis Jubae* and *Kleinia nereifolia* go rather far down to the sea, just as *Argyranthemum frutescens* thrives vigorously here.

On the steep rocky coast north of Santa Cruz, on the road to the hamlet of St. Andres, several plants are to be found which are more or less attached to the

sea. Here one meets with the succulent *Astydamia Canariensis, Beta patellaris, Rumex vesicarius* and *Portulaca oleracea.* In rocky crevices the bushy *Campylanthus salsoloides* was growing, reaching a height of about a metre; it has terete, succulent leaves. It was here also that I made the acquaintance for the first time of the thorny *Zollikoferia spinosa* which in places was very common, being however not specifically maritime, though often to be found near the sea.

Astydamia Canariensis was also common on rocky shores south of Las Palmas on the road to Telde.

I have already mentioned that *Euphorbia Canariensis* may grow rather near to the sea, but this plant has its principal habitat in the interior, on the rocky slopes and lava-torrents far from the sea, where the conditions suit it. On the other hand I do not believe this to be the case with another succulent *Euphorbia* peculiar to the Canarian Islands, namely *E. aphylla*, which, as far as my observations go, and contrary to the common understanding, must even be accounted as a rather marked holophyte. I became acquainted with this plant for the first time at Gran Canaria, when I came up into the hills which, beginning at Bahia del Confital along the east coast of the island, stretch towards the south, leaving a narrow border of lowland next to the sea. When one goes from the east coast up the slopes, the usual low shrubs and herbs characteristic of these dry regions, which will be mentioned later on, are at first to be met with. But coming over the hill-crest, where one is met by the fresh wind from the sea, and then descending the slopes towards Bahia del Confital, one soon meets first scattered specimens and later on even a rather dense vegetation of *Euphorbia aphylla* (Fig. 6). It is only near the Bahia del Confital that it is found; withdrawing from the sea towards the south-east one finds that it soon ceases. I have not seen it in the environs of Las Palmas[1] and still less south of the town.

If it is asked why this is so, I believe the answer is that *Euphorbia aphylla* is a plant preferring to grow near the beach in places where the fresh, moist sea air blows over it, carrying with it particles of salt. When this is once clearly understood, one soon notices how even a slight rise in the ground may prevent its occurrence. On the side facing the wind it grows vigorously, while it is quite absent on the sheltered side, or only present in a few wretched specimens. Thus it is entirely lacking on the side of the hills facing east, but it increases in number as one approaches Bahia del Confital, until the sand from the large dunes and the buildings put a stop to its occurrence.

My opinion had been abundantly confirmed that, all things considered, it must surely be regarded as a holophyte or at any rate as a plant growing near the sea,

[1] Describing the vegetation in Baranco de Guiniguada ENGLER writes (l. c., 1910, p. 831): »Am linken Ufer erscheint sehr häufig oft eine 10—20 Quadratmeter grosse Association bildend *Euphorbia aphylla* Brouss.« As said above I have not seen it near Las Palmas; very likely it is exterminated owing to the great amount of building; but as Baranco de Guiniguada passes through Las Palmas down to the sea, it has perhaps been growing near the beach.

when one day I prolonged my walk on the Isleta beyond the places on the north side of Bahia del Confital at which I was examining the algæ. Here, on the north side of the bay, I had found the above-mentioned sandy-beach vegetation, but I had seen nothing of *Euphorbia aphylla*. However, one day I continued my walk round the sharp western corner of the peninsula. When one passes the promontory, the ground rises rather steeply, and it is consequently comparatively sheltered, but

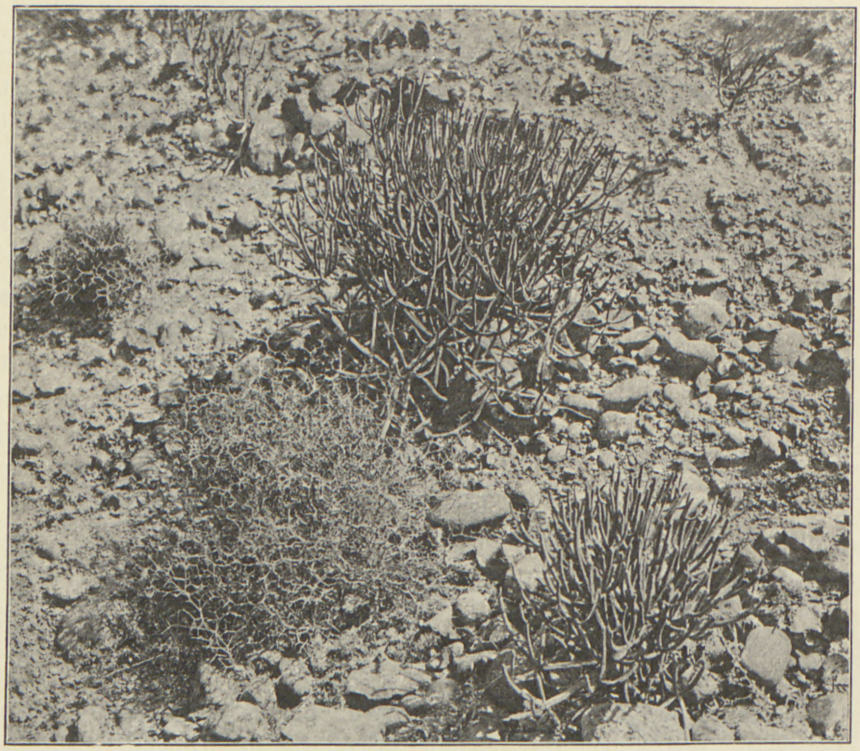

Fig. 6. *Euphorbia aphylla* together with *Zollikoferia spinosa* from dry hills near Bahia del Confital.

at the very moment that one reaches the ridge and sees, on the other side, the rock sloping slightly to the sea, one is met by the wind, and at the same time the vegetation very suddenly changes its character. As far as the eye could reach, innumerable specimens of *Euphorbia aphylla* grew here side by side. It is remarkably vigorous here, the picture of health, and it had, like the best-developed specimens on the hills, a bluish-green hue. That it is a beach plant here, growing as it does in close proximity to the sea, cannot be denied. The northern coast of the Isleta is extraordinarily exposed. The swells break against the rocks in high cascades and the wind carries the spray and foam far up over the evenly sloping foreland, giving to the plants a rich contribution of moisture and salt particles from the sea. Growing as it does here, in all its luxuriance, far more vigorously than on

the hills on the other side of Bahia del Confltal, it appears, in my opinion, to be undoubtedly a halophyte. The whole appearance of the plant also shows that it must be a halophyte. Indeed it strikingly resembles a *Salicornia* that CHRIST has pointed out (l. c., 1885, p. 467), without however emphasising that it had anything to do with the sea, which, on the other hand, he expressly mentions when speaking of *Statice*. Unfortunately I had no opportunity of seeing its known place of growth on Teneriffe, which is at the most westerly point of the island, Punta de Teno, and therefore in close proximity to the sea, and very likely in a place just as exposed as its habitat on the Isleta.

Of its occurrence on Teneriffe ENGLER only writes (l. c. p. 845): »Nahe am Strande findet sich *Beta macrocarpa* Guss, *Atriplex parviflorum* Lowe, *Salsola longifolia* Forsk., *Euphorbia aphylla* Brouss.«

And when consulting the literature on the subject in order to find out how this plant is regarded by different investigators, one finds that with a single exception it is regarded as characteristic of the driest regions, but, on the other hand, not as a halophyte. SCHENCK, for instance, writes (l. c., 1907, p. 258) as follows about its occurrence: »Auf Tenerife kennt man für die Tolda (the Canarian name of this plant) nur einen Standort, nämlich Felsen in der Nähe der Küste bei Buenavista in der Nähe der Westspitze der Insel, der Punta de Teno. Auf Gran Canaria wächst sie häufig an Felsen bei Las Palmas und auch auf Gomera kommt sie vor.« I have not been able to find anything about its occurrence on the last-mentioned island. BOLLE (in Zeitschrift f. allgem. Erdkunde, N. F., XII, 1862) does not mention it.

In his work: Vegetation und Flora der Canarischen Inseln (Englers bot. Jahrb., Bd. 6, 1885) CHRIST writes p. 467: »Mehr den trockensten, südostlichen Insellagen eigen ist eine niedrigere, aber um so dichtere Strauchform: die *E. balsamifera*, ... ebenso die durch tiefroten Bracteen hervorragende *E. atropurpurea*, die völlig blatt- und stachellose *E. aphylla*, einer dickgliedrigen *Salicornia* vergleichbar.«

VAHL (l. c., 1904, p. 123) does not specially mention this plant, but only writes in a general way: »The lowest region is a typical succulent steppe especially formed by half-bushy *Euphorbieæ*, *Kleinieæ*, *Compositæ* and *Labiatæ*.«

In WARMING'S Oecological Plant Geography (l. c., p. 856) *Euphorbia aphylla* on the other hand is mentioned as being characteristic of the lowland vegetation together with *Euphorbia Canariensis*, *Kleinia nereifolia* etc. WARMING relies on the observations of CHRIST, VAHL and SCHRÖTER.

Only in LEOPOLD VON BUCH'S »Physikalische Beschreibung der Canarischen Inseln« p. 168 the following is to be found about its distribution and occurrence: »Auf den Abhängen unter dem Fort S. Nikolas. Las Palmas, Gran Canaria und Isleta, sonst nicht weiter. Wahrscheinlich eine Meerpflanze.« As is well-known, BUCH was accompanied by CHR. SMITH, but in his diary I have found nothing about the occurrence of *Euphorbia aphylla*. BUCH'S remark about this plant has consequently been overlooked.

I therefore believe that this plant, which grows, as is evident from the above

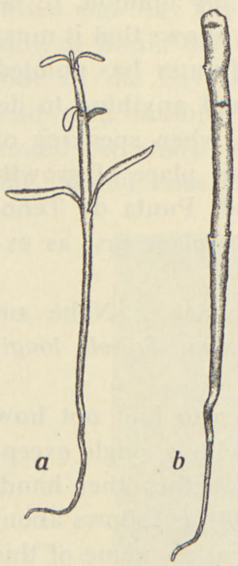

Fig. 7. *Euphorbia aphylla* Brouss. *a*, a cotyledonous plant from the hot house in the Botanic Garden, Copenhagen. *b*, a young plant with scars of the cotyledons from the hills at Las Palmas.

mentioned description, on rocky shore or on hard, firm, stony ground near the sea, must be looked upon as an halophyte.

Euphorbia aphylla is a small richly-ramified bush, seldom more than $^1/_2$—$^3/_4$ metre high. The branches are given off several together at the top of the mother-branch. The leaves are only present as small scales. The topmost branches are bluish-green, lower down the older branches become greyer. The inflorescences are yellow, collected at the top of the branches. The fruits are reddish brown.

A transverse section of a branch shows a water storing tissue in the middle, round this a circle of vascular bundles and these are again surrounded by a parenchymatic tissue, the cells of which contain a good many large granules of starch. Then follows a layer of lengthened palisade-like cells containing chloroplasts and finally round about these there is an epidermis formed by large cells with very thick peripheral walls.

In the very dry spring of the year 1921, I did not succeed in finding any quite young cotyledonous plants. On the other hand several young plants were to be found, which probably originated in the previous much damper year (Fig. 7 *b*). They were unramified, terete and clavate, about 5—6 cm. high. At the base of the stem, scars were left by the cotyledons. Up the stem there were opposite, small, scaly leaves, more rarely there were three in a whirl.

When by chance I happened to examine an old plant in the hot-houses of the Botanical Garden, Copenhagen, I found in the gravel below it a number of cotyledonous plants of which fig. 7 *a* shows one. From this it is seen that the young plant has two well-developed, linear-lanceolate cotyledons; the stem is also in the quite young plant somewhat clavate, and this character is most probably more developed in its native growing place, growing as it did here in shadow and much moisture. By reason of this the succeeding leaves were also rather large, while those in plants from Las Palmas were scale-like.

In the following list (Table 6) the species found are arranged in accordance to their life-forms, while regarding the phanero-

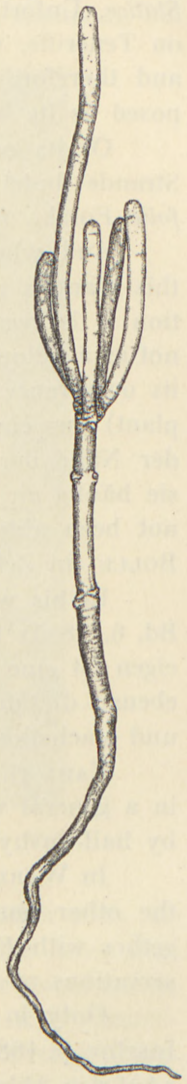

Fig. 8. *Euphorbia aphylla* Brouss. A somewhat older plant with the first whirl of branches.

phytes and chamaephytes notes are given as to their size of leaf, if they are hairy or not etc.

Table 6. Plants mostly from the rocky shore at Orotava and the coast north of Santa Cruz.

1 S.	Euphoraia Canariensis L.	Milky juice.
2 S.	Euphorbia aphylla Brouss,	Milky juice.
1 N.	Aeonium Lindleyi Webb et Berth.	Nanophyl but near the limit of microphyl; leaves succulent, spatulate, sticky.
2 N.	Atriplex glauca L.	Leptophyl; leaves oval, about 5 mm. long and 2—3 mm. broad, greyish with airfilled hairs.
3 N.	Campylanthus salsoloides Webb.	Nanophyl; leaves linear, fleshy, about 4 cm. long and $1^1/_2$ cm. broad.
4 N.	Euphorbia regis Jubae Webb et Berth.	Microphyl; leaves lanceolate, about 7 cm. long and 6 mm. broad. Milky juice.
5 N.	Kleinia nereifolia Haw.	Microphyl; leaves linear-lanceolate to spatulate, about 14 cm. long and 15 mm. broad, succulent.
6 N.	Salsola longifolia Forsk.	Leptophyl; leaves about 12 mm. long and $1—1^1/_4$ mm. broad, linear, succulent; near the base of the plant the leaves are bigger = nanophyl.
7 N.	Zollikoferia spinosa Boiss.	Leptophyl (se remarks p. 291, Dune-plants).
1 Ch.	Argyranthemum frutescens Schultz Bip.	Laciniate leaves, fleshy, glaucous with linear lobes.
2 Ch.	Artemisia Canariensis Lees.	Laciniate leaves with linear lobes, densely white-haired.
3 Ch.	Crithmum maritimum L.	Laciniate, fleshy, glaucous leaves.
4 Ch.	Lobularia intermedia Webb et Berth.	Leptophyl; leaves linear-spatulate, densely haired, about 15 mm. long and 1 mm. broad.
5 Ch.	Micromeria hyssopifolia Webb et Berth.	Leptophyl; leaves about 6 mm. long and 1 mm. broad, densely haired.
6 Ch.	Petrophyes brachycaulon Webb et Berth.	Leptophyl; leaves succulent, spatulate, about 8 mm. long and 3 mm. broad.
7 Ch.	Petrophyes polyphyllum Webb et Berth.	Leptophyl; leaves succulent, about 5 mm. long and 2 mm. broad.
8 Ch.	Polycarpæa Teneriffæ Lam.	Leptophyl but near nanophyl, leaves densely haired.
9 Ch.	Sisymbrium millefolium Ait.	Laciniate leaves with linear lobes,whitish with dense hairs.
10 Ch.	Spergularia marginata Kittel.	Leptophyl; leaves linear, fleshy, about 25 mm. long and $^1/_2—1$ mm. broad.
11 Ch.	Statice pectinata Ait.	Nanophyl; leaves spatulate.
1 H.	Andropogon hirtus L.	
2 H.	Astydamia Canariensis D. C.	
3 H.	Cyperus rotundus L.	
4 H.	Senecio Tussilaginis Lees.	
5 H.	Urginea Scilla Steinh.	
1 Th.	Aizoon Canariense L.	
2 Th.	Antirrhinum Orontium L.	
3 Th.	Beta patellaris Moq.	
4 Th.	Beta procumbens Chr. Sm.	
5 Th.	Beta vulgaris L.	
6 Th.	Chenopodium murale L.	
7 Th.	Linaria Græca Chav.	

8 Ch.	Lobularia Lybica Webb et Berth.
9 Th.	Mesembryanthemum nodiflorum L.
10 Th.	Parietaria Judaica L.
11 Th.	Portulaca oleracea L.
12 Th.	Rumex vesicarius L.

On the base of this list the following biological spectrum (Table 7) is obtained.

Table 7. Biological spectrum of the rocky coast vegetation.

	Number of species	Percentage of species under each life form									
		S	E	M M	M	N	Ch	H	G	H H	Th
Rocky Shore.....	37	5	..	..	..	19	30	13	..	..	33
Normal spectrum....	1000	2	3	8	18	15	9	26	4	2	13

From this it is seen that the therophyte $^0/_0$ has been much reduced as compared with the spectrum of the sandy beach, reaching only 33 $^0/_0$, the chamaephyte $^0/_0$, 30 $^0/_0$, is a little lower, too, than that of the sandy beach; on the other hand the hemicryptophyte $^0/_0$ is much increased. And furthermore here is 5 $^0/_0$ succulents.

The Vegetation of the dry Flats and Hills.

Along the east coast of Gran Canaria, beginning south of the large dune lying between the Isleta and the main island, a belt of lowland is to be found, which inland merges into rounded hills reaching a height of 4—500 feet or somewhat more, making an even transition to the highlands of the interior.

On this belt of land Las Palmas is situated. It continues further on towards the south past the town of Telde where it spreads out into wider plains. On these dry and hot areas a particularly zerophytic, desertlike vegetation is to be found. Cultivation can only take place where irrigation is possible, and in such localities bananas as well as oranges thrive excellently.

The soil of these regions is a stiff, yellowish clay, almost as hard as stone in its dried-up and sunburnt state. As a rule many smaller and larger stones are mixed with it, just as the soil in places is more sandy or gravelly.

The climate here is very dry. Unfortunately the meteorological records as regards Gran Canaria, are very few, and in the case of Las Palmas even rather irreconcilable. In Hann's Handbuch der Klimatologie, III. Bd., II. Teil, 1911, p. 46 the yearly amount of rain for Las Palmas is thus said to be 28.6 cm. whereas the corresponding figure in Brown's Madeira, Canary Islands and Azores, London 1919,

p. e 2, is 8.348 inches or nearly 21 cm., rather a great difference. But as these observations were made during a period of only 5 years, whereas HANN's are based upon 15 years, the latter is probably the most correct. On the accompanying hydrotherm figure I have given the curves for the temperature and rainfall of Las Palmas.

By this it is to be seen that the temperature is rather uniform all the year round. The coldest months are January and February with 17.1 degrees C, the hottest is August with 23.2 C°. The greatest amount of rain, 7.2 cm., falls in November, in December it sinks to 6.6, and in January to 3.5, and in February—March it remains about 2.5. In April it goes down to 1.7 and then it is, in the following 5 hottest months, below 1, indeed in June and July there is practically no rain. As said, the above figures apply to Las Palmas. However, south of this town it is very likely far drier. While the vegetation of the northern hills, particularly that of Bahia del Confital, is still influenced by the air coming direct from the sea and thus conveying to it some freshness and dampness, this effect is found to be diminished as one gradually comes southward. And when Telde is reached, the wind, having first passed the interjacent rather high country, has become dry and often foehn-like. The vegetation here therefore is very xeromorphic. And this dryness increases still more towards the south. A few miles south of Telde in the areas belonging to the driest regions of the Canarian Islands, Montaña de las Quatro Puertas is situated, where the Canarian people dried and embalmed their dead.

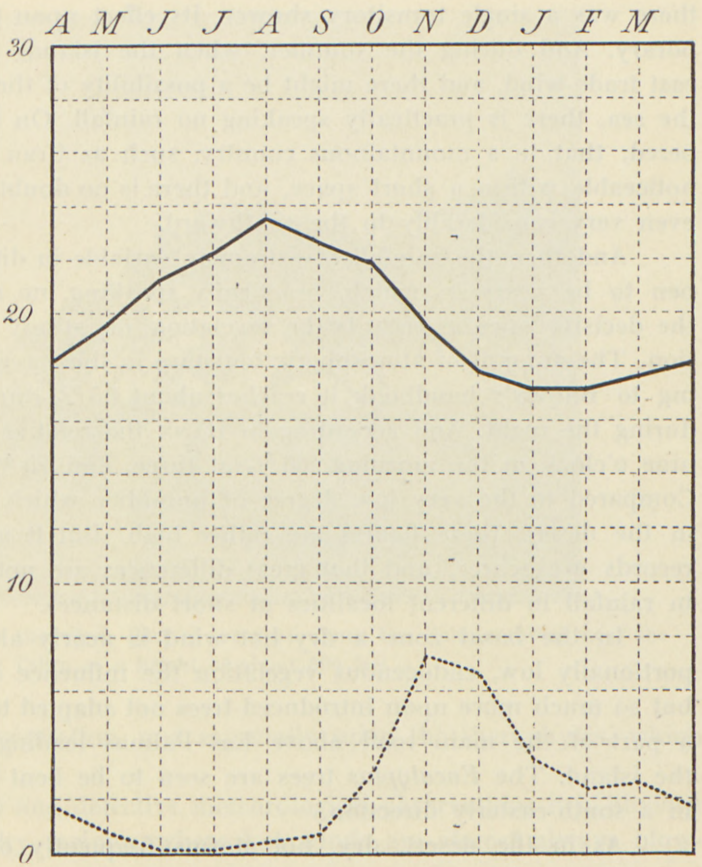

Fig. 9. Hydrothermic figure of Las Palmas. —— curve of temperature, ····· curve of rain fall. The figures signify Centigrade for the temperature and cm. for the rain curve.

Now this area of land lies along the east coast of the island and so might be supposed beforehand to be influenced by the north-east trade-wind, but during the

winter time the trade-wind withdraws from the islands so that these are partly beyond its influence. According to HANN the south wind is then said to be the most common, but during the time I stayed in Las Palmas (in March to the 8th of April) it almost always blew from the north or rather north-west. And the consequence of this was that the showers partly drifted over the Isleta, partly over the heights in the inland, while the belt of low country had no rainfall. Only twice or thrice there was a single transitory shower. Its effect upon the vegetation was quite temporary. And during the summer, when the islands are in the path of the north-east trade-wind, and there might be a possibility of the conveyance of moisture from the sea, there is practically speaking no rainfall. On the whole it must be remembered, that in a mountainous country, such as Gran Canaria, great differences are noticeable within a short space, and there is no doubt but that the rainfall decreases even very considerably to the southward.

And then the rainfall is extremely variable in different years. Often there happen to be years in which, practically speaking, no rain falls, and such years are the decisive ones as regards the vegetation, or, at any rate, greatly affects the vegetation. The amount of atmospheric moisture in these regions is also very low. According to BROWN's handbook it reaches about 65 % during the day, and about 75 % during the night. And according to HANN the relative average humidity is 68 % at nine o'clock in the morning, 66 % at three, and 75 % at 9 o'clock in the evening. Compared to the very low degree of humidity which is to be found in many places in the desert, these figures are rather high. But it must not be forgotten that the records are scarce, and that great differences are noticeable both in humidity and in rainfall in different localities at short distances.

In the basal zone a dry hot wind is nearly always blowing. Upon the proportionally low, endogenous vegetation the influence of the wind is not much seen, but so much more upon introduced trees not adapted to the climate. Figure 10 shows a part of the main road above Las Palmas leading to Tafira and the interior of the island. The *Eucalyptus* trees are seen to be bent like long banners by the wind in a south-easterly direction.

As in the desert, dry, hot storms frequently occur in the Canarian Islands, often followed by showers of sand and dust. Such a sand-storm took place, for instance, in the days from the 8th to the 11th of February 1920 on Gran Canaria. It is described in »The Canary Islands« by DAVID A. BANNERMAN, London 1922, Appendix A. Note on a Fall of Dust, »Blood Rain«, at Gran Canaria, 8th to 11th Febr. 1920 by W. CAMPBELL SMITH, who examined the sample of sand collected. Regarding the storm Mr. BANNERMAN writes as follows: »We are suffering here from a terrible so-called 'Sand-storm', the worst known for years. (The dust) appears over the sea as a thick mist, which gradually envelops everything. We can see about a quarter to half a mile, but sometimes not 200 yards. Shipping is entirely disorganised, and many boats are lying outside apparently afraid to move. The dust finds its way into everything, through barred doors and windows, and is making life here

very miserable. The storm commenced on the afternoon of the 8th with a very high south-westerly (?) wind. The entire island is affected. It cleared slightly on the afternoon of the 9th, but is worse than ever to-day (10th). P. S. $^{11}/_{2}$ 20. Pouring in torrents: dust-storm ended.« Unfortunately no further details are given as to the temperature and the humidity of the air. Such storms have of course an extremely

Fig. 10. *Eucalyptus*-trees bent by the wind. Part of the road above Las Palmas rather near the village Tafira at a height of about 800 feet.

destructive effect upon the vegetation, and especially upon the therophytes, which are less capable of resistance.

In spite of the very few and defective meteorological observations it is obvious that transpiration in these dry regions, where hot winds are almost always blowing, must be very rapid[1].

On account of these habitat factors it is a low and very scattered vegetation which is to be found on these dry hills and flats, seldom more than $^{1}/_{2}$—$^{3}/_{4}$ meter high, often lower. Everywhere the parched, greyish yellow soil is to be seen between the plants, and there is generally room enough to walk between them. The vegetation mainly consists of more or less evergreen (or more rightly greyish) nanophanerophytes, generally without bud scales, and of more or less bushy chamaephytes to which

[1] Compare on this point O. Burchard in Engler, Bot. Jahrb., vol. 49, Beiblatt p. 44 who says: »In der unteren Küstenregion beträgt die Höhe der Niederschläge, je nach der Exposition, nur 200—350 mm, während die Höhe des hier jährlich oberflächlich verdunstenden Wassers nach verschiedenen Messungen 2000 – 2500 mm beträgt! Wir finden hier ein ausgesprochenes Steppenklima.«

are added especially in damp years a good many larger and smaller therophytes which may live for a shorter or longer period. The growth of the perennials takes place especially in the damp season of the year and stops partially or entirely in the dry season. During this period a good many of the leaves fall off, especially in the case of the species which have comparatively large leaves. Those which remain

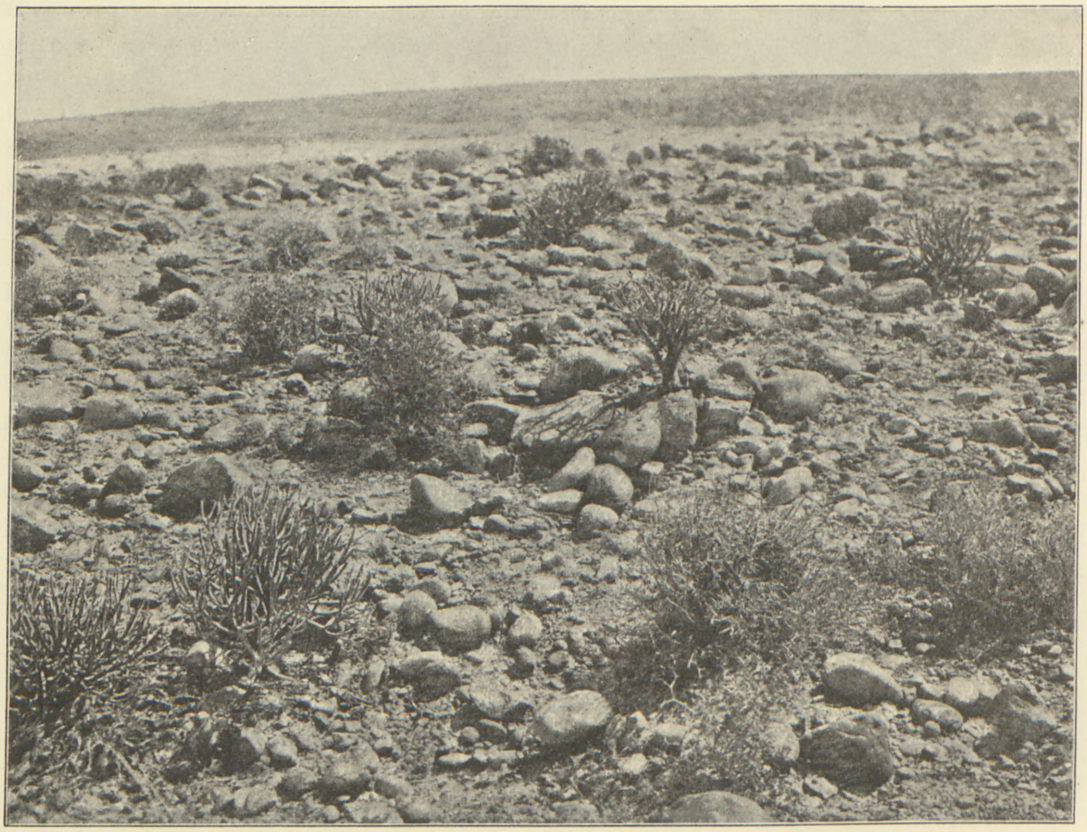

Fig. 11. View of the vegetation from the dry hills north of Las Palmas. In the foreground to the right *Zollikoferia spinosa*, to the left *Euphorbia aphylla*, in the middle a small *Euphorbia balsamifera* and above it a little to the left *Reseda scoparia*.

roll up more or less, or hang down. Unfortunately I have not had the opportunity of examining the vegetation myself in the dry, hot time of the year. But VAHL has been for a short time on the islands during the summer of 1902 and he has recorded his observations in a small paper: »Notes on the Summer-Fall of the Leaf on the Canary-Islands« (Dansk Botanisk Tidsskrift. vol. 26, København 1904). In this he makes it clear that a great many species lose their leaves more or less in the summer time. When VAHL however simply calls several of the species he mentions »deciduous«, among others *E. obtusifolia*, *E. regis Jubae*, *Kleinia nereifolia*, I do

not consider this designation to be quite correct. Of course the species mentioned will react against the drought by getting rid of some of their leaves, thereby reducing transpiration, which is only what one may expect, but they will surely always keep some leaves at the upper end of the branches. So they cannot in the proper sense of the word be called deciduous. And indeed VAHL says so himself, writing as he does at the top of page 302: »several of them had, however, a few

Fig. 12. *Euphorbia balsamifera* Ait. from the dry territory near the village Buenavista at Teneriffe.

fresh leaves«; and about *Kleinia* he says: »On this plant many of the branches still had small rosettes consisting of a few leaves left at the ends.«

When in the first days of January, I arrived on the islands, it was excessively dry, as yet no rain had fallen. Nevertheless *Euphorbia regis Jubae* and *Kleinia* had rather abundant leaves. However there is no doubt but that in the dry time the vegetation on the hills and flats heated and dried up by sun and wind, is in a more or less withered state, reminding one in this respect for instance, of the West Indian *Croton*-thicket which also in the dry season, partly by the loss of a good deal of its leaves, partly by the rolling and drooping of those which remain, reacts against desiccation.

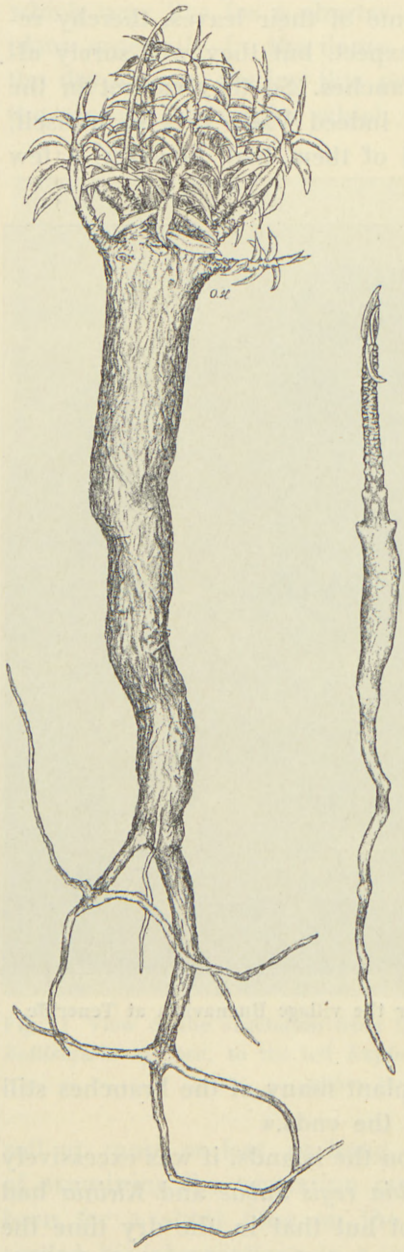

Fig. 13. *Euphorbia balsamifera* Ait. A young not yet ramified plant showing scars after the cotyledons and the swelled hypocotylar part of the stem and a somewhat older plant.

We shall now begin the description of the vegetation with an examination of the heights and flats north of Las Palmas.

The soil is here firm, a mixture of clay and sand, sprinkled with numerous larger and smaller stones. And the vegetation is just as scattered. The low shrubs often grow at a distance of several meters from their nearest neighbour (Fig. 11). Among the perennials some annuals were to be found, but generally in very small number, and only in the most favourable places. But in damp years in these places such a herbaceous vegetation may be present to a considerable extent. This appeared from the fact that the ground in places was rather densely covered with the dried up remnants of such a vegetation, which in the previous damp year had sprouted up, but had died soon afterwards, when the hot summer came.

When, in the year 1921, in March—April, I explored the hills, it was, as I have already said, a very dry year, and I really saw no other herbaceous plants of any importance besides *Aizoon Canariense*, and a few others, especially near roads and in more favourable places.

Euphorbia balsamifera (Fig. 12) is the plant which one meets with here first of all and which, on account of its appearance in masses, is far the most important. Near Bahia del Confital, it is, however, owing to these places being almost too favourable for it, not yet more common than most of the other bushes to be met with here. But as one comes southward it is the plant which characterises the vegetation more and more, and on the hills surrounding Las Palmas, not to speak of those further south, it is often dominant. It seldom reaches more than 2 feet high, or, at the most 3—4 feet, but it is, on the other hand, very broad, often 6—7 feet or even more. It is rather poorly provided with leaves, which become fewer as the soil gets drier. The stem is easily to be seen among the leaves. The stem is very thick at the base, often more than 25 cm. in diameter, and rapidly divides

upwards into a great number of branches, which spread out on all sides and finally end in innumerable branchlets where the few leaves are gathered at the top. It is decidedly a »Federbusch« plant (compare SCHIMPER in SCHENCK, l. c. p. 271). The youngest leaves are always covered by the upward-turned older ones which gradually, as they increase in size, bend downwards. The branches are covered with a glabrous grey bark. The leaves are small, about $3^1/_2$ cm. long, greyish-green with reddish margins and, like the whole plant, full of white milky juice. The flowers are yellow.

Of this plant a good many young specimens (Fig. 13) were to be found, however, there were no quite young with the cotyledons. Apparently it was too dry a year for the germinating of seeds. Already at an early stage the hypocotylar part of the stem becomes barrel-shapedly swelled, and may, in plants only 5—6 cm. high, reach a thickness as much as 2 cm. This swelled part serves as a water-storage tissue for the plant. In transverse section it is apparent that in the middle it consists of a thick medullary tissue consisting of clear cells filled with juice, and round the vascular bundles there is again a thick, clear, parenchymatous tissue between these and the bark.

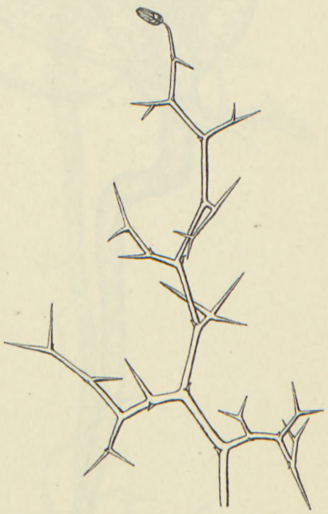

Fig.14. *Zollikoferia spinosa* Boiss. showing the ramification.

In the innumerable, thin branches, so dry apart from their milky juice, this is not to be found. A transverse section of a thin branch looks thus: On the outside there is a thick layer of cork, consisting of about 10 layers of cells, then follows a parenchymatous tissue, the cells of which are filled with starch. In this tissue large lactiferous vessels are to be found. After that the central cylinder follows, and finally there is in the middle a medulla, the cells of which are filled with starch.

Around this plant in the most northern part of the hills, a good many different species group themselves, but as one comes southwards to the drier and hotter regions, most of these disappear by degrees, and *Euphorbia balsamifera* is dominant over wide areas.

The unpleasant, thorny *Zollikoferia spinosa* is common, forming small, dense bushes $1—1^1/_2$ feet high. Its ramification (Fig. 14) is peculiar, owing to the fact that the main shoot constantly grows out as a short thorn, while the side-shoot becomes vigorously developed, and continues the growth at an obtuse angle. The branches thereby become bent in a peculiar zig-zag fashion. The yellow flowers are terminal on the thorn-branches. In the older plant the leaves are quite small, scalelike; the branches are green and perform the work of assimilation. With young plants (Fig. 15) laciniate, dentate, rosulate leaves are to be found at the base, and such may, gradually getting smaller upwards and linear, reach a little way up the branches. BER-

THELOT gives a picture of a branch of a young plant with leaves, and a flowering branch without leaves. But, judging by the state of the plant in 1921, only scales seem to be formed on the vast majority of branches. FITTING writes about its leaves (l. c., p. 235), after having pointed out that, together with a good many other smaller bushes, it is able to receive by a relatively smaller osmotic pressure sufficient moisture from the soil: »Die Blätter der *Zollikoferia* sind kaum xerophytisch gebaut. Sie sind lang lineallanzettlich, buchtig gezähnt, blaugrün, kahl, dicklich. Die Aussenwände der Epidermis und die Cuticula sind dünn, die Stomata beiderseits zahlreich und nicht eingesenkt. Ich glaube nicht, dass die Blätter auch im Sommer frisch bleiben.« By practically doing without leaves and only forming scales the plant, in the Canary Islands, seems consequently to be built a good deal more xoromorphically than that of the desert (Biskra).

Fig. 15. *Zollikoferia spinosa* Boiss. A young plant with the yet preserved laciniate ground leaves.

Reseda scoparia is another not very conspicuous plant. It forms low, roundish bushes, seldom more than 1 foot high, and often broader than they are high. The branches are stiff and extended, and generally end in a long, more or less dry tip, viz: the axis of the inflorescence left behind. The leaves are few in number, linear and fleshy, about $1^1/_2$ mm. thick, and 4 cm. long. The younger branches are green, and thus take part in the work of assimilation. A transverse section of the leaf is almost semicircular. There are very large, clear, epidermal cells with a thick cuticle, and a few mucilage cells. But I did not find the very large, peculiar cells which I have found in *Oligomeris* and which VOLKENS (l. c., p. 99) found with several species of *Reseda*. The layer of palisade-tissue is vigorously developed on the uppermost, flatter side of the leaf, and a central clear water storage tissue encloses the vascular bundles.

Helianthemum Canariense is a small, rather common, dwarf bush (Fig. 16). From the mighty rugged main root, numerous quite short branches issue, so that the plant, in very dry places often forms, above the soil, a dense rosette only a few cm. high, while the root goes foot-deep into the soil. The drier and more exposed the situation, the lower and denser are the tufts of the plant. The small leaves, almost 1 cm. long, are ovate to oval and a little pointed, with a margin more or less rolled up, and densely covered with short greyish hairs. The anatomy of the leaf is quite con-

sistent with *H. Kahiricum* Del. as VOLKENS describes and pictures it (l. c., p. 101, pl. 8, fig. 5) indeed his figure might just as well represent the Canarian plant. The particularly densely-placed hairs are bunched quite in the same way as described by VOLKENS. Only the clear tissue seems in the Canarian plant to be less developed than in the Egyptian. The Canarian plant is considerably lower than the Egyptian which grows a foot high, and it forms more compact, dense rosettes.

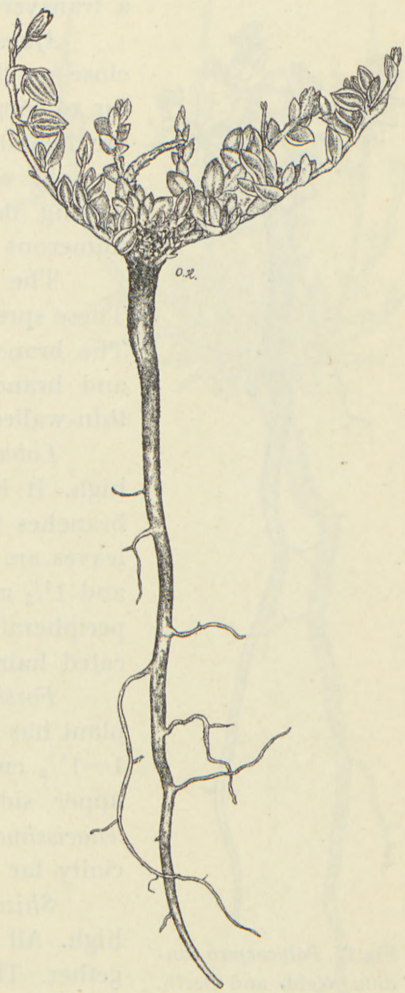

Fig. 16. *Helianthemum Canariense* Pers. A small plant.

Polycarpœa candida (Fig. 17) is another quite small, low bush, growing only a few cm. above the soil. It has a vigorous, deep striking main-root, which is very rugged. From the upper end of this a great many branches issue, they are densely placed, usually not ramified, and more or less covered with old leaves. These are tiny, spatulate, and greyish-white on account of densely placed hairs, as much as $^3/_4$ cm. long. A transverse section of the leaves corresponds exactly with the picture which VOLKENS gives of *Polycarpœa fragilis* (l. c., tab. X, fig. 1), namely, in the middle of the leaf there is a water tissue of large, round cells, in which the vascular bundles run. The cells of the epidermis have strongly thickened walls and from these thin-walled long hairs arise.

In the *Euphorbia* bushes or other larger plants climbs *Linaria scoparia*. The thin, green branches have come to perform the work of assimilation almost entirely, the leaves being very few in number and early dropped. They are linear and terete, about $1^1/_2$ cm. long.

Lotus glaucus var. *leptophyllus* has a vigorous, deep striking main-root from which a number of thin branches issue, which more or less lie along the ground and may reach as much as $^1/_2$ meter in length. The trifoliate leaves are quite small with a very short stalk. The leaflets are obovate or spatulate with close silky hairs and therefore greyish white. In transverse section, it is seen that the cells of the epidermis are papillously curved and have very thick outer walls. The vigorous stiff hairs lie along the surface and cover it densely. Compared to *Lotus villosus* (comp. VOLKENS, p. 116) the Canarian plant apparently is considerably xeromorphic in structure. *Lotus villosus* grows much larger and has much larger leaves.

Salvia Ægyptiaca (Fig. 18) forms a small, low bush only 5—6 cm. high. It has a strong rugged main root, from which short shoots (4—6 cm. long only) are developed. The leaves are linear-elliptic with a waved margin, turned upwards and covered with long hairs with glandular ones among. VOLKENS describes and pictures a transverse section (l. c., p. 136, tab. IX, fig. 8).

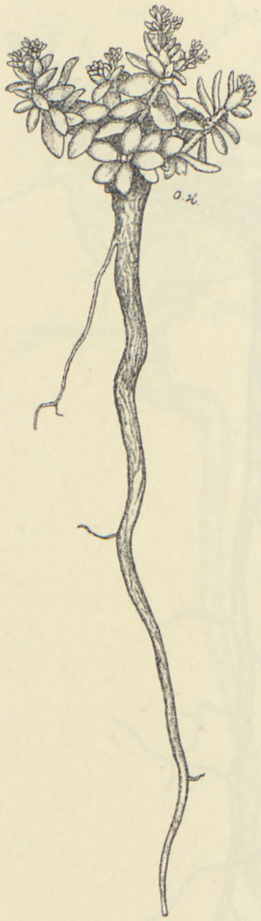

Fig. 17. *Polycarpæa candida* Webb and Berth. A small plant.

Ajuga Iva forms low whitish cushions. The stems lie close on the ground. The whole plant is covered with a dense fur of long, white hairs. The leaves are about 1 cm. long, they are dentated along their margins and placed closely together; the old withered leaves remain long attached to the stalks. Among the long vigorous, many-celled hairs, there are also numerous shorter glandular hairs.

The stems of *Artemisia repens* also lie flat on the ground. These spread in every direction from the deep striking main root. The branches and leaves are densely white felted. The leaves and branchlets are often scarcely 1 cm. long. The hairs are thin-walled, air-filled and woven together.

Lobularia intermedia is a small, bushy plant, about 25 cm. high. It has a vigorous main-root, from which a number of branches issue, which lie more or less along the ground. The leaves are small and linear, reaching as much as 2 cm. in length and $1^1/_2$ mm. in breadth. The epidermal cells have very thick peripheral walls, here and there carrying short-stalked, bifurcated hairs, which cover the leaf thickly.

Forskålea angustifolia forms small, low, prickly tufts. The plant has a vigorous main-root. The small, thorny leaves, about 1—$1^1/_2$ cm. long and 5—6 mm. broad, are dark green on the upper side, and white felted below. Compared to *Forskålea tenacissima* L., the Canarian plant has far smaller, and especially far narrower, leaves, and it does not grow nearly so high.

Shizogyne sericea is a yellow-flowered bush about $^1/_2$ meter high. All the branches are upright and grow very densely together. The whole plant is grey felted. The leaves are linear. A transverse section shows a water storing tissue around the vascular bundles. The epidermis-cells have a thick outer wall, and the stomata are deeply sunken. The whole leaf is enveloped in long, thin hairs with irregularly waved walls.

Atriplex glauca is a rather large bush, with drooping or slightly ascending branches. The whole plant is greyish. The leaves are small and lanceolate, $^1/_2$—1 cm. long and are thus much smaller than the leaves of the corresponding desert species *Atriplex Halimus* L. Regarding the anatomy of the leaf, this quite agrees with the Egyptian plant. We have in the young leaves exactly the same, large, water-filled

blisters, arranged in several layers. Beneath the cells of the epidermis there is a water-tissue and in the middle of the leaf lie the assimilative and conductive tissues.

Zollikoferia nudicaulis (L.) Boiss. is very likely annual. Its leaf-construction, for instance the peculiar blisters on the upper side of the leaves, is described and pictured by VOLKENS.

Here and there on the slopes, especially on rocky ground, a *Plocama pendula* bush is to be met with, and in the more favourable places a few specimens of *Kleinia neriifolia* appear, but neither species is common. *Kleinia* is here, owing to the dryness of the place, quite low, usually not ramified, with a short, thick stem, and quite narrow, linear leaves. A specimen (Fig. 19) from the dry hills south of Las Palmas thus had a markedly barrel-shaped stem, being only 10 cm. high and more than 2 cm. thick. The leaves were about 5 cm. long and $2^1/_2$ mm. broad and had involute margin.

Along paths a couple of small *Plantago* species were growing: *Plantago decumbens* with close silky hairs, linear leaves, 5—6 cm. long, and an almost spherical inflorescence, and the somewhat smaller and broader-leaved, densely hairy *Plantago amplexicaulis*, as well as *Plantago Coronopus* and *Plantago serraria*.

Matthiola tristis is a small annual plant, 10—12 cm. high. It was to be found here and there in more favourable places. In the leaf rosettes at the base the leaves are lobed, higher up they are dentate, and at the top entire and almost linear. A transverse section of the leaf shows just the same picture as that VOLKENS gives of the *Matthiola livida* examined by him (l. c., p. 90, Tab. 6, fig. 2). The leaf is densely covered with quite similar stellate hairs, only the glandular hairs are smaller, and especially, shorter.

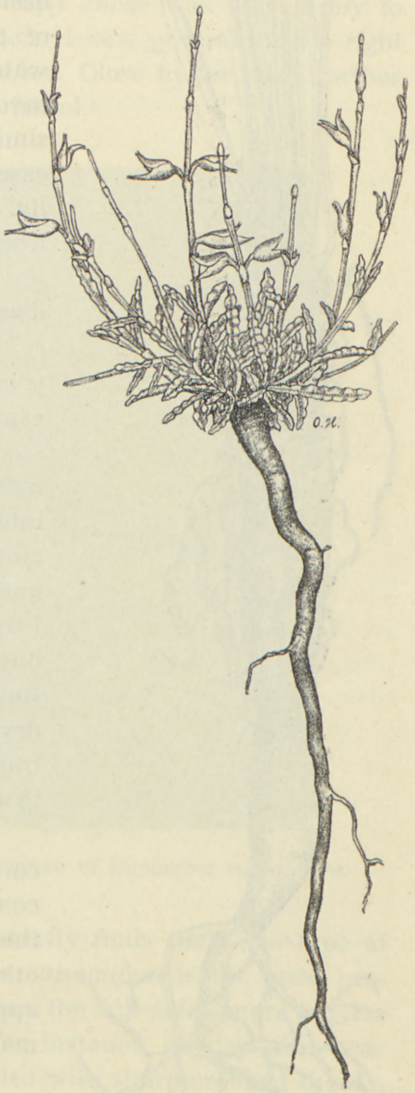

Fig. 18. *Salvia Ægyptiaca* L. A small plant.

Here and there bushes of *Lycium Afrum* are to be found. The anatomy of this species quite resembles the description that VOLKENS gives (l. c. p. 133) of *Lycium Arabicum*. The leaves are about $1^1/_2$ cm. long, and about 4 mm. broad, and rather thick. The epidermal wall being not especially thickened, has, seen from the flat, undulated walls and cuticular stripes. Below the epidermis there is a layer of large, clear hypodermal cells.

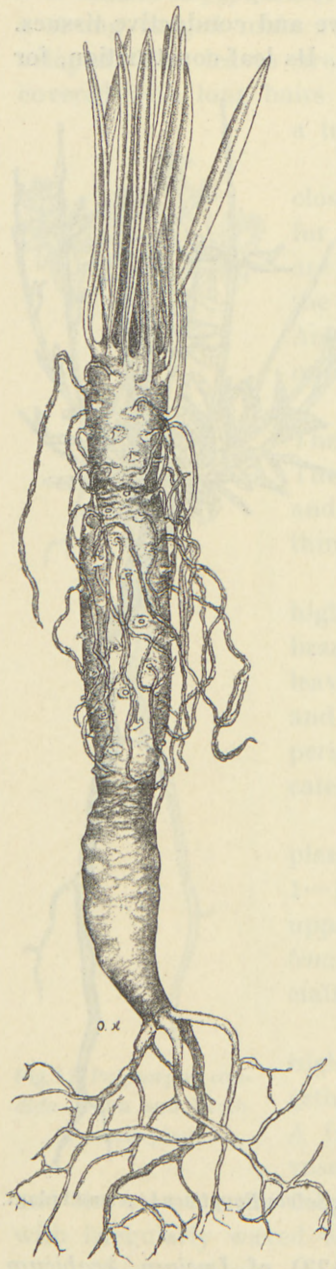

Fig. 19. *Kleinia neriifolia* Haw. A small plant from a dry place. Each of the swellings in the stem answers to a year's growth.

The grasses are represented by *Cynodon Dactylon*, *Andropogon hirtus* and the small *Schismus calycinus*.

Of plants common to beach and dune, *Frankenia lævis* is also to be found here. As to the leaf anatomy of this plant, it must be emphasised that there is a water tissue in the centre of the leaf. The margins are involute and the cavity thus formed is covered with similar hairs to those which VOLKENS mentions in the case of *Frankenia pulverulenta* (l. c., p. 108—9, tab. 5, fig. 14). Large, clear cells are present everywhere on the free sides of the leaf both above and below.

Moreover *Beta patellaris*, *Heliotropium erosum* and dwarfish specimens of *Senecio flavus*.

Reaching the summit of the hills the thorny *Fagonia Cretica* is common, spreading its branches like an espalier along the ground.

In its main features this is the vegetation to be met with, when one sets out from the east coast up into the hills. But having crossed the summit, and beginning again to descend towards Bahia del Confital, one is not long in coming across *Euphorbia aphylla*. First a few scattered specimens are to be found, but as one descends it gradually gets more and more common. But as I have explained fully above I believe that the dry hills are not its right home, but that on the contrary it must be looked upon as a halophyte attached to the sea shore.

Continuing southward, the habit of the vegetation corresponds to the increasing dryness of the climate, becoming more and more xeromorphic. This is shown by the fact that several species gradually disappear, while others become more and more common. This is most apparent when, for instance, the hills south of Las Palmas behind the old tower of Castillo, are examined.

Here *Euphorbia balsamifera* becomes the dominant species (Fig. 20). The plants are scattered over the stony hill-sides, generally a distance apart of about one meter or more. They are small, often only 1—2 feet high. Among the plants of this dominant species and beneath their shade a few other of the species mentioned above from the northern hills are to be found, namely *Artemisia reptans*, *Frankenia lævis*, *Helianthemum Canariense*,

Salvia Ægyptiaca, Plantago amplexicaulis. And besides these a few other species occurred here namely the little, densely ramified, viscous bush, *Micromeria thymoides β citroides* and some dwarfish specimens of *Linum strictum* densely enveloped in hairs. Finally it must be mentioned that *Euphorbia regis Jubae* was very rarely to be found save in a very poor state. The few specimens I saw generally grew right in the middle of a larger bush of *Euphorbia balsamifera.* Close by the road, further on, a few larger clumps of *Aloë vulgaris* were to be found.

Fig. 20. Dry slopes south of Las Palmas with a scattered vegetation of *Euphorbia balsamifera.*

Continuing southward along the coast, one constantly finds the same type of vegetation, only drier and more wretched. *Euphorbia balsamifera* is the most prevalent plant, often the only one to be seen, and covers the hill-sides more or less densely. Of course locally there may be differences, for instance, on dry hills near Telde large, flat bushes of *Asparagus pastorianus,* provided with sharp crooked thorns, were to be found, and in and along the sides of the broad brook-bed which, no doubt, only carried water for quite short periods, large, vigorous specimens of *Plocama pendula* were growing.

Otherwise the landscape had, as far as one could see from the heights towards the south, the greyish tone which marks the *Euphorbia balsamifera* association, that vegetation which apparently characterises the driest regions of the Canary Islands. From the diary of Chr. Smith, who together with Leopold von Buch wandered round

most of Gran Canaria I shall quote a couple of sentences about these desolate regions. On page 42 one reads: »Through Telde to Guimes where the naked, brown fields scarcely showed a trace of vegetation.« About the region between Arguineguin and Maspalomas in the south of the island he says (p. 44): »The road was now less troublesome, passing over small hills and valleys, but the landscape was no better looking. *Euphorbia balsamifera* stripped of its leaves covered them with a copse wood, and only awakened feelings of emptiness and melancholy« and on the same page, about the region between Maspalomas and Aguimes he writes: »Across the barest of brown plains to a village below Guimes.«

And about *Euphorbia balsamifera* LEOPOLD VON BUCH writes p. 167: »Eine der wärmsten Pflanzen der Inseln; selbst im Clima von Sta. Cruz bleibt sie nur unansehnlich und klein, und steigt nur bis 360 Fuss. Klein bei Fuente del Rey und Realeyo abaxo. Aber grösser bei Puerto los Christ. bis nahe bei Adexe. Bis 500 F. hoch auf Gran Canaria bei Las Palmas und Telde. Noch höher hinauf bei Aguimez. Als Wald von Bäumen 20 F. hoch über Tazarte und Mogan. Nicht bei Sta. Cruz de la Palma, wohl aber bei Tazacorte etwa 400 F. hoch hinauf. Im südwestlichen Theile von Lancerote bei dem Hafen von Rubicon. Sonst noch bei Haria bis oben, so weit der Nordost abgehalten ist.«

Finally I have met with *Euphorbia balsamifera* on the flat country in the environs of the town of Buenavista, situated in the northwestern corner of Teneriffe. The country thereabout seems to be very dry, and gives one quite a desertlike impression. The ground is quite flat, and the soil consists of a dry, hard, yellowish mixture of clay and sand. Here there grew, as far as one could see a scattered vegetation, consisting of this frugal plant and also, at any rate near the town of a good deal of long-thorned *Opuntia*. Unfortunately time did not allow me to note what other plants were to be found among the Euphorbias. From here round the south-west side, the broadly rounded south side, and the long south-east side of Teneriffe to near St. Cruz is *Euphorbia balsamifera*, according to the description of the investigators the dominant plant in these with few exceptions mostly very dry and hot places. And on the dry islands of Lanzarote and Fuertaventura, this is, according to BOLLE (l. c., 1893, p. 244), the species of which the vegetation over wide areas mainly consists. Here in favourable places it may reach the size of a small fig-tree, but generally it is far smaller. It here provides the inbabitants with the fuel they require.

In this vegetation, which covers the driest regions of the Canary Islands, no succulent plants are found, at any rate in the areas I have visited. To be sure *Euphorbia balsamifera* has a water storage tissue in the basal part of the stem, but this has so far as I know not been recorded earlier, and according to RAUNKIÆR'S scheme this plant is not a succulent. The same is the case with *Aloë vulgaris* which as mentioned was to be found in one place south of Las Palmas, but it seems to be quite peculiar to this spot, and whether the plant grows spontaneously here is perhaps a question. Suitable conditions for the growth of the succulent plants

(which are otherwise found exclusively on the rocky slopes) only exist in these areas when a lava-torrent has entirely altered the edaphic character of the soil. The vegetation of these will be described later on.

So when VAHL (l. c., 1904, p. 123) calls the vegetation of the lowest region that of a »typical succulent steppe«, this vegetation of *Euphorbia balsamifera* cannot be thus designated. VAHL writes in English translation: »The lowest region is a typical succulent steppe composed especially of species of Euphorbia, Kleinia, Compositæ and Labiatæ. About 100 metres up, suffruticose Crassulaceæ appear also in great number.« In the last edition of WARMING'S Lehrbuch der ökol. Pflanzengeographie, 3te Aufl., 1918 by E. WARMING and P. GRAEBNER, the vegetation of the lowest regions of the Canary Islands is referred to as »Succulenten-Halbwüsten«. On pag. 856 we find the following: »Das Unterland der Canarischen Inseln ist ein Bergland, welches von tiefen Schluchten durchzogen ist, deren Abhänge mit einer charakteristischen Steppenvegetation bedeckt sind. Die grössten Sträucher bilden die kaktusähnliche *Euphorbia Canariensis* und die gleichfalls succulente *Kleinia neriifolia*. Unter den kleineren Sträuchern, welche ungefähr 1 m hoch sind, befinden sich mehrere *Euphorbia*-Arten; von diesen ist *E. aphylla* blattlos, die übrigen haben nur im Sommer kein Laub. Untermischt mit den Sträuchern wachsen xerophytische Halbsträucher, und in einer Höhe von etwa 100 m werden sie von zahlreichen Crassulaceen begleitet; zwischen diesen leben Gräser mit eingerollten Blättern, Zwiebelgewächse (darunter *Urginea* und *Scilla*) und einjährige Kräuter[1].«

To this it must be remarked that if the designation »succulent steppe« can be rightly used at all in speaking of the Canary Islands, it can only be as a general term for the total vegetation of all the lower region comprising that of the lava torrents, the rocky slopes, the barrancos etc. But as no succulent plants are to be found in the dry, hot, flatter regions with a clayish soil, and as the term »steppe« to me seems a hardly well chosen one, as far as it concerns the vegetation of the steep rocky slopes and barrancos, as well as that of the lava torrents, into which the succulent plants enter as a common ingredient, the expression »succulent steppe« appears to me inapplicable.

If now we ask to which type of vegetation this xeromorphic vegetation of the Canary Islands may most naturally be referred, a closer examination of the life-forms of the species found here is the best way to answer the question.

In the lists (table 8 and 9) below, the species are grouped according to their life-forms. Moreover as far as the phanerophytes and chamaephytes are concerned, notes are given as to the size of leaves, as to whether these are hairy or not, etc.

[1] CHRIST 1885; VAHL 1904 b; SCHRÖTER 1908.

Table 8. List of plants from dry hills north of Las Palmas behind Fuenta de Sta. Catalina.

1 N.	Atriplex glauca L.	Leptophyl; leaves oval, about 5 mm. long and 2—3 mm. broad, greyish with airfilled hairs.
2 N.	Euphorbia balsamifera Ait.	Nanophyl; leaves elongated elliptical, about 3 cm. long and 7 mm. broad.
3 N.	Kleinia neriifolia Haw.	Microphyl; leaves linear-lanceolate to spatulate, about 14 mm. long and 15 mm. broad, succulent. Water storing tissue in the stem.
4 N.	Lycium Afrum L.	Leptophyl; leaves about 10 mm. long and 2 mm. broad, somewhat succulent.
5 N.	Plocama pendula Ait.	Nanophyl; leaves linear, about 40 mm. long and 1 mm. broad, fleshy with hairs at the furrows.
6 N.	Schizogyne sericea Schultz Bip.	Leptophyl; leaves linear, about 15 mm. long and 1 mm. broad, covered by long white hairs; often a chamaephyte only.
7 N.	Tamarix Gallica L.	Leptophyl; all specimens seen only about 1 m. high.
8 N.	Zollikoferia spinosa Boiss.	Leptophyl (se remarks p. 291, Dune, Las Palmas).
1 Ch.	Ajuga Iva Schreb.	Leptophyl but rather near nanophyl; leaves elongate-spatulate, about 10—15 mm. long and 2—3 mm. broad; densely white-felted.
2 Ch.	Artemisia reptans Chr. Sm.	Leaves laciniate with linear lobes, about 1 mm. broad, whitish felted.
3 Ch.	Fagonia Cretica L.	Leptophyl, some few of the biggest leaves near the limit of nanophyl.
4 Ch.	Forskålea angustifolia Retz.	Nanophyl; leaves lanceolate, about 3 cm. long and 1 cm. broad, long-haired on upper side of the leaf, white-felted below.
5 Ch.	Frankenia lævis L.	Leptophyl; leaves about 3—4 mm. long and $^3/_4$ mm. broad, with involute margins and hairs at the cavities.
6 Ch.	Helianthemum Canariense Pers.	Leptophyl; leaves densely whitish haired.
7 Ch.	Heliotropium erosum Lehm.	Nanophyl; leaves 10—12 mm. long and 4—5 mm. broad, greyish with densely placed, rough hairs.
8 Ch.	Linaria scoparia Brouss.	Leptophyl; leaves of variable length, mostly about 20 mm. long and 1 mm. broad.
9 Ch.	Lobularia intermedia Webb et Berth.	Leptophyl; leaves linear-spatulate, densely haired, about 15 mm. long and 1 mm. broad.
10 Ch.	Lotus glaucus Ait. β leptophyllus Lowe.	Leptophyl; the leaflets scarcely 2 mm. long and 1 mm. broad, densely felted.
11 Ch.	Polycarpæa candida Webb et Berth.	Leptophyl, but near nanophyl, leaves oval, about 6 mm. long and 4 mm. broad, whitish haired.
12 Ch.	Reseda scoparia Brouss.	Nanophyl; leaves linear, about 40 mm. long and 1 mm. broad.
13 Ch.	Salvia Ægyptiaca L.	Nanophyl: leaves with waved, involute margins; scattered hairs, mostly on the lower surface.
1 H.	Andropogon hirtus L.	
2 H.	Cynodon Dactylon Rich.	
3 H.	Picridium intermedium Schultz Bip.	
4 H.	Plantago serraria L.	
5 H.	Zollikoferia nudicaulis Boiss.	
1 Th.	Aizoon Canariense L.	

2 Th.	Atriplex laciniata L.	
3 Th.	Beta patellaris Moq.	
4 Th.	Euphorbia exigua L.	The determination of this species is not quite certain.
5 Th.	Matthiola tristis R. Br.	
6 Th.	Mesembryanthemum nodiflorum L.	
7 Th.	Plantago amplexicaulis Cav.	
8 Th.	Plantago Coronopus L.	
9 Th.	Plantago decumbens Forsk.	
10 Th.	Schismus calycinus Coss. et DR.	
11 Th.	Senecio flavus Sch. Bip.	
12 Th.	Sisymbrium Irio L.	

Table 9. List of Plants from dry hills south of Las Palmas behind the old tower Castillo San Christoballo.

1 N.	Euphorbia balsamifera Ait.	Forms the most of the vegetation.
2 N.	Euphorbia regis Jubae Webb et Berth.	Microphyl; rare and badly developed.
1 Ch.	Artemisia reptans Chr. Sm.	
2 Ch.	Frankenia lævis L.	
3 Ch.	Helianthemum Canariense Pers.	
4 Ch.	Micromeria thymoides Webb.	Leptophyl; leaves greyish with stiff hairs.
5 Ch.	Salvia Ægyptiaca L.	
1 Th.	Linum strictum.	
2 Th.	Plantago amplexicaulis.	

While in Table 8 38 species are mentioned, Table 9 only includes 9 species. The vegetation was here very poor. As described above it consisted almost exclusively of low, scattered bushes of *Euphorbia balsamifera*, with quite a few other species interspersed here and there. By a thorough investigation in a more rainy year there is no doubt that more species would very likely be found. Of the 9 species mentioned in Table 9, 3 have not been found in the locality to which Table 8 belongs. When these three species, namely *Euphorbia regis Jubae, Micromeria thymoides* and *Linum strictum* are added to the 38 in Table 8, a total of 41 species is obtained. On this basis the biological spectrum given below (Table 10) is arrived at, to which, for the sake of comparison, I have added some biological spectra from other dry, subtropical and tropical regions obtained by Raunkiær (l. c., 1908, p. 55).

Table 10. Biological spectrum of the vegetation of dry flats and hills in the environs of Las Palmas together with spectra from other dry places.

	Number of species	Percentage of species under each life form									
		S	E	M M	M	N	Ch	H	G	H H	Th
Dry hills at Las Palmas	41	..	..	..	..	22	34	12	..	..	32
Aden	176	1	..	..	7	26	27	19	3	..	17
Death Valley	294	3	..	..	2	21	7	18	2	5	42
Libyan desert	194	..	..	..	3	9	21	20	4	1	42
El Goléa	169	..	..	..	..	9	13	15	5	2	56
Normal spectrum	1000	2	3	8	18	15	9	26	4	2	13

At first sight it cannot be denied that this biological spectrum from the dry hills and flats looks rather startling, especially when one considers that the biological spectrum of the rocky slopes agrees well with that of the desert. Here especially, on these areas of Gran Canary which are among the driest and hottest regions of the Canary Islands, there was reason to expect a spectrum which would to a very great extent be identical with that of the desert.

However, I must immediately emphasise the fact that in the case of a list composed of proportionally few species from a rather restricted area, a single species more or less in one of the groups may alter the result considerably. And it must also be remembered as a possible and very likely error that in a damp favourable year more therophytes would surely be developed than in the dry year 1920—21. Further it must not be left out of consideration that when, as here, a single more local flora is compared with the flora of a whole country, or at any rate with the flora of a larger area, where the external conditions are generally very varied, the biological spectrum of the larger territory will have, so to speak, a more common character, whereas the biological spectrum of the small territory will have a more special stamp on account of the more uniform conditions of life prevailing there.

However, according to the numbers obtained, the vegetation of the dry, Canarian lowland, which was examined, is, with regard to its therophyte %, considerably inferior to that of the desert, whereas, on the other hand, we have, as regards the nanophanerophytes and chamæphytes, a considerably higher percentage here than we find when we look at the corresponding figures for the desert. Thus the vegetation occurring here rather much approaches the dry, tropical vegetation which we find, for instance, near Aden. It is best described as occupying an intermedial position between the desert vegetation and that of Aden. And looking into matters more closely the explanation is perhaps not so hard to find. It must, I believe, especially be sought for in the very uniform temperature of the Canary Islands,

where we have neither the great differences between the day and night temperature found in the desert, nor the low winter temperature occurring in the latter. In this respect the climate of these very dry and hot regions on the Canary Islands is more apt to resemble that of Aden, where, according to KRAUSE (l. c. p. 687), the hottest month, July, has a temperature of 33.5° C., and the coldest month, December, has often a temperature of 17° C. The yearly amount of rain in Aden is only 7.5 cm.[1] and is thus much below the figure for Las Palmas, 28.6. In this comparatively favourable amount of rain, in conjunction with the comparatively uniform temperature all the year round, the reason for the conspicuous development of nanophanerophytes and chamæphytes must certainly be looked for.

But how closely the Canarian vegetation is nevertheless related to that of the desert distinctly appears when the two floras are compared, and that such a comparison also presents other features of interest, will be seen in the following.

Of the 41 species which I have found in the lowland and on the hills north and south of Las Palmas, 25 are also to be found in the desert. These 25 species are the following: *Atriplex glauca, Lycium Afrum, Tamarix Gallica, Zollikoferia spinosa, Ajuga Iva, Fagonia Cretica, Frankenia lævis, Heliotropium erosum, Polycarpæa candida, Salvia Ægyptiaca, Andropogon hirtus, Cynodon Dactylon, Picridium intermedium, Zollikoferia nudicaulis, Aizoon Canariense, Atriplex laciniata, Euphorbia exigua, Linum strictum, Mathiola tristis, Mesembryanthemum nodiflorum, Plantago amplexicaulis, Plantago decumbens, Schismus calycinus, Senecio flavus* and *Sisymbrium Irio.* Altogether these species amount to 61 % of those found.

Of the remaining 16 species, 12 are endemic in the Canarian, or at any rate in the Macaronesian flora. The 12 species are: *Euphorbia balsamifera, Euphorbia regis Jubae, Kleinia neriifolia, Plocama pendula, Schizogyne sericea, Forskålea angustifolia, Helianthemum Canariense, Linaria scoparia, Lobularia intermedia, Lotus glaucus, Micromeria thymoides, Reseda scoparia.*

It is interesting to notice that all these endemic species are either nanophanerophytes or chamæphytes; there are no therophytes, and the high percentage of these two groups in the biological spectrum is justly attributable to this circumstance.

And if we examine these endemic species somewhat more closely, we find that *Euphorbia balsamifera* is undoubtedly able to compete with most of the desert plants owing to its structure and whole habit. Several of the other species are represented in the desert by very similar and nearly related species: *Forskålea angustifolia* by *Forskålea tenacissima, Helianthemum Canariense* by *Helianthemum Cahiricum, Linaria scoparia* by *Linaria Ægyptiaca, Lobularia intermedia* by *Lobularia maritima* which is also to be met with in the Canary Islands, *Lotus glaucus* by *Lotus villosus* and *Reseda scoparia* by *Reseda pruinosa.* As to these species it cannot be denied that the Canarian representatives, compared with those which take their place in the desert,

[1] According to BLATTER, E., Flora of Aden (Records Bot. Survey of India, vol. 7, 1914, p. 33) the annual rainfall rarely exceeds 6 or 7 inches, while occasionally there falls no rain for a year and a half.

seem to be fully up to the standard of these last with regard to external adaptations for enduring a dry and hot climate. Indeed, several of the Canarian species seem to be even better fitted for this purpose, by having, for instance, smaller leaves than the corresponding species of the desert.

The real home of the remaining endemic species: *Euphorbia regis Jubae, Kleinia neriifolia, Plocama pendula, Schizogyne sericea* and *Micromeria thymoides* is the rocky slopes and the barrancos. I have only seen here in the dry and hot regions a few specimens of *Euphorbia regis Jubae* and *Kleinia neriifolia,* and they were generally poorly developed; they are only well developed and common in higher or cooler regions. *Plocama pendula* is not common either. It is to be found here and there where there is rocky ground, or growing at the bottom of the bed of a river, for instance at Telde. But otherwise it is entirely wanting in the dry areas which I have examined. *Micromeria thymoides* has only been found in the shape of a few shrivelled specimens on rather stony ground south of Las Palmas. *Schizogyne sericea* is not common either, and is, as far as I have seen, quite lacking in the dry regions where *Euphorbia balsamifera* is dominant. These 5 species should therefore most rightly be regarded more as occasional guests.

Finally the following 4 species remain: *Artemisia reptans, Plantago serraria, Plantago coronopus* and *Beta patellaris. Artemisia reptans* has been found on the Iberian peninsula as well as on the Canary Islands. By its extremely small leaves, densely covered with silky hairs and by the way in which it grows closely pressed to the ground, its habit seems to be rather xeromorphic, more so than *Artemisia Judaica* and *Artemisia Herba alba,* which are to be met with in the desert. *Plantago serraria, Plantago coronopus* and *Beta patellaris* are to be found in North Africa, but do not seem to have been found in the desert itself. Neither do they seem to play any greater part in the vegetation of the Canarian desert-like regions.

Thus it appears from this comparison that, of the 41 species, 33 species (over 88 %) are either common to the Canarian and the desert flora, or are replaced in the Canarian flora by species which are equipped to a similarly high degree for growth in a markedly dry climate.

As to the remaining 10 species they must mostly be considered as chance-comers, having their homes in other localities, which do not play any part worth mentioning in the vegetation in question.

As is evident from the above description, this vegetation appears both floristically and in its appearance and structure to correspond very much with that found in the desert or at any rate on the marginal zone of it, and I have therefore thought that a comparison of the climate here with that of the desert would be of interest, and for this purpose I have chosen Biskra in the North Sahara.

A hydrothermic figure of this place based on the average rainfall and temperature for the year, according to HANN'S climatology, has the appearance shown in Fig. 21.

From this it is to be seen that the variation of temperature during the year at Biskra is far greater than at Las Palmas. While here the whole difference be-

tween the coldest months January and February (17.1° C.) and the hottest August (23.3° C.) is only 6.2° C., the difference at Biskra is not less than 21.3° C., the temperature going down to 10.6° C. in January and rising in the hottest month July to 31.9° C.

With regard to the amount of rain, the maximum for Las Palmas is reached in November with 7.2, and the minimum in June and July, when there is practically no rain. At Biskra the amount of rain is 1.3 at the beginning of the year, in January, then during the following months it slowly increases till the maximum is reached in April with 3.1. Then again it evenly decreases, until the minimum is reached with 0.4 in July and 0.3 in August, a little more than the driest months at Las Palmas. The aggregate amount of rain is 17.7 at Biskra, somewhat less than at Las Palmas.

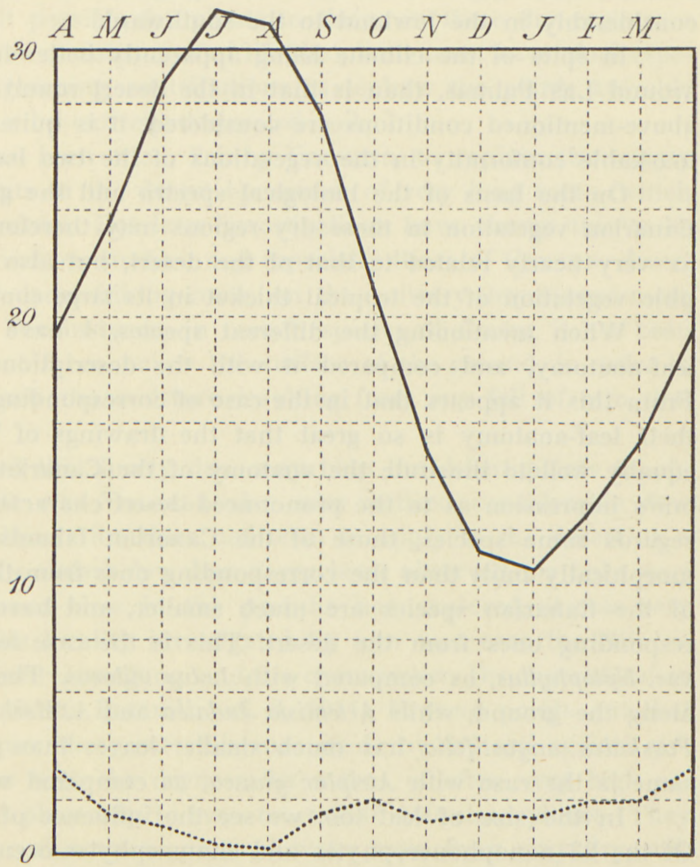

Fig. 21. Hydrothermic figure of Biskra. —— curve of temperature, ... curve of rainfall. The figures signify Centigrade for the temperature and cm. for the raincurve.

While thus both as regards temperature and the distribution of rainfall a somewhat considerable difference between the two localities is noticeable, there is, however, a marked likeness in one feature, which is charateristic on the whole of the desert climate, namely that the period during which there is the least amount of rain, or, to put it more correctly, practically no rainfall whatever, coincides with the hottest season. This of course is especially unfavourable to the vegetation, the transpiration of a vegetation being necessarily greatest in the hot season.

The frequent occurrence of temperatures below the freezing point at night in the winter-time can of course only have an injurious effect on the desert vegetation. On the other hand the low winter temperature might be of advantage to the

growth of plants, because a smaller amount of rain will have a far greater effect at a low temperature than at a higher one. And the fact that the maximum rainfall occurs in April, so that the growing season is comparatively long, is of course also of great significance as contrasted with the dry spring at Las Palmas. And as I mentioned before, it must not be forgotten that the rainfall statistics are for Las Palmas, and that there is no doubt but that the amount of rain soon decreases considerably in the lowland to the southward.

In spite of the climate being apparently better for the vegetation, at any rate around Las Palmas, than is that in the desert round Biskra I think that when the above-mentioned conditions are considered, it is quite clear that we find a very remarkable conformity in the vegetations of the two localities.

On the basis of the biological spectra and the great likeness of the floras, the Canarian vegetation in these dry regions may therefore be most properly described as very nearly related to that of the desert, but also as approaching the xeromorphic vegetation of the tropical thicket in its large contingent of nanophanerophytes.

When mentioning the different species, I have also shortly referred to their leaf-anatomy, and compared it with the descriptions and drawings of VOLKENS. From this it appears that in the case of corresponding species, the likeness between their leaf-anatomy is so great that the drawings of VOLKENS might often be used equally well to illustrate the anatomy of the Canarian plant. This further confirms one's impression as to the pronounced desert character of the vegetation. Indeed, as regards some species, those of the Canarian Islands seem to be even more xeromorphically built than the corresponding ones from the desert. For instance several of the Canarian species are much smaller, and have smaller leaves than the corresponding ones from the desert. This is the case for instance with *Lotus glaucus* var. *leptophyllus*, as compared with *Lotus villosus*. The stems of *Artemisia repens* lie along the ground, while *Artemisia Judaica* and *A. Herba alba* are rather large bushes. *Forskålea angustifolia* has much smaller leaves than *Forskålea tenacissima*, and the same is the case with *Atriplex glauca*, as compared with *Atriplex Halimus*.

In the size of leaf too, we see the influence of the climate distinctly visible. Of the 23 nanophanerophytes and chamaephytes occurring, 1 species (*Artemisia reptans*) has laciniate leaves. If this is left out of consideration (its leaves are very small) of those remaining

14 are leptophyllous = 64 %
6 - nanophyllous = 27 %
2 - microphyllous = 9 %

The very small size of leaves is clearly seen from this survey.

As to hairs, we find more or less thickly grey-felted or hairy leaves in *Ajuga Iva*, *Forskålea angustifolia*, *Heliotropium erosum*, *Lotus glaucus*, *Polycarpæa candida*, *Helianthemum Canariense*, *Artemisia reptans*, *Schizogyne sericea* and *Salvia Ægyptiaca*; more scattered or locally gathered hairs in *Atriplex glauca*, *Lycium Afrum* and *Plocama pendula*.

Kleinia neriifolia, *Lycium Afrum*, *Plocama pendula*, *Zollikoferia spinosa*, *Reseda scoparia*, and other species have more or less succulent leaves.

Euphorbia balsamifera and *Euphorbia regis Jubae* have milky juice.

Kleinia neriifolia and *Euphorbia balsamifera* have water tissue in the stem.

Considering these various facts the conclusion to be drawn is that nature in the anatomical and morphological building up of the here occurring plants has done everything in order to make it possible for plants to thrive in these dry regions.

But water necessary for the maintenance of life the plants must have. And especially FITTING has given enlightening contributions as to how the plants are able to get it from what appears to be entirely desiccated soil.

At an earlier date it has been tried, f. i. by VOLKENS, to explain the supply of water necessary to the plants in the desert by means of very long roots, which could reach the underground water. But later investigations have shown this to be untrue. According to more recent researches, and especially those of CANNON, desert plants have not got especially deep-striking roots, on the contrary they spread more horizontally in all directions. For instance, in certain species of *Cactus*, it has been found that they run only about 5 cm. below the surface of the ground, in order to be ready immediately to absorb the moisture resulting from any fall of rain that may occur.

It has also been believed that heavy dew may help the desert plants to obtain a good deal of water. It was VOLKENS also who noticed considerable dew formation. At any rate this observation does not seem to apply to the desert as a whole. Over large areas in the desert dew has never been observed, or only very rarely, and when VOLKENS found dew in the part he has explored, it was very likely oving to the fact that the locality investigated by him was near the Nile[1].

In the treatise: »Die Wasserversorgung und die osmotischen Druckverhältnisse der Wüstenpflanzen« (Zeitschrift für Botanik, vol. 3, 1911) FITTING points out that desert plants are able to conquer the great resistance made by dry soil against giving off water, which increases with the dryness, by means of often very high osmotic pressures going in some plants up to even more than 100 atmospheres. They are thus able to receive the necessary amount of water even from very dry soil. Unfortunately I had no apportunity to make experiments as to the osmotic pressure in the Canarian desert vegetation, but there is no doubt that the same features are present here. We have to do with many of the same species here as in the desert, and it is surely by means of high osmotic pressures that the plants are able to live in these dry regions, too.

But in dry years and especially in the dry, hot season of the year, however high the osmotic pressure may be, the supply of water will of course at last become insufficient, so that the plants, as I mentioned before, fall into a more or less

[1] Also H. HAMSHEW THOMAS mentions »heavy dews« in March in his treatise: »Some Observations on Plants in the Libyan Desert«, Journal of Ecology, vol. IX, 1921, p. 78. But this, too, was near the valley of the Nile.

half withered state. The Russian botanist MAXIMOW, in a work quite recently published (l. c.), based upon examinations made in Tiflis, declares that the half-withered state of the desert plants during the dry period »ist eine natürliche und in ihren Folgen wohltätige Reaktion der Pflanze auf den Wassermangel in ihren transpirierenden Teilen.« By means of experiments in the laboratory it was found that, as long as desert plants are able to vegetate, however much protected they may be by means of hairs, thick cuticula and other xeromorphic characters, they lose by transpiration even considerably more water than mesophytic plants under similar conditions, while on the contrary evaporation is almost nil as soon as, during the dry season, they fall into a half-withered, dormant state, the stomata being tightly closed when the turgescence of the cells is lost. And during this dormant state hairs, thick cuticle, small leaves etc., with all of which the Canarian plants are richly endowed, of course help to protect them further, just as on the whole the vigorous development of the mechanical tissue helps to counterbalance the injurious effect of the loss of turgescence, and is of importance in making the plant still further resistent to dry conditions.

As emphasised above, *Euphorbia balsamifera* becomes more and more common as one gradually comes southward to drier regions, indeed, in places it almost seems to be without a rival. And recapitulating shortly what is said above one finds on closer examination that this plant, as not many others, is perhaps endowed to a special degree with the capacity for growing in a dry, hot climate. The leaves are small, stiff, but full to bursting of a milky juice which, as in the case of the plant as a whole, oozes out from the smallest scratch. They are gathered in small rosettes at the end of the branches, and are diminished by the fall of leaves in the dry season. All the remaining parts above the ground are enveloped in a thick greyish layer of cork, whereby the transpiration from these parts is of course reduced to a minimum. And in the basal part of the short stem, partly hidden in the soil, a great water storing tissue is to be found. Finally the plant has, as I had the opportunity of seeing along the side of a recently made road, a mighty root system spreading out especially in a horizontal direction on all sides.

This vegetation, surely the most xeromorphic on the Canary Islands, seems to reminds one much of the West Indian *Croton* thicket which I know so well from my repeated visits to the West Indies. Here, as there, it is a bush-vegetation which covers the dry hard soil, burnt by the sun. In both cases the inconsiderable number of leaves which are left during the dry period are more or less involute and shrivelled. The difference is that while the *Croton* bushes consist of erect shoots, growing closely together up to each other, the *Euphorbia*-bushes form low, broad bushes mostly at a great distance apart from each other. Finally there is also this difference in their xeromorphic properties, namely that the *Croton* bushes are strongly aromatic, wheras the *Euphorbias* are full of milky juice.

The Vegetation of the Rocky Slopes.

The vegetation of the more or less steep rocky slopes is of special importance in the physiognomy of the Canarian landscape. I have had the opportunity of becoming acquainted with it more particularly in the environs of Santa Cruz. Behind this town rise the bastions of the southern spurs of the steep Anaga mountains. They fill up the north-western corner of Teneriffe, rising steeply from the surface of the sea far up into the cloud region. But here I shall only deal with the hot, sunlit region at their base.

I agree with VAHL'S estimate (l. c., p. 125) that the upper limit of the basal region is most naturally placed at about 500 metres. Of course there is a considerable difference between the south and north side of the islands and great local differences are also very noticeable, but on the whole I believe the most natural limit of the coastal region to be at that height.

On the rocky slopes facing due south, exposed to the burning sun, it is a matter of course that the vegetation is poorly developed. If the exposure becomes only slightly different in a westerly or still more in a northerly direction, at once the vegetation becomes in proportion more luxuriant, indeed it may in places, for instance in small valleys eroded by brooks, prove to be even overwhelmingly rich. At the bottom of these, where a larger quantity of sand and gravel is often accumulated, one finds an abundance of vigorously developed therophytes. And along the sides of the rocky clefts and cracks, larger and smaller bushes grow, and even the wild olive-tree is to be met with here and there. On the whole the vegetation here is far more luxuriant and rich in species, than that of the hills and the flatter low-land.

And when one considers it over, it does not seem so strange. One must remember that the mountains reach far up into the damper region, so that there is a possibility that water constantly oozes down into the chinks and cracks of the rocky wall, allowing deeply-rooted species to have a chance of getting some moisture. There is hardly any doubt either that the lower region also may have a little rain from the clouds which form daily throughout most of the year in the higher mountain region, while the wind blows across the lower, flatter regions without giving up any of the moisture which it carries. The rainfall which in this way might reach the vegetation is perhaps extremely small but hardly without effect.

Here on the rocky slopes one meets with the many characteristic succulents and thick-leaved plants; in the less dry places especially representatives of the family of *Sempervivum* are common. Several of these species in comparatively cool places go as far down as the spray from the sea permits. Regarding these plants CHRIST writes in his description of the vegetation of the islands (l. c., p. 470): »Scheinbar leben diese saftstrotzenden Prachtpflanzen von der Luft, denn sie hängen an dem scharfkantigen, unverwitterten Gestein: aber das ist nur Schein, in Wirklich-

keit sind die Berodes wahre Leitpflanzen des im Innern der Spalten cirkulirenden, aus tiefen Rinnen capillar aspirirten Wassers, und ihre strickähnlichen Wurzeln laufen unglaublich tief in das feuchte Innere des Felsen hinein.« This observation of CHRIST is very interesting and contributes to the explanation of the fact why so many different plants are able to grow so luxuriantly as they do in these often at least apparently very dry places.

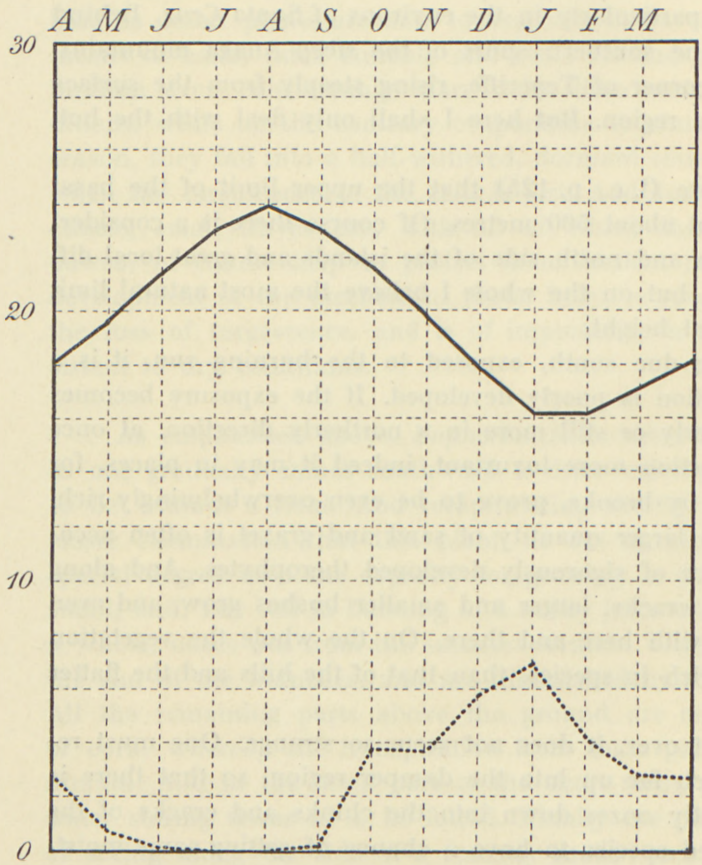

Fig. 22. Hydrothermic figure of Santa Cruz. —— curve of temperature, ····· curve of rain fall. The figures signify Centigrade for the temperature and cm. for the rain curve.

According to HANN's »Klimatologie« the yearly amount of rain at Santa Cruz is 30.7, being a little more than that at Las Palmas. A hydrothermic figure looks like that given in Fig. 22. The greatest amount of rain 6.9, falls in January, while in June only 1 mm. falls and in July and August none. The temperature of the whole year is a little hotter than at Las Palmas, in August, the hottest month, almost one degree higher, namely 24°.

In the following I shall now briefly mention some of the most important species which are found on the rocky slopes above Santa Cruz.

The plant especially characteristic of the rocky slopes, and which one already notices from a long distance off shore when approaching Teneriffe, is *Euphorbia Canariensis*. Its greyish-green or, when the sun is reflected from its glabrous surface, almost whitish yellow bushes more than a man's height, and just as broad, are to be seen as shining points as far as one can see up the mountain sides. It seems especially to prefer the hot mountain sides which face towards the sun.

Then one meets with the two species *Kleinia neriifolia* and *Euphorbia regis Jubae*, both very characteristic of the rocky slopes (Fig. 23). Both have a single stem, which at a height of about 1—2 feet or more, is divided into a number of branches.

Kleinia has a yellowish green glabrous stem with large whitish scars left by the leaves. Later on in older specimens, the stem becomes greyish and more uneven. Even at an early stage in young specimens the stem is thick, slightly barrel-shaped, and reaches a diameter of as much as 3—4 cm., in older specimens more. In the middle of the stem there is a water storing tissue. The leaves are

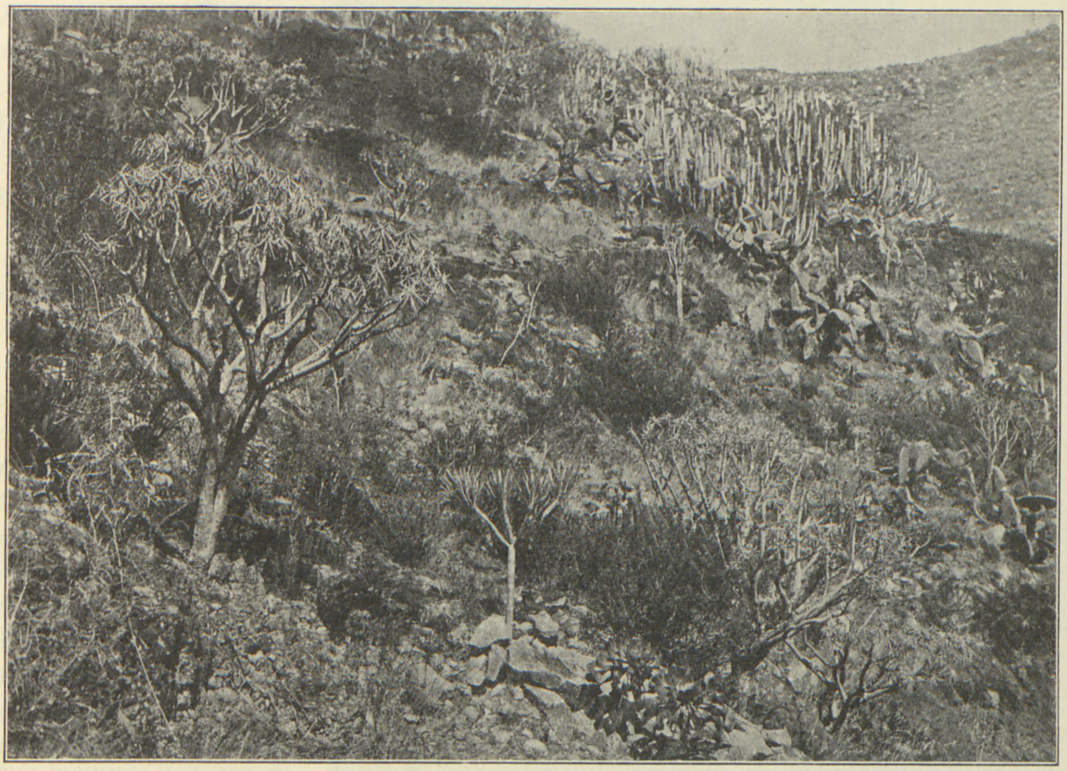

Fig. 23. View of the vegetation on rocky slopes facing north-west above Santa Cruz, Teneriffe. A large specimen of *Euphorbia regis Jubae* is seen at the left side and several smaller ones round about; in the foreground in the middle a young specimen of *Kleinia neriifolia*; to the right side of it a *Micromeria* and below it *Sempervivum*. On the right side upwards *Euphorbia Canariensis* and *Opuntia*.

narrow, almost linear, but varying in size according to whether the plants grow in more or less favourable spots. A leaf of a plant in a favourable place thus proved to be 16 cm. long, $2^1/_2$ cm. broad, and rather thick, whereas a leaf of a plant in a dry place was almost linear, 13 cm. long and only $^1/_2$ cm. broad at its broadest part. A transverse section shows that the epidermal cells have a thick cuticle; there are two—three layers of not very high palisade cells, and below those a spongy parenchyma. The stomata are very small, almost on a level with the surface. They are to be found on both sides but are most numerous on the underside. Regarding the anatomical building up of the leaves compare CLAUDITZ, l. c. p. 13. The ramifica-

tion is verticillate and recurs very regularly after each flowering. This plant and *Euphorbia regis Jubae* are typical examples of the »Federbuschgewächse« as described by SCHIMPER, characterised by the tufted leaves in the upper end of the branches, a feature found in so many species of the Canarian flora belonging to the most widely divergent families.

The stem of *Euphorbia regis Jubae* is light-yellowish green in young specimens, but it soon becomes surrounded by a greyish bark. The leaves are narrow, linear-lanceolate, about 7 cm. long and 6 cm. broad. While in the older plants the leaves are found in the upper end of the branches, in the young plant on the other hand the leaves are placed spirally up along the clavate stem (Fig. 24).

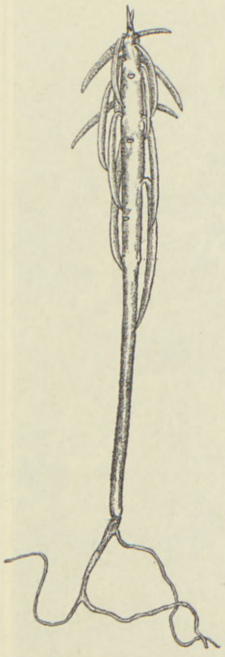

Fig. 24. A young plant of *Euphorbia regis Jubae*.

A transverse section of the stem shows in the middle a rather large medulla filled with starch.

The graceful *Plocama pendula* (Fig. 25) is rather common, forming fresh-green bushes on the mountain sides. The plant is extremely neat and elegant looking: at its best it is to be compared to a miniature willow. The thin, flexible and elaster hanging branches are light green just like the linear terete leaves. The latter are about 40 mm. long and 1 mm. broad. The leaf has a furrow on the upper and under side. The epidermis is very thick, with prominent cuticular ridges. The stomata are small and only slightly sunken. In the middle of the leaf there is a water storage tissue both above and below extending to the epidermal cells in the furrows. Thus the assimilating tissue is divided into two, in transverse section, semicircular portions at each side of the leaf. The tissue of assimilation consists of about 3 layers of palisade cells and among these here and there large bundles of raphides. The flowers are small and yellowish green. The stem is brownish-green and striped. Although this plant is frequently to be found on the slopes near Santa Cruz, one finds it most luxuriantly developed in the gravelly and stony brook-beds at the bottom of the barancos. These, carrying water only for extremely short periods, and with intervals of year between are under ordinary conditions apparently quite dry. But here *Plocama* grows extremely vigorously, and often forms perfect, pure growth. Very likely its deep-striking roots reach down to damper layers. At any rate after rain up in the mountains some water will always ooze down through the subsoil in the brooks even if the stony gravel at the surface looks quite dry. When the brook-bed, after unusual rainfalls, is filled with water rushing down, the *Plocama* by its flexible, elaster leaves and branches, reminding one as it does almost of an alga, is excellently adapted to offer the least possible resistance to the force of the water.

Then one finds in dry places low bushes of *Periploca lævigata*, about $^1/_2$ m. high with glabrous, stiff, leathery, sclerophyllous, lanceolate leaves, about 5 cm. long

and $1^1/_4$ cm. broad and full of milky juice. It generally keeps low, but if by chance it is near an *Euphorbia Canariensis* or any other higher bush it can climb up into these.

Allagopappus dichotomus is a little evergreen Composite-bush, about $^1/_2$ meter high, resembling a *Daphne*. It has small, leathery, linear-lanceolate leaves turning stiffly upwards. They are glabrous and shiny, with some single hairs along the edge. The rejuvenescence takes place immediately below the inflorescence.

Then there are three small species of *Phagnalon: Ph. saxatile, Ph. rupestre* and *Ph. purpurascens*. All three have small, more or less linear, upward turning leaves, which are white-felted below, and more or less sparsely hairy above.

Lavandula multifida has laciniate leaves with almost linear lobes entirely covered with stiff hairs.

Inula viscosa is a bush reaching almost a meter in height, with erect linear-lanceolate leaves. They are dark-green with scattered hairs, about 6 cm. long and $1^1/_2$ cm. broad. It is a nanophanerophyte, the rejuvenescence often taking place $^1/_2$ metre up the branches.

Fig. 25. *Plocama pendula* Ait. on steep rocky slopes at Santa Cruz. Together with it *Allagopappus dichotomus, Phagnalon saxatile, Micromeria, Inula viscosa* and above between *Plocama Euphorbia Canariensis, Kleinia* and *Euphorbia regis Jubae.*

Micromeria terebinthinacea is a small, much ramified bush. The leaves are ses-

sile, about $^3/_4$ mm. long. They are ovate-cordate, glabrous, with dark green, shiny upper-side, lighter below. The rejuvenescense often taking place rather high up the branches, this plant is on the verge of being a phanerophyte.

Micromeria thymoides is a small bush about a foot high, with more or less decumbent branches, and nearly linear leaves with revolute margins and scattered hairs.

Schizogyne sericea has small, almost linear, erect leaves, greyish with densely placed hairs, about 3—4 cm. long and 2—3 mm. broad.

Asparagus arborescens with long glabrous stems as much as 2 metres long. The linear leaves reach a length of 9 cm.

Artemisia Canariensis with finely divided, densely silky-hairy leaves reaches a height of more than $^1/_2$ metre.

Then one finds two Convolvulaceæ: *Rhodorhiza fruticulosa* with narrow, linear-lanceolate, densely hairy leaves, twining up into larger bushes, and *Convolvulus althæoides* with cordate, 3 cm. broad and 5 cm. long leaves, densely covered with stiff hairs and rooting stems lying along the ground.

Rubia fruticosa climbs up into the bushes with its rough leaves and stalks. The leaves are lanceolate, about $1^1/_2$ cm. long and 7 mm. broad.

In clefts of the rocks *Lobularia intermedia* grows, forming dense hanging cushions. The leaves are small and densely hairy.

Achyranthes argentea, otherwise common along roads and in outskirts of fields, also appears here on rocky terraces; the leaves are densely haired below and with scattered hairs on the upper side. Here one also finds *Andropogon hirtus* common, and in small, flat depressions on stones and rocks, the little, neat *Cyperus rotundus* grows socially in large clusters. Its basal part is swollen and tuberous.

Of grasses besides *Andropogon*, one finds *Pennisetum cenchroides* and the annual *Lamarckia aurea*.

Of *Sempervivum* an *Æonium* species (*urbicum*? *Canariense*?, unfortunately not in bloom at the time), was the species of this group growing in the driest localities and going the furthest down the slopes. In tolerably favourable places the rosettes were about 20—25 cm. in diameter, and by degrees it might form a stem more than half a metre in height, and the withered inflorescences were as much as half a metre long.

Fagonia Cretica is common, on its prostrate branches the rejuvenescence is often found more than 10 cm. from the base. *Forskålea angustifolia*, too, is very common, also *Psoralea bituminosa*, especially perhaps in somewhat more favourable localities. The rejuvenescence often happens considerably above 25 cm., so that this species might just as well be called a phanerophyte. Professor RAUNKIÆR has told me that this species is always a chamaephyte in the Mediterranean countries. In the hot houses of the botanical garden it is on the contrary a phanerophyte, the same as it often is in the Canary Islands. On the roots of *Psoralea*, *Phelipœa coerulea*[1] is often parasitic.

[1] The plant was extremely common on cultivated tomatoes in the environs of Santa Cruz.

The Umbelliferæ, *Todaroa aurea* was locally common in dry places.

And to these perennials of which of course considerably more are to be found on closer inspection, a large number of annuals must be added: *Lamarckia aurea, Echium plantagineum, Plantago Psyllium, Erodium Chium, Malva parviflora, Calendula arvensis, Rapistrum rugosum, Stachys hirta* and several others.

The geophytes are represented by *Scilla hæmorrhoidalis* W. et B. and the *Phelipæa coerulea* mentioned above.

When one goes somewhat higher (400—500 feet), and at the same time further into the barrancos or round on to the north side of the steep rocks, the vegetation quickly becomes more luxuriant and more species appear. Here one may meet with the wild olive tree[1], and very likely in earlier times, *Dracæna Draco* as well as *Phoenix Jubae* have occurred here although they may not have been common, in these localities. Now-a-days wild *Dracæna Draco* are only very seldom to be met with in the most out-of-the-way places[2]. On the other hand one may, especially on Gran Canaria, sometimes meet with a wild palm. For instance I have seen some on the hills behind Las Palmas, at a height of about 600—800 feet and on the steep mountain side at the road near Moya. But in the mountains at Santa Cruz I have seen none. The increasing luxuriance in the vegetation is shown by the fact that *Kleinia* and *Euphorbia regis Jubae* become common, large, and strongly developed. Besides the above-mentioned rather large *Æonium* species, *Æonium Lindleyi* was to be found, which is a small nanophanerophyte somewhat more than $^1/_2$ a metre high. It is a typical »Federbusch« plant with a much ramified woody stem, forming with the closely packed leaf rosettes at the end of the branches a small, dense bush, not unlike a small-leaved *Rhododendron*. The leaves are thick, sticky, spatulate, 3 cm. long and about 15 mm. broad in the broadest place.

Here one also meets with the two *Asphodelus* species: *A. ramosus* and *A. tenuifolius*.

But one finds here more especially a vast number of therophytes. At the bottom of a small baranco, where here and there yet a little stagnant water remained, a particularly luxuriant, herbaceous vegetation was to be found in the hollows filled with sand and gravel. I shall mention promiscuously some of the species: *Briza maxima, Briza minor, Parietaria debelis* and *Parietaria Judaica, Medicago denticulata, Scandix pecten veneris, Silene Gallica, Galium saccharatum, Lamarckia aurea, Antirrhinum Orontium, Stachys hirta* and *St. arvensis, Avena fatua, Vicia atropurpurea, Campanula dichotoma, Polycarpon tetraphyllum, Urospermum picroides, Wahlenbergia lobelioides, Campanula Erinus, Rumex bucephalophorus, Torilis infesta, Plantago Lagopus, Bromus maximus, Dianthus prolifer, Galactitis tomentosa, Mercurialis annua, Tri-*

[1] According to Webb et Berthelot, l. c., t. III, p. 74 the wild olive-tree is said to have formed extensive woods in former days.

[2] Schroeter in »Eine Exkursion nach den Canarischen Inseln«, p. 31 mentions having seen 28 wild *Dracæna Draco* on steep rock walls of the »Hombres de Taganana«. Comp. also: Børgesen: Drageblodstræet (Geografisk Tidsskrift, 26. Bd., 1921).

folium stellatum, Erodium moschatum, Chenopodium murale, Geranium molle, Centaurea Melitensis, Scorpiurus sulcatus and many others.

On the rocks of this baranco *Petrophyes brachycaulon* and *Sedum rubens* were growing, and in damp soil *Petrophyes polyphyllum.*

To these species a great number of *Cacti* and *Agaves* must finally be added, as well as the often rather high bush *Nicotiana glauca. Cacti* and *Agaves* have everywhere run wild on the rocks, and often appear in a great number and luxuriance. *Nicotiana glauca,* too, is to be found as wild on the rocky slopes. However it is especially common in waste ground on the outskirts of the towns. All of them have been introduced to the islands from America.

So that it may better be understood which types are especially characteristic of the vegetation, and to show how on the whole the vegetation here is adapted to the surroundings, I have in Table 11 below given a survey of the species to be found here, with information as to the life-form etc.

Table 11. List of species from rocky slopes and the barrancos behind Santa Cruz, Teneriffe.

1 S.	Euphorbia Canariensis L.	Milky juice.
1 M.	Olea Europæa L.	Microphyl. Leaves about 4 cm. long and 12 mm. broad, densely haired below, scattered above.
1 N.	Æonium Lindleyi W. B.	Nanophyl but near the limit of microphyl. Leaves succulent, spatulate, sticky by means of gland-hairs.
2 N.	Æonium spec.[1]	Mesophyl; leaves succulent.
3 N.	Allagopappus dichotomus Cass.	Nanophyl; leaves shining almost as if lackered with scattered hairs.
4 N.	Asparagus arborescens Willd.	Nanophyl; leaves lineate, about 9 cm. long and 1—1½ mm. broad.
5 N.	Euphorbia regis Jubae W. B.	Microphyl; leaves lanceolate about 7 cm. long and 6 mm. broad; milky juice.
6 N.	Inula viscosa Ait.	Nanophyl; leaves densely haired.
7 N.	Kleinia neriifolia Haw.	Microphyl; leaves linear-lanceolate to spatulate, about 14 cm. long and 15 mm. broad, succulent. Water storing tissue in the stem.
8 N.	Periploca lævigata Ait.	Nanophyl; leaves lanceolate, coriaceous, about 5 cm. long and 1¼ broad. Milky juice.
9 N.	Plocama pendula Ait.	Nanophyl; leaves linear about 4 cm. long and 1 mm. broad.
10 N.	Rhodorhiza fruticulosa Webb et Berth.	Nanophyl; leaves densely haired.
11 N.	Rubia fruticosa Jacq.	Nanophyl.
12 N.	Tamarix Gallica L.	Leptophyl.
1 Ch.	Achyranthes argentea Willd.	Nanophyl.
2 Ch.	Argyranthemum frutescens Schultz Bip.[2]	Laciniate, glaucous, fleshy leaves with linear lobes.
3 Ch.	Artemisia Canariensis Lees.[2]	Laciniate leaves with linear lobes, densely haired, whitish.
4 Ch.	Fagonia Cretica L.	Nanophyl, though the largest leaves only, namely 14 mm. long and 3 mm. broad; most of the leaves leptophyl.
5 Ch.	Forskålea angustifolia Retz.	Nanophyl; leaves haired.

6 Ch.	Lavandula multifida L.[2]	Leaves laciniate with linear lobes, greyish haired.
7 Ch.	Lobularia intermedia Webb et Berth.	Leptophyl; leaves linear-spatulate, densely haired, about 15 mm. long and 1 mm. broad.
8 Ch.	Micromeria terebinthinacea Webb et Berth.[2]	Leptophyl, but sometimes near nanophyl. Leaves glabrous, sclerophyllous with large clear glands.
9 Ch.	Micromeria thymoides Webb « rupestris Webb et Berth.	Leptophyl; leaves greyish with stiff hairs.
10 Ch.	Petrophyes brachycaulon Webb et Berth.	Leptophyl; leaves succulent, spatulate, about 8 mm. long and 3 mm. broad.
11 Ch.	Petrophyes polyphyllum Webb et Berth.	Leptophyl; leaves succulent, about 5 mm. long and 2 mm. broad with papillose surface.
12 Ch.	Phagnalon purpurascens Schultz Bip.	Nanophyl; leaves linear, grey-felted on the surface above, whitish on the lower surface with involute margins.
13 Ch.	Phagnalon rupestre D. C.	Nanophyl; hairs like the species above.
14 Ch.	Phagnalon saxatile Cass.	Nanophyl; hairs like the species above.
15 Ch.	Psoralea bituminosa L.[2]	Compound leaves; the terminal leaflet largest: microphyll, leaves densely haired below.
16 Ch.	Salvia Ægyptiaca L.	Nanophyl; leaves with waved, involute margin, scattered hairs especially on the lower surface.
17 Ch.	Sonchus gummifer Link.	The rosulate leaves most probably gradually raised up on a short stem; laciniate leaves, densely short felted below.
1 H.	Andropogon hirtus L.	
2 H.	Convolvulus althæoides L.	
3 H.	Cyperus rubicundus Vahl.	
4 H.	Lythrum Græfferi Ten.	
5 H.	Pallenis spinosa Cass.	
6 H.	Pennisetum cenchroides Rich.	
7 H.	Tamus edulis Lowe.	
8 H.	Todaroa aurea Parl.	
1 G.	Asphodelus ramosus Desf.	
2 G.	Asphodelus tenuifolius Cav.	
3 G.	Phelipæa coerulea Meyer.	
4 G.	Scilla hæmorrhoidalis W. B.	
1 Th.	Aichryson dichotomum W. B.	
2 Th.	Anagallis arvensis L.	
3 Th.	Antirrhinum Orontium L.	
4 Th.	Atractylis cancellata L.	
5 Th.	Avena fatua L.	
6 Th.	Bidens pilosa L. v. discoidea Sch. Bip.	
7 Th.	Briza maxima L.	
8 Th.	Bromus maximus L.	
9 Th.	Calendula arvensis L.	
10 Th.	Campanula dichotoma L.	
11 Th.	Campanula Erinus L.	
12 Th.	Centaurea Melitensis L. « genuina.	
13 Th.	Chenopodium murale L.	
14 Th.	Dianthus prolifer L. v. uniflora.	

15 Th.	Echium plantagineum L.
16 Th.	Erodium Chium Willd.
17 Th.	Erodium moschatum L'Hér.
18 Th.	Ervum hirsutum L.
19 Th.	Galactites tomentosa Moench.
20 Th.	Galium saccharatum All.
21 Th.	Geranium molle L. v. genuina.
22 Th.	Lamarckia aurea Moench.
23 Th.	Malva parviflora L.
24 Th.	Medicago denticulata Boiss.
25 Th.	Medicago minima Grufb.
26 Th.	Mercurialis annua L.
27 Th.	Nigella Damascena L.
28 Th.	Notoceras Canariense R. Br.
29 Th.	Parietaria debilis Forsk.
30 Th.	Parietaria Judaica L.
31 Th.	Plantago amplexicaulis Cav.
32 Th.	Plantago Lagopus L.
33 Th.	Plantago Psyllium L.
34 Th.	Polycarpon tetraphyllum L.
35 Th.	Portulacca oleracea L.
36 Th.	Rapistrum rugosum All. α scabrum.
37 Th.	Rumex bucephalophorus L.
38 Th.	Rumex vesicarius L.
39 Th.	Scandix pecten veneris L.
40 Th.	Scorpiurus sulcatus L.
41 Th.	Sedum rubens L.
42 Th.	Silene Gallica L.
43 Th.	Sonchus asper All.
44 Th.	Sonchus oleraceus L.
45 Th.	Stachys arvensis L.
46 Th.	Stachys hirta L.
47 Th.	Torilis infesta Hoffm.
48 Th.	Trifolium campestre Schreb. α genuinum.
49 Th.	Trifolium stellatum L.
50 Th.	Urospermum picroides Desf.
51 Th.	Vicia atropurpurea Desf.
52 Th.	Wahlenbergia lobelioides D.C.

[1] Most probably two different species occurred but they were not flowering and therefore could not be determined.

[2] The rejuvenescence of these species is as a rule formed below or near 25 cm. above the surface but now and then in favoured places it may take place higher up. Compare f. i. my remarks on *Psoralea bituminosa*, p. 334.

On the basis of this survey, the following biological spectrum (Table 12) is obtained to which in order that the plant-geographical position of the flora may be better understood I have added for comparison some spectra from desert-regions obtained by RAUNKIÆR (l. c., 1908, p. 55).

Table 12. Biological spectrum of rocky slopes at Santa Cruz together with spectra from other dry places.

	Number of species	Percentage of species under each life form									
		S	E	M M	M	N	Ch	H	G	H H	Th.
Rocky slopes near Santa Cruz	95	1	..	..	1	13	18	8	4	..	55
Ghardaia	300	(0.3)	..	..	..	3	16	20	3	..	58
El Goléa	169	..	..	..	..	9	13	15	5	2	56
Cyrenaica	375	..	..	1	1	7	14	19	8	..	50
Normal spectrum	1000	2	3	8	18	15	9	26	4	2	13

From this it appears that the therophyte % is about the same as that of the desert-regions. On the other hand the phanerophyte % (1 % M and 13 % N) is considerably higher than that of the real desert-regions, and the % reached by the plants with succulent stems is higher also, for in the flora of Ghardaia only a trace (0.3 %) is to be found. This vigorous development of the nanophanerophytes which appear even more in the vegetation of the dry planes and hills, is a characteristic feature of the vegetation of the Canarian lowland, where many species, in the uniform and comparatively favourable Canarian climate, are able to grow taller, and rejuvenate at a greater distance from the surface of the ground than in the more unfavourable desert climates with their remarkably great variations in temperature. Thus several species, or their closely related substitutes, which in less favourable regions are chamaephytes become nanophanerophytes in the Canarian Islands. According to the note to the chamaephytes (p. 336—7) several of these included in the survey in this group might with nearly equal right have been considered as nanophanerophytes, the percentage of this group being herewith yet more increased[1]. The chamaephyte % also is somewhat higher than in the desert. On the other hand the hemicryptophyte % is much reduced reaching not even half of that of the desert.

When we look at the size of leaf, 4 species, or 13.3 % of 30 species of phanerophytes and chamaephytes have laciniate leaves, 2 species or 6.6 % are mesophyllous, 3 species or 10 % microphyllous, 15 species or 50 % nanophyllous, and finally 6 species or 20 % are leptophyllous. Compared with the leaf size of the vegetation on the dry hills and plains, the more favourable conditions are here evident in larger leaves. But the size of leaf is nevertheless inconsiderable. And when we look for other signs of a dry climate we find many such here. Thus not less than 16 species are more or less strongly hairy, 6 species have succulent leaves,

[1] *Dracaena Draco*, which in the wild state is nearly exterminated, and *Phoenix Jubae* which I have seen on Gran Canaria growing wild on mountain slopes, were not to be found here. But even if they are included, the phanerophyte % will hardly be altered, the list of species also in the other groups having to be completed, as it must be remembered that the species collected and mentioned in the list belong to a very limited territory.

and 6 species have small, stiff, dry, sclerophyllous, often almost lackered leaves. Three species have milky juice, some species have bluish-green leaves, etc.

As is evident from the foregoing the rocky slopes near Santa Cruz exposed to the glow of the sun, have a vegetation which in its biological spectrum and its whole structure resembles the desert vegetation in a marked degree. But the vege-

Fig. 26. View of the vegetation on steep rocky slopes near the village of Juan de la Rambla on the north side of Teneriffe. The large *Sempervivum* is *S. (Æonium) Canariense*, the small flat one *S. (Æonium) tabulæforme*. Between these *Andropogon*, *Cineraria cruenta*, *Psoralea bituminosa* and others.

tation of the basal rocky slopes is far from being like this everywhere. On the contrary the vegetation varies within a short distance to an incredible degree. If the slopes have a slightly different exposure, facing, for instance, a little more towards the north, or if the situation is somewhat higher, or, most of all, if there is water oozing out or running down the rocks, the vegetation immediately reacts, and one may meet with an extremely vigorous flora.

I shall shortly mention a few of these localities. On account of the very short visits I have been able to make to these the record of what I have seen is necessarily very incomplete and disconnected. On the northern side of Teneriffe near the little town

of Juan de la Rambla, where the rocks rise steeply from the sea to a considerable height, and where there is shade from the burning mid-day sun and it is therefore fresh and cool, a very fertile vegetation is to be found. The beautiful *Sempervivum* are present here, often in great abundance. In the accompanying picture (Fig. 26) among the species appearing here are to be seen the splendid *Æonium Canariense*, often equipped with leaf rosettes more than 30 cm. broad, and the smaller, quite flat *Æonium tabulæforme* with closely placed imbricated leaves. On rocky spurs *Habenaria tridactylitis* was growing in abundance and in company with this *Senecio cruentus, Psoralea bituminosa, Desmophyllum pinnatum, Picridium Tingitanum, Lotus glaucus*, var. *sessilifolius, Leucophaë Massoniana, Globularia salicina, Andropogon hirtus, Davallia Canariensis, Dryopteris dentata* (Forsk.) C. Chr. and many others. High up on the steep, inaccessible mountain sides several of the large, beautiful *Sonchus*-species were growing with their great leaf rosettes and large, yellow inflorescences. Moreover the huge *Echium giganteum* almost reaching a man's height.

As one approaches Icod the country gets flatter and drier. The almost horizontal, or slightly sloping, rocky flats are only partly covered with a thin layer of soil, of which extensive *Cistus*-heaths in places have taken possession. The vegetation consisted mainly of two species of *Cistus*: *C. Monspeliensis* and *C. Berthelotianus*. The height of the bushes was almost 2 feet. They are strongly aromatic and sticky. *Cistus Berthelotianus* has leaves about 10 cm. long and 3 cm. broad, thus mesophyllous, and they, as well as the stems, are covered with long, stiff hairs. *Cistus Monspeliensis*, on the other hand, has narrow leaves 6—7 cm. long and 7—9 mm. broad, and is, therefore, microphyllous. Stems and leaves have long, scattered hairs. Here and there among the *Cistus*-bushes were found: *Globularia salicina, Argyranthemum frutescens, Polycarpœa Teneriffæ, Lotus glaucus, Phagnalon rupestre, Plocamium pendula, Euphorbia regis Jubae, Withania aristata, Justicia hyssopifolia, Helianthemum Canariense, Rubia fruticosa, Psoralia bituminosa, Andropogon hirtus, Micromeria hyssopifolius*. In damper hollows in the rocks *Scilla hæmorrhoidalis, Asphodelus ramosus* and *Dracunculus Canariensis* occurred.

On dry rocky slopes exposed to the sun above the small village El Palmar at a height of about 1500 feet, a vegetation very rich in species was to be found, consisting in its main features of: *Hypericum glandulosum*, a small bush (nanophanerophyte) with microphyllous leaves appearing here in an almost glabrous form and a rather hairy one, *Bystropogon Canariensis*, a small bush (nanophanerophyte) with coarsely dentated ovate-lanceolate, microphyllous leaves with scattered hairs. *Carlina salicifolia*, a typical »Federbusch« plant (nanophanerophyte) with linear, lanceolate, microphyllous leaves, green and glabrous on the upper side, white-felted below and with thorns along the margin. *Cedronella Canariensis*, a chamaephyte with coarsely dentated leaves, above with scattered hairs and densely haired below. *Leucophaë Massoniana*, a nanophanerophyte, microphyllous, the leaves being dark green, with scattered hairs above, white-felted below. *Callianassa Canariensis*, the beautiful Canarian *Digitalis*, very likely often a nanophanerophyte, woody as compared with the north-

ern *D. purpurea*, and having much smaller and especially much narrower leaves, about 8 cm. long and 2 cm. broad, therefore microphyllous. *Sonchus congestus*, one of the large, magnificent species with the great leaf-rosette, forming an embellishment for the rocky walls in the barancos, and also common in the town of Laguna where it adorns the roofs of the houses. *Andryala pinnatifida* a white-felted bush (nanophanerophyte) with microphyllous leaves. *Asparagus scoparius*, an elegant plant (nanophanerophyte) with leptophyllous soft leaves. *Echium aculeatum* a typical »Federbusch« plant (nanophanerophyte) with narrow, almost linear, nanophyllous, densely hairy leaves, whitish-grey, with stiff thorns along their margins. Then *Æonium Haworthii*, a nanophanerophyte, was rather common; it is a richly ramified bush, reaching the height of about half a metre with small thick leaves about 3 cm. long and 2 cm. broad gathered at the end of the branches. In dry rocky cracks finally *Ceterach aureum* was found. The upper side of the leaves is dark green, below they are densely covered with brown coarse scales which entirely cover the outside when, in dry weather, the leaves roll up.

Fig. 27. *Daphne Gnidium* L. from rocky slopes above Realejo alto.

As may be seen from the certainly most incomplete list, the vegetation here is composed of species, mostly belonging to the periphery of the laurel wood to the lower limit of which we are also in close proximity. Howewer I did not see any trees or larger bush here. But on my way up through the valley of El Palmar here and there some small specimens of *Heberdenia excelsa* were to be found.

Ascending still higher up one is mostly not long in meeting the first representatives of the laurel wood, at any rate such species as are to be found in the macchi surrounding it. This gradual transition I have especially had the opportunity of observing on the rocky slopes on the western side of the Orotava valley above the town Realejo alto. Climbing up the steep rocky slope which bounds the valley groves of *Daphne Gnidium* (Fig. 27) are to be met with at the height of about 1500 feet and also *Rubus*-species, *Cytisus Canariensis*, *Origanum vulgare*, *Callianassa Canariensis* and many others. Having reached the crest, Corona, as it is called, 2,800 feet above the sea, and going further up the sloping mountain ridge, a thicket is

soon reached, in which *Erica arborea* is common, and further *Myrica Faya, Ilex Canariensis, Smilax Mauritanica, Viburnum rugosum* and stunted *Laurus Canariensis.*

And just the same happens in a barranco, where there is water and dampness. As if by magic the vegetation changes its character and becomes overwhelmingly vigorous. Mighty ferns, especially *Woodwardia radicans* and *Pteris arguta,* hang down the rocky walls which are overspread by a luxuriant covering of moss, in which smaller ferns, such as *Asplenium Adianthum nigrum, Cystopteris fragilis, Polypodium vulgare, Athyrium umbrosum, Asplenium palmatum, Adianthum capillus veneris* and *A. reniforme* grow and among which *Selaginella denticulata* forms large tufts. The narrow cleft[1] is overshadowed by *Salix Canariensis, Ilex Canariensis* and sometimes by *Laurus Canariensis,* which in damp places can descend rather far into the lowland.

On Gran Canaria, on the steep rocky walls along the road on the north side of the islands below Firgas, an extremely vigorous vegetation was to be found at a height of about 1000 feet, the rainfall being here comparatively great, on account of the trade-wind, which comes straight from the sea and meets the high mountains.

Of species I met with here, the following must be mentioned: *Eupatorium adenophorum, Kleinia neriifolia, Ferula Linkii, Echium strictum, Galactites tomentosa, Rubia peregrina, Webbia Canariensis, Psoralea bituminosa, Senecio Webbii, Achyranthes argentea, Carlina salicifolia, Convolvulus Canariensis, Rumex Lunaria, Asparagus arborescens, Rubus* spec., *Euphorbia regis Jubae, Sonchus leptocephalus, Ranunculus cortusæfolius, Stachys hirta, Bromus Madritensis* with several other species. Then at least three species of *Æonium, Æonium ciliatum, Æ. virgineum* and *Æ. Youngianum,* large, more or less richly ramified species with rosulate leaves at the tips of the branches. Of ferns *Davallia Canariensis, Adianthum capillus veneris, Asplenium adianthum nigrum* were to be found and large tufts of *Selaginella denticulata.* Here and there on the rocks a *Phoenix Jubae* might also be seen.

The Vegetation of the Lava-field.

While in the dry and hot regions of the lowlands one is usually bound to go either to the rocky slopes, the barrancos or the coast in order to find succulent plants the vegetation one meets with on the lava-fields forms an exception. Where these occur in the lowland, one finds, as far as my observations go, even in the driest regions, a vegetation corresponding on the whole with what one finds on the rocky slopes. Only the luxuriance and number of species are usually less here.

The Canarian lava, at any rate the lava of the smaller torrents which I have had occasion to examine, is a hard black mass, full of larger and smaller holes and cracks with a very uneven undulating surface. As disintegration takes place very

[1] In such a cleft at Realejo alto crusts of *Hildenbrandia rivularis* (Liebm.) J. Ag. were to be found growing here rather abundantly upon rocks and stones in a small waterfall and at the bottom of the brooklet running through the cleft. This alga also occurred in a similar locality at Agua Mansa at a height of about 5000 feet.

slowly there is only a very little mould. In process of time some is of course always gathered in cracks and depressions. But in spite of the small amount of soil, and although one might suppose beforehand that such a place would be especially unfavourable to growth, the older lava-field appears nevertheless to harbour a rich and variable flora, and it even appears to do so in otherwise unfavourable localities where the vegetation of the surrounding country is quite desert-like. This can most

Fig. 28. View of vegetation on the lava torrent at Orotava. The vegetation mostly consists of *Kleinia neriifolia*, in the background, too, of *Euphorbia regis Jubae* and round about *Opuntia*.

probably be explained in the same way as the fact that in the lowland one is able by means of rock work to grow rock plants which on flat ground would die quickly. The stones retain the moisture, and the porosity of the ground, increased by the accumulation of the stones, contributes still more to keep the mould that is present damper than that of the surrounding plateau. While the climatic factors in both areas are quite the same, the adaphic and partly the physiographic factors, too, are much altered, coming near to that of the rocky slopes.

The flora of the lava-field is on the whole, as already mentioned, the same as that which we find on rocky slopes. But there are floristic differences. The flora of the lava-field is, I am sure, less rich in species. For instance, I have only found

one single species of *Sempervivum* in the localities I have examined. Of course I am here only speaking of the lowland lava-torrents, but the large characteristic species viz. *Euphorbia Canariensis, E. regis Jubae, Kleinia neriifolia* are to be found in both places. The peculiar feature of the flora of the lava-field is therefore that here the flora of the rocky slopes is, so to speak, transferred to the flat regions where otherwise it is not able to thrive. Of this fact, so it seems to me, earlier investigators have not taken sufficient notice, and the designation »the succulent steppe« has probably arisen just because the flora of the barancos and lava-torrents have been reckoned among the rest of the lowland flora.

Fig. 29. *Euphorbia regis Jubae* from the lava torrent at Orotava.

I have had occasion to examine the vegetation of the lava-field in two places especially, the first being on the remnants of the little torrent of lava which once flowed out of the small volcano Montaña de las Arenas in the valley of Orotava, and on which most of Puerta Orotava is now built, likewise the large Hotel Taoro Humboldt. The other place was a very interesting little torrent of lava, which one passes going south from Las Palmas to Telde. The torrent lies like a stiffened snake at the bottom of a broad valley. The vegetation here is of specially great interest. While that in the valley of Orotava is in a highly-cultivated and colonised region, this one is in a deserted, uninhabited and very dry region with no cultivation of any kind. Hence the original vegetation is surely almost completely preserved (however flocks of goats go everywhere), and the proportionally rich flora of the torrent of lava differing entirely from that of the surrounding country, thereby stands out so much the more distinctly.

To begin with I shall mention the vegetation on the torrent of lava in the valley of Orotava. The plant that first of all atracts attention is *Euphorbia Canariensis.* In this comparatively favourable spot it reaches an enormous development, greater than I have seen it in any other locality. In places it was, I am sure, 3—4 metres high, and the breadth of the compact bush was still greater. *Kleinia neriifolia* (Fig. 28)

and *Euphorbia regis Jubae* (Fig. 29) are both very common. Both of them reach almost the height of a man, and they resemble the dragon-tree in miniature with their undivided straight trunks and broad crowns at the top consisting of numerous branches with the leaves gathered in feathery tufts.

Then there is the finely foliaged *Sonchus leptocephalus* (Fig. 30) which can reach the height of a man and has at the base a stem often several centimetres thick from which several thin branches rise.

Fig. 30. *Sonchus leptocephalus* from the lava torrent at Orotava. The pieces of lava are light grey with crusts of Lichens. *Eucalyptus*-trees in the background.

Among the blocks of lava creeps *Rhus Coriaria* here and there sending branches up almost half a metre high with finely divided leaves.

And to these a list of species must be added the most common of which are *Allagopappus dichotomus, Rubia fruticosa* and *R. peregrina, Globularia salicina, Periploca lævigata, Lavandula multifida, Psoralea bituminosa, Chrysanthemum frutescens, Polycarpœa Teneriffæ, Forskålea angustifolia, Andropogon hirtus* and many others. Here and there the large bush *Rumex Lunaria* grows with thick, shiny, glabrous leaves. In depressions where there was a little soil, *Scilla hæmorrhoidalis* and *Allium*

trifoliatum were common, and where there was shade and a little moisture, *Dracunculus Canariensis* was to be found.

Over the blocks of lava, even in places open to the sun, *Davallia Canariensis* creeps, and in cracks and chinks one finds among other ferns *Nohtolæna vellea* and *Cheilanthes pulchella*. Finally there are numerous cacti and agaves.

As a very essential ingredient of the vegetation of the torrent of lava the lichens must at last be mentioned (Fig. 30). They cover the whole with a dense greyish-white crust, especially all the topmost driest parts, and on or between the crust-lichens great tufts of bush-lichens, especially *Roccella*-species, are numerous.

I tried, as far as I was able, to make as complete a collection as possible of the species found here. Professor VAINIO has done me a great service in identifying them. Compare the Appendix.

Of *Roccella*-species *R. Teneriffæ* Vainio nov. spec. was here to be found, a large, light-greyish to chocolate-coloured, forked forms, in shape very much resembling *Gigartina mamillosa*; moreover *Roccella fuciformis* (L.) D. C. f. *ensiformis* Vain., a tiny, forked, greyish plant was also present, and finally *Roccella Boergesenii* Vain. likewise a smaller, darker, brownish-grey species, di-polychotomously ramified with narrow thallus-lobes reminding one in shape of *Polyides*. Then there were low bushes and tufts of *Cladonia foliacea* Willd. var. *alcicornis* (Lightf.) Schaer. which is greyish-green and *Cladonia Krempelhuberi* Vain. var. *subcervicornis* Vain. of a more greyish hue. *Ramalina Bourgaeana* Mont. forms low greyish-green tufts on the rocks. Then there was *Stereocaulon Vesuvianum* Pers., with a low tufted, irregularly folded, lobed thallus.

Below and among these larger lichens the crust-shaped lichens formed an almost continuous greyish-white cover. Of *Lecanora*-species *L. glaucopsera* (Nyl.) Vain. and *L. Orotavensis* Vain. were to be found, both forming greyish crusts, and moreover *L.* (*Squamaria*) *crassa* (Huds.) Ach. forma *rhyacophila* Vain. with a somewhat irregularly lobed greenish-yellow thallus. Other species were *Ramalina coralloidea* (Mey. et Flot.) Vain. with a whitish-grey, irregularly lobed thallus, *Diploschistes aggregatus* Vain. with light grey to yellowish-brown thallus, *Pertusaria Teneriffensis* Vain. with greyish-white thallus, *Pertusaria inconveniens* Vain. with a whitish, thick, cracked thallus, and finally *Lecidea macrocarpa* (D. C.) Th. Fr. var. *contigua* (Fr.) Vain. with a darker greyish-black thallus. And among this rather homogeneous greyish cover, the orange-coloured thallus of *Xanthoria parietina* (L.) Th. Fr. shone out.

The other torrent of lava and in reality the most interesting and enlightening is, as aforesaid, the small torrent originating from a small crater situated on the eastern side of Gran Canaria close by the town of Telde. Being at first divided into two torrents owing to the contour of the ground, it is again combined in a broad valley which runs down towards the sea. It is only a small torrent, in places hardly more than 50 metres broad, and it occurs, as I have already said, in an exceedingly dry region. The surroundings of Telde are among the driest and hottest in the islands, so it is of great interest to see what the altered habitat factors are capable of producing. For although the flora of this torrent, as well in luxuriance as

in number of species, is inferior to that found in the lava torrent of Orotava, it shows a disconcerting abundance in comparison with the dry, poor vegetation of the surrounding hills.

The most abundant plant was here *Euphorbia Canariensis* (Fig. 31). It was to be found in innumerable specimens most of them, to be sure, small, not reaching

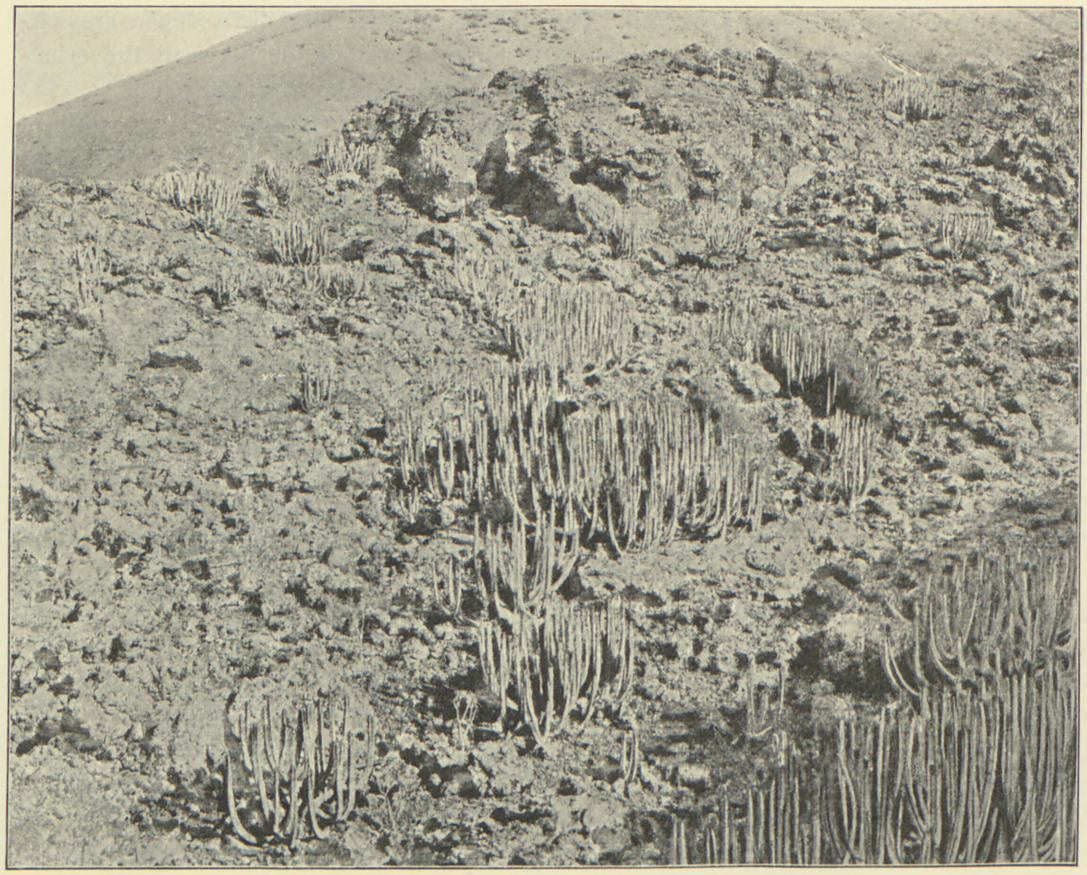

Fig. 31. View of a small piece of the lava torrent near Telde. Most of the vegetation visible is *Euphorbia Canariensis* but here and there, too, *Kleinia neriifolia* and *Euphorbia regis Jubae* are to be seen. In the background the nearly bare hills here and there with some few *Euphorbia balsamifera* are visible.

the colossal development seen at Orotava. In the immediate environs this species is not to be found at all. The nearest place in which one may find it is, I believe, up the mountain slopes in the territory of Lentiscal. But although the distance is not great, this, on account of the height, is in a much more favoured locality. Moreover both *Kleinia neriifolia, Euphorbia regis Jubae,* and *Sonchus leptocephalus* were to be found well-developed here, all three being searched for in vain in the surrounding flats and hills, and like *Euphorbia Canariensis* not met with until in the

higher, more favourable region. Furthermore we here met with *Plocama pendula, Rubia fruticosa, Asparagus arborescens, Urospermum picroides, Zollikoferia spinosa, Torilis infestans, Wahlenbergia lobelioides, Forskålea angustifolia, Mercurialis annua, Reseda scoparia, Antirrhinum orontium, Plantago Lagopus, Bromus rubens, Brachypodium distachyon, Aristida adscensionis*; even a fern, *Cheilanthes pteridioides* was able to grow here.

By a more thorough investigation of the flora, this list would certainly be considerably extended, although the number of species would hardly be so great as in more favoured places. But the list of species found is long enough to show the enormous difference between the composition of the flora on the torrent of lava and that of the vegetation of the surrounding hills, which, as I have said, are mainly covered with an almost unmixed growth of *Euphorbia balsamifera.*

In the subsequent list (Table 13) of species found on lava torrents these are grouped according to their life form. The species from Orotava are marked O., those from the torrent near Telde T.

Table 13. Plants from lava-streams.

Orotava (O.) and Telde (T.).

1 S.	Euphorbia canariensis L.		O. T.
1 M.	Rumex Lunaria L.	Leaves microphyl but near mesosphyl, ovate-cordate, about $5^1/_2$ cm. long and broad, a shrub up to 3 m. high.	O.
1 N.	Aeonium urbicum Webb et Berth.	Microphyl; leaves spatulate, 8 cm. long and 3 cm. broad, succulent.	O.
2 N.	Allagopappus dichotomus Cass.	Nanophyl; leaves linear-lanceolate, about 4 cm. long and 4 mm. broad.	O.
3 N.	Asparagus arborescens Willd.	Nanophyl; leaves linear, about 9 cm. long and $1—1^1/_2$ mm. broad.	T.
4 N.	Bosia Yerva mora L.	Microphyl; leaves lanceolate, about 8 cm. long and $2^1/_2$ cm. broad.	O.
5 N.	Euphorbia regis Jubae Webb et Berth.	Nanophyl; leaves linear-lanceolate, about 6 cm. long and 5 mm. broad.	O. T.
6 N.	Globularia salicina Lamk.	Microphyl; leaves lanceolate, 1 cm. broad and $1^1/_2$ long, glabrous, sclerenchymatous.	O.
7 N.	Kleinia neriifolia Haw.	Microphyl, but near the limit of mesophyl; leaves linear-lanceolate, 14 cm. long and 15 mm. broad, succulent, water tissue in the stem.	O. T.
8 N.	Messerschmidia fruticosa L.	Microphyl; leaves elongated lanceolate with ovate base and elongated apex, about 12 cm. long and 2 cm. broad.	O.
9 N.	Periploca lævigata Ait.	Microphyl; leaves lanceolate, $4^1/_2$ cm. long and 13 mm. broad.	O.
10 N.	Plocama pendula Ait.	Nanophyl; leaves about 40 mm. long and 1 mm. broad, linear, nearly terete.	T.
11 N.	Rhodorhiza florida Webb et Berth.	Nanophyl but near the limit of microphyl; leaves linear, 7 cm. long and 4 mm. broad where broadest, densely whitish haired.	O.
12 N.	Rhus Coriaria L.	Pinnate leaves, leaflets microphyl but near nanophyl, 4 cm. long and 2 cm. broad, scattered haired, yellowish felted below.	O.

13 N.	Rubia fruticosa Ait.	Nanophyl; leaves lanceolate.	O. T.
14 N.	Rubia peregrina L.	Microphyl; leaves lanceolate, about 5 cm. long and 17 mm. broad.	O.
15 N.	Sonchus leptocephalus Cass.	Laciniate leaves with hair-fine lobes.	O.
16 N.	Zollikoferia spinosa Boiss.	Comp. remarks, p. 291.	T.
1 Ch.	Argyranthemum frutescens Schultz Bip.	Laciniate leaves, fleshy, glaucous with linear lobes.	O.
2 Ch.	Forskålea angustifolia Retz.	Nanophyl; leaves hairy.	T.
3 Ch.	Lavandula multifida Lam.	Laciniate leaves with linear lobes, greyish with densely placed hairs.	O.
4 Ch.	Micromeria hyssopifolia Webb et Berth.	Leptophyl; leaves about 6 mm. long and 1 mm. broad, densely haired.	O.
5 Ch.	Polycarpæa Teneriffæ Lam.	Leptophyl, but near nanophyl; leaves spatulate, 1 cm. long and 3 mm. broad where broadest, densely haired.	O.
6 Ch.	Psoralia bituminosa L.	Pinnate leaves, terminal leaflet largest, microphyl.	O.
7 Ch.	Reseda scoparia Brouss.	Nanophyl; leaves linear, about 40 mm. long and 1 mm. broad.	T.
1 H.	Andropogon hirtus L.		O. T.
2 H.	Pennisetum cenchroides Rich.		O.
3 H.	Picridium Tingitanum Sch. Bip.		O.
1 G.	Allium trifoliatum Cyr.		O.
2 G.	Dracunculus Canariensis Kunth.		O.
3 G.	Scilla hæmorrhoidalis Webb et Berth.		O.
1 Th.	Antirrhinum Orontium L.		T.
2 Th.	Arenaria serpyllifolia L.		O.
3 Th.	Aristida Adscensionis L.		O. T.
4 Th.	Brachypodium distachyon Roem. et Sch.		T.
5 Th.	Bromus rubens L.		T.
6 Th.	Cuscuta Epithymum Murr.		O.
7 Th.	Euphorbia terracina L.		O.
8 Th.	Fumaria confusa Jord.		O.
9 Th.	Mercurialis annua L.		T.
10 Th.	Plantago Lagopus L.		T.
11 Th.	Scandix Pecten Veneris L.		O.
12 Th.	Scleropoa rigida Griseb.		O.
13 Th.	Silene Gallica L.		O.
14 Th.	Torilis infesta Hoffm.		T.
15 Th.	Urospermum picroides Desf.		T.
16 Th.	Wahlenbergia lobeloides D. C.		T.

On the basis of this list the undermentioned biological spectrum is obtained.

Table 14. Biological spectrum of the flora of the lava-streams.

	Number of species	Percentage of species under each life form									
		S	E	M M	M	N	Ch	H	G	H H	Th
Species from lava-streams	47	2	..	..	2	34	15	6,5	6,5	..	34
Normal spectrum.....	1000	2	3	8	18	15	9	26	4	2	13

From this it appears that the phanerophyte $^0/_0$ here is considerably higher than on the mountain slopes, while on the contrary the chamæphyte $^0/_0$ is a little lower, and the therophyte $^0/_0$ considerably lower, than on the mountain slopes. This may perhaps partly be the case owing to the very dry year. At the bottom of the barrancos in the mountain slopes, there are more favourable localities for the therophytes even in dry years, while such places of growth are lacking on the torrents of lava.

Compared with the spectrum of the dry hills the phanerophyte $^0/_0$ is considerably higher on the torrent of lava. In return the chamæphyte $^0/_0$ is less than half, while the therophyte $^0/_0$ is about the same.

It would be an interesting task to follow the development of the vegetation of the lavafields. Since the time of conquest of the islands rather precise information is obtainable as to the dates of the different volcanic eruptions, and the lavafields originating from them. Unfortunately my time did not allow me to undertake such an investigation. The two localities which I have examined more closely both originate from the time before the conquest.

II.

The Montanic Region.

Here I have had the chance of seeing the laurel wood, the pine wood and the maqui.

The Laurel Wood and surrounding Maqui.

On the two main islands Gran Canaria and Teneriffe, the only islands I had the opportunity of visiting, the extent of the laurel wood is now much less than it was at one time, in fact on Gran Canaria it is practically exterminated. When however WEBB and BERTHELOT say (l. c., p. 125), that in 1526 Teneriffe was almost entirely covered with wood this does not at any rate apply to the laurel wood. The real laurel wood was, I am sure, only to be found in patches in the dampest and most favourable places in the temperate zone. But that only a hundred years ago it had a far wider distribution than now is clear from the earlier travellers' descriptions.

It is mercilessly cut down and used as fuel and for the making of charcoal. And, as WEBB and BERTHELOT emphasise, the fear that the highly volcanic islands would hardly exist for long, contributed to a great extent to this. »Tenerife ne durera pas deux cent ans« was the answer given to WEBB and BERTHELOT when they deprecated the destruction of the woods. If that were so, they might just as well be cut down. And if the belief had not prevailed among the inhabitants that the springs would dry up if the woods and the shade were destroyed, surely most of the small remaining woods we find now would not have existed to-day.

But it is not only the merciless felling of the trees which contributes to the destruction of the woods. The violent competition, which now-a-days prevails in obtaining water and leading it as quickly as possible down into the valleys for the irrigation of the low land cultivation, has of course a no less destructive effect. Higher and higher up the engineers build their aquaducts. The water is so to speak, nabbed, just when it springs from the rock, and the surrounding lands are transformed into barren reaches. Nowhere is this better seen than in the valley of Orotava. High up above Agua Mansa, at the height of 5000 feet at least, the water is gathered in cemented mains which carry it quickly down alongside the valley. In this way what was once wooded valleys are now laid waste, and only a low open

maqui with here and there a few stunted fir-trees is able to grow here, where in earlier days the laurels were at home; only in a few especially favourable places, where a little moisture is still allowed to trickle from the rock or where the mains are leaky a few species of the laurel wood might be present.

In BUNBURY's paper (l. c., p. 28—9) we have the following description of the vegetation about Agua Mansa: »Although there has been a lamentable waste of the beautiful forests of Teneriffe, yet there are still some accessible spots where the woodland vegetation may be seen in all its luxuriance. Such is the wood of Agua Mansa, above Orotava, which is fortunately preserved unhurt . . . The large trees in the wood are principally Viñaticos, *Persea Indica*, and some of them are indeed of great size and noble aspect. Beneath them is a luxuriant and beautiful undergrowth of *Erica arborea*, *Myrica Faya*, *Viburnum rugosum*, *Ilex Canariensis*, Webb and Berth. (the Aceviño of the Canarians), *Hypericum grandiflorum*, and one or two species of *Cistus*.« And this luxuriant laurel wood, thus described by BUNBURY must even then have been of recent date, because one reads in WEBB and BERTHELOT, l. c., p. 122 that the laurel wood at Orotava was burnt in 1815, and later on it was substantiated that *Erica* soon appeared, and still later, by degrees, the laurel trees.

And the reckless hewing away of the wood is continued up to the present day. In Agua Garcia I was told that its area had been very considerably restricted in later years, especially during the war. And during my visits to the woods of Las Mercedes the axe sounded unceasingly and crash upon crash proclaimed that old veterans had fallen for ever. And the way in which the last remaining til-trees on Gran Canaria were treated will be mentioned later.

And yet the laurel wood has, I am sure, considerable vitality and power of regeneration. The above-mentioned observations on the forest in Agua Mansa are suggestive of this, and I got the same impression when I visited these places; especially in the country that surrounds Moya and Gran Canaria; there is no doubt but that, if the cleared parts were left in peace, a fresh wood would quickly shoot up. But men and goats compete in keeping it down, so in that respect there is not much hope.

The haunts of the laurel wood are the dampest localities in the montainous temperate zone, at a height of about 700—1600 m., while the maqui establishes itself in the more dry and open places. Consequently the laurel wood appears especially in those valleys and clefts that face north and east where the moisture carried in such great quantity by the trade-wind is condensed, causing the rainfall there to be the highest. Round about in these dampest places the laurel wood is at home, and by degrees as the ground gets drier it merges evenly into the maqui which generally spreads far and wide round about the often small areas that are covered with real laurel wood. The maqui is mostly obliged to get the water it needs from mist or drizzling rain, while under the conditions prevailing in the localities where the laurel grows, the moisture often condenses in heavy rain.

Unfortunately there are no meteorological records from the laurel forest. The nearest place is Laguna situated at a height of about 550 m. close to the high pass by which one crosses to the north side of Teneriffe. According to HANN's »Handbuch der Klimatologie« a hydrothermic figure from there has the appearance shown in Fig. 32.

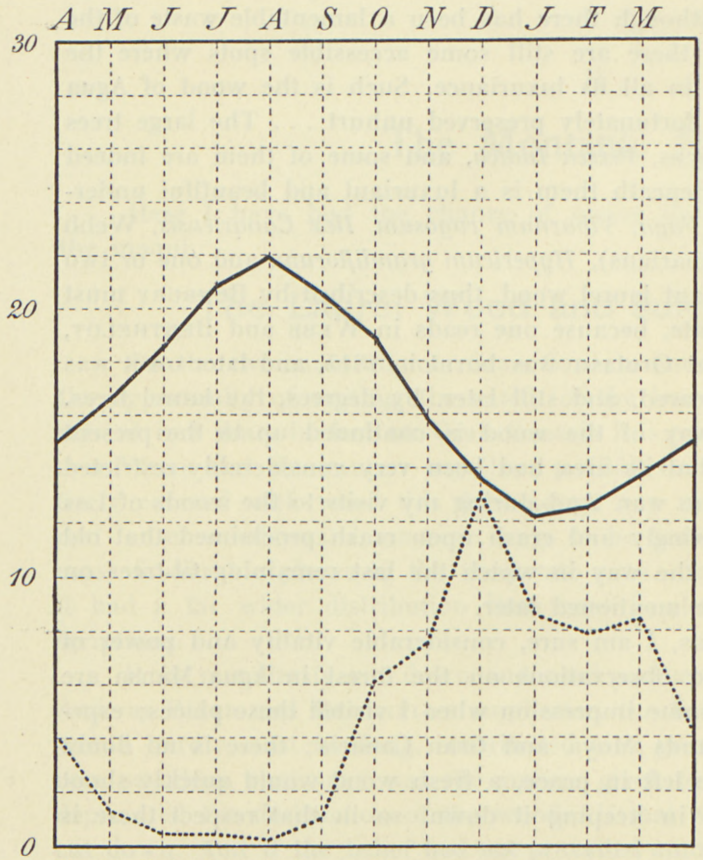

Fig. 32. Hydrothermic figure of Laguna. —— curve of Temperature, ····· curve of rain fall. The figures signify Centigrade for the temperature and cm. for the rain curve.

From this it appears that the lowest temperature 12.2 C.° occurs in January and the highest 21.9 C.° in August. The highest amount of rain with 13 cm. falls in December, decreasing to 7.9 cm. in February, rising a little to 8.4 in March, whence it rapidly decreases through the following months, being only 0.4 in June and July and 0.2 in August, when it rises again first slowly to 1 cm. in September, more quickly in the following months until the maximum is reached. The distribution of the rain during the year is therefore not especially fortunate, as the greatest amount falls in the coldest part of the year. The yearly rainfall for Laguna is 590 mm.

However, it must not be forgotten that the amount of rain in the valley of Las Mercedes, lying to be sure only 4—5 miles away, is no doubt nevertheless far greater than in La Laguna, just as mist and the formation of clouds are here very considerable.

However, these facts are so often mentioned by earlier investigators, for instance in SCHIMPER—SCHENCK's description of the vegetation, that I shall not dwell further on this matter. And in the same work one also finds a thorough description of the laurel wood's composition in general and its origin, both of which I shall here refer to.

So in the following account I shall only give a short description of the localities I have visited.

On Teneriffe I have had the opportunity of seeing the laurel wood in the two

well known and often described localities Agua Garcia and Las Mercedes; moreover in the environs of Agua Mansa where it mostly consisted only of a few trees and above Corona on the eastern side of the valley of Orotava.

On Gran Canaria I was fortunate enough to find a small still preserved remnant of the forest that earlier covered the rocky slopes near Moya on the northern side of the island and of which WEBB and BERTHELOT as late as in 1820 saw beautiful remnants that soon after were destroyed. The little yet remaining woody valley is called »Los Tilos« after the most predominant tree »til«, *Oreodaphne foetens.*

The laurel wood at Agua Garcia is most easily reached from the village Tacaronto situated by the main road between Santa Cruz and Orotava, about 1700 feet above the sea. One follows a bridle path in a south-easterly direction. The path goes alongside a little baranco cut out in the ground by a small brook. The sides of this baranco have a luxuriant vegetation. First of all one may here have the chance of admiring the beautiful Canarian Campanula, *Canarina Campanula* which stood for a long time as the solitary representative of a peculiar type until closely allied species were found recently, partly in East Africa and partly in the south of Abyssinia. Then there are the beautiful *Pericallis*-species, the primitive forms of the Cinerarias now cultivated in our hothouses. The slopes are densely covered with species of *Rubus*, among which the *Canarina* climbs, of *Daphne Gnidium*, *Adenocarpus*, *Hypericum* etc.

Almost half-way up at a height of about 2350 feet, one passes by a little well, Fuente de Agua Garcia, to which the people of the neighbourhood thronged to fetch water, and soon after the wood is to be seen (Fig. 33). The first trees one reaches, *Laurus Canariensis* and *Ilex Canariensis*, are few and far between. *Laurus Canariensis* attains a height of more than 20 metres, *Ilex Canariensis* is mostly to be found in the shape of a large bush but it may become a tree as much as 15 metres in height; on the whole it is rather variable, its leaves being sometimes quite small and almost roundish, sometimes much larger, oval and with a thorny margin. The undergrowth consists of *Viburnum rugosum* and, in the outskirts, of *Erica arborea* and *Myrica Faya.* Soon the wood gets thicker and new species emerge, for instance *Oreodaphne foetens*, a tree with grey, scabrous bark and a broad, dense crown. As one continues to walk along the narrow path one finds oneself rather suddenly after having walked only for a few minutes, and at a height of about 2600 feet, in a narrow cleft with damp, deep, fertile mould at the bottom, and steep almost vertical walls on both sides. Here where the air is generally strongly saturated with moisture, and where deep shadow reigns is the real home of the viñatico, *Persea Indica*, and here one meets with magnificent old specimens of this the most stately tree of the Canarian laurel wood (Fig. 34).

The lowest part of the trunk of these veterans is short and thick, reaching 4—5 metres or even more in diameter. At about twice the height of a man or somewhat more, a greater number (5—10) of vigorous stems of different ages reaching no doubt a height of more than 30 metres, issue from it. But besides these older

branches numerous smaller ones of all ages grow from the stem, and often the mighty trunk is quite covered with innumerable, young branches breaking out everywhere from dormant buds. The viñatico has quite taken possession of this ravine and banished most of the other trees to drier parts around it.

Fig. 33. View of the laurel wood of Agua Garcia near the outskirts. The trees are *Laurus Canariensis* and *Oreodaphne foetens*. Between them *Ilex Canariensis* and *Myrica Faya*. The shrubs in the foreground are *Viburnum rugosum*, *Hypericum* etc.

In the deep shadow under the viñatico one of the most beautiful and peculiar types of the laurel wood is to be found, namely *Ilex platyphylla*, of all known species of *Ilex* the one, that has the largest leaf. This magnificent plant has only been found in a few damp places on Teneriffe. The oval leaves become as large as a clenched fist and carry strong thorns along the margin. The leaf has a fresh green colour and a shining surface.

In the darkest part of the wood the ground is all but bare, but here and there grow ferns especially *Cystopteris fragilis* with its great Macaronesian variety *Canariensis*, *Asplenium Adiantum nigrum* **onopteris* and *Polystichum setiferum*. Where it is a little lighter, one finds the large *Geranium anemonæfolium* with its splendid

leaf rosettes; gradually as it grows older it may get a true stem and will most likely become a nanophanerophyte; compare the figure in SCHENCK and SCHIMPER's work, l. c., p. 331. Then there is the large bushy Gentianace, *Ixanthus viscosus* with great, lanceolate leaves. In a few places *Rubia peregrina* climbed on the bushes.

On the steep rocks and earth walls and also in caves one finds a thick covering of moss; according to the determination of Prof. BROTHERUS the most common species of these are: *Bryum Canariense*, *Epipterygium Tozeri*, *Trichostomum brachydontium*, var. *robustum*, *Eurhynchium Stokesii*, var. *Tenerifae*, *Fissidens serrulatus*, *Mnium undulatum*, *Thamnium alopecurum*, *Fissideus pallidicaulis* and Hepaticæ. Between the mosses in the darker places *Trichomanes radicans* was found here and there. On the two occasions that I visited Agua Garcia in the month of January it was very much shrivelled up on account of drought. I have not found it as SCHIMPER says, growing near waterfalls by which means it would constantly be sprinkled over with water. Indeed I saw no waterfall here but only a small brook at the bottom of the valley. On the slopes and earth banks one finds the *Asplenium hemionitis*

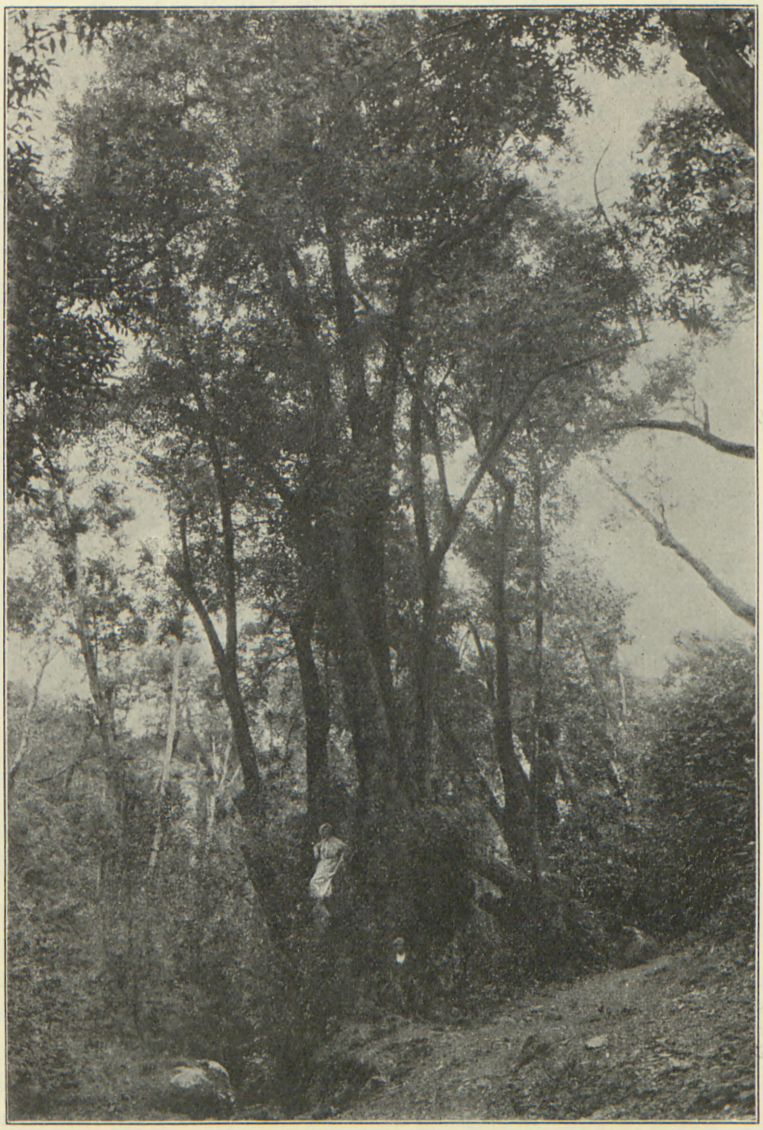

Fig. 34. Old *Persea Indica* trees showing the huge basal trunks from which a number of vigorous branches arise.

rather commonly. And on the branches of the trees the large Canarian variety of *Polypodium vulgare* var. *serrata* was here and there to be found.

On the stems of *Laurus Canariensis* the large *Exobasidium Lauri* Geyler was rather common. Its brownish ramified thallus has the appearance of fingers crowded together.

Down the rocky slopes creeps the Canarian Ivy, *Hedera Helix* var. *Canariensis*; it seldom climbs on the trees, but lies along the ground. But the accompanying photo shows (Fig. 35) that all the same it is sometimes able to creep into the trees.

Fig. 35. *Hedera Helix* L. var. *Canariensis* climbing upon the stem of *Laurus Canariensis* surrounded by young *Ilex Canariensis* etc.

As already mentioned the damp valley is narrow and short, one can easily pass through it in a few minutes and I am sure there are hardly more than a score left of the large viñatico-trees.

When one ascends the slopes one is so to speak suddenly transferred into quite another scene, but one that is no less peculiar. The damp soil and the twilight are at an end; one is dazzled by the sunlight that freely penetrates the scattered trees, and the soil is dry and firm. The trees that here first attract attention are the huge *Erica arborea* (Fig. 36), reaching here in these comparatively favourable spots the imposing height of about 50 feet, and a trunk diameter of about two feet. They were in full flower, sprinkled over with the innumerable tiny, white flowers which seen at a distance give the *Erica*-maqui a greyish white tone. Of other trees *Laurus Canariensis* and *Ilex Canariensis* were growing here. The undergrowth consists of *Myrica Faya* which becomes a large bush or a small tree, and of *Viburnum rugosum*. Then one finds several Hypericacé-bushes which reach about a man's height: *Androsaemum Webbianum* with a brownish, terete stem and ovoid-lanceolate leaves, *Hypericum glandulosum* with lanceolate leaves and *Webbia Canariensis* with narrow linear-lanceolate leaves. Numerous *Rubi* lie with long branches along the ground, or climb into the bushes close by, and often make the passage anything but convenient to which also the very thorny *Smilax Mauritanica* contributes. On slopes and

in more open places a lanate form of *Pteridium aquilinum* is common, and intermingled with it one finds *Daphne Gnidium* and more rarely *Andryala pinnatifida*.

By and by as one withdraws from the ravine and finds the soil more and more dry, and the conditions on the whole more unfavourable, the *Erica* gets smaller and smaller, but at the same time the vegetation becomes more thick, until it gradually forms a dense impenetrable maqui reaching up to twice the height of a man.

Fig. 36. *Erica arborea* trees. The lower vegetation consists of *Ilex Canariensis, Myrica Faya. Daphne Gnidium, Rubus* spec., *Smilax Mauritanica*, several *Hypericum*, etc.

Above the *Erica* a small tree, *Cytisus proliferus*, here and there spreads its long branches. It was blooming at the time and was densely covered with white flowers; it is rather xeromorphically built, the ternate leaves are rather small, dark green with densely placed hairs on the upper side, and white felted below. Moreover *Myrica Faya* is commonly to be found in the maqui, with its highly light-reflecting, upturned, dentate leaves. Finally one may find here and there the little *Adenocarpus foliosus* var. *glabrescens* provided with extending branches and tiny leaves.

How large the area of the wood and the surrounding maqui at Agua Garcia is, I do not know. According to MEYER (l. c., p. 82) it is not supposed to be larger than about 3 square km. and I am sure it has become a great deal smaller since then.

For instance I saw areas that had certainly quite recently been cleaned by colonists and taken in for cultivation.

The laurel wood near Las Mercedes is of a far larger extent but also of a somewhat different character. WEBB and BERTHELOT l. c. p. 128 give an enthusiastic description of the wood about Laguna which then was very extensive and of which the wood of Las Mercedes was a part. Now there is no wood at Laguna, it is all

Fig. 37. View from the interior of the wood-clad valley at Las Mercedes. Regarding dimensions of trees note the woman to the left and the two persons in the middle of the photo.

arable land. The easiest way to get to this wood of Las Mercedes is by following the road from Laguna, which, planted with huge *Eucalyptus*-trees throughout the broad, fertile valley to the north-east, leads to the little village of Las Mercedes. Passing by this at a height of a little more than 2000 feet, one continues to walk up a little path, until the wood is reached at a height of about 2300 feet. Close to the entrance of the wood there are a few *Salix Canariensis*, which together with *Sambucus Palmensis* represent the deciduous trees on the islands. But already at the end of February ($^{25}/_{2}$) *Salix Canariensis* had large leaves and long shoots; its leaves are densely white-haired on the underside.

Directly afterwards one meets with *Persea Indica* and *Laurus Canariensis* and

finds oneself in the wood. The path goes up through a broad valley at the bottom of which a brook runs (Fig. 37). Here are no trees which are imposing either on account of their diameter or their height, as is the case in Agua Garcia; most of them may be compared as to dimensions with an about 50—80 years' old beech wood, the larger stems being about half a metre in diameter, but several of them much thinner. Often the trees are rather strongly twisted and ramified far down. The leafy canopy comes at a height of about 50 feet, perhaps still heigher in the most fertile places, and it is very dense, so that a deep shadow, almost twilight, reigns in the wood. On the whole one has here more the impression of being in a forest than in Agua Garcia.

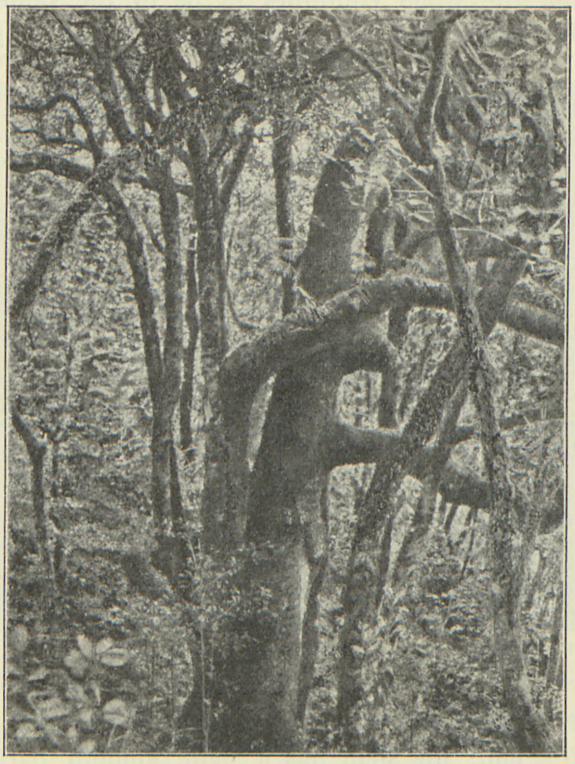

Fig. 38. *Oreodaphne foetens* Webb et Berthelot, an old, much ramified tree, the branches of which being covered with mosses often forming long garlands; in the moss cover *Polypodium vulgare*.

Persea and *Laurus* are the principal trees. Below them one finds as larger bushes or as small trees *Ilex platyphylla* already mentioned as occurring at Agua Garcia. In lighter places the large bush *Rhamnus glandulosa* occurs with its oval dentate, dark green leaves about 7 cm. long and 3 cm. broad. Here and there one meets with the bushy *Phyllis Nobla* reaching a height of about a metre with large, elliptical, sparsely haired leaves and *Ixanthus viscosus* more than a metre high.

A common plant in the Mercedes wood is *Senecio appendiculatus* growing in dark places in moist earth; the leaves of this plant are dark green on the upper side and densely white-felted below. *Galium ellipticum* with small, ovate-oval, rough-haired leaves, appears now and then, the same being the case with *Viola silvestris*.

In ravines where leaves are heaped up, and form a deep mould, *Aichryson punctatum* grows, a yellow-flowered, richly ramified, herbaceous plant growing to the height of half a metre or more, with fresh-green, thick leaves and green stalks except for the main stem which is of a reddish hue. *Aichryson dichotomum* is to be found here and there. In damp spots rich in humus, *Ranunculus cortusæfolius, β silvaticus* was found now and then. Besides these species it is chiefly ferns that one finds spread near the ground, especially *Asplenium hemionitis, Asplenium Adian-*

tum nigrum, Aspidium aculeatum and in dark, moist places the little elegant *Gymnogramma.*

The plants are very scattered, the ground is seen everywhere; only here and there a few mosses are to be found, for instance *Ceratodon purpureus, Eurhynchium Stokesii* var. *Tenerifae* and *Hepaticæ.*

In the middle of the valley one passes a spring which gives rise to a brook, but the wood continues to be of the same type, until one approaches the ridge. Here the wood shows a marked change; it gets lower, and *Persea* and *Laurus* draw back and new species come instead. Here one meets with Til, *Oreodaphne foetens* (Fig. 38) in this place a comparatively small tree with a highly rugged, uneven bark, and rather small, glabrous, shining leaves; while some of the trees were putting out fresh leaves, others were quite at rest, a peculiarity one meets with in most of the Canarian trees in the laurel wood. Aderno, *Heberdenia excelsa,* is a fine rather large tree, with smooth, shining leaves, reaching a length of 14 cm. and a breadth of $5^1/_2$ cm.; the stem has a light, smooth bark. Barbusano, *Apollonias Canariensis,* is a smaller tree with leaves about 6—9 cm. long and as much as $3^1/_2$ cm. broad; Palo blanco, *Notelæa excelsa,* a pretty tree with smooth, shining, light green leaves about 9 cm. long and $3^1/_2$ cm. broad.

Fig. 39. View from the road with thickets of *Prunus Lusitanica.*

Along the outskirts of the wood and along the roads, Hija, *Prunus Lusitanica* is common (Fig. 39). It is a large bush or a small tree, with dark green, shining leaves waved at the margin, and arranged prettily in a pennate way up the branches. Moreover, here in the outskirts one meets with *Ilex Canariensis,* either as a small tree or a large bush.

The trees here are generally small, hardly very much more than 30—50 feet, twisted and gnarled, and they are rather scattered so the light is able to get down among them. On the stems is found a dense moss covering of *Scleropodium illecebrum, Pogonatum aloides, Mnium undulatum, Neckera intermedia* and several other species. Several of the mosses hang from the branches like long garlands. Further-

more there are Hepaticæ and the large, yellowish-grey lichen *Lobularia intermixta* with perforated thallus.

And in this moss-cover *Davallia Canariensis* and *Polypodium vulgare* often grow.

Owing to the stronger light the ground vegetation is also more developed and in places forms a rather dense covering, in which *Brachypodium vulgare* is often the most common species. And among this *Hypericum glandulosum, Cedronella Canariensis, Arisarum vulgare, Pericallis, Polystichum setiferum, Asplenium Adiantum nigrum, Pteridium aquilinum* are found more or less abundantly, while *Convolvulus Canariensis, Smilax Mauritanica* and *Rubus* climb up into trees and bushes.

As one approaches the edge of the mountains, since the strength of the wind there is greater, the character of the vegetation is again considerably altered, turning gradually, in consequence of the increased exposure, into maqui consisting chiefly of *Erica arborea*, this vegetation covering to a great extent the wind-swept mountain slopes.

Besides *Erica* which forms the mass of the vegetation, and is larger or smaller according to the exposure of the place, one finds in places, and those not the very most exposed, *Ilex Canariensis* and *Myrica Faya*. On the other hand *Cytisus proliferus* var. *Canariæ*, a little richly ramified tree (Fig. 40), with much expanded branches and leaves densely haired on the upper side, white-felted below, grows in very exposed places. Moreover *Bystropogon Canariensis*, a little much ramified bush with leaves about 5 cm. long and 3 cm. broad, sparsely hairy on the upper side and white-felted below, and finally *Cytisus Canariensis* var. *ramosissima*, a little bush with densely white felted leaflets, $^1/_2$ cm. long and yellow flowers are to be found.

On the branches of *Cytisus proliferus, Davallia Canariensis* was often growing, and on the ground the little *Rumex bucephalophorus* var. *Canariensis* is in places found abundantly and dense low tufts of *Polycarpæa Teneriffae*. Here and there grew the green, somewhat fleshy orchid *Peristylis cordatus*, and the small *Romulea Columnæ* var. *grandiscapsum* stretches its *Crocus*-like, purple flowers up among the vegetation.

Finally at a height of about 1000 m., out on the most exposed ridges, sloping towards the north, therefore exposed to the strong wind rising from the narrow valleys, the vegetation consists of an open *Erica* heath, half a metre high, with bushes scattered here and there. Among these are to be found low bushes of *Cytisus Canariensis* var. *ramosissima* and *Adenocarpus foliosus* var. *glabrescens* both much ramified bushes, the last mentioned with stiff branches in all directions and tiny dark-green leaves with stiff hairs. Furthermore *Micromeria thymoides* var. *rupestris* a little, low heathy bush, the leaves of which scarcely reach a length of $^1/_2$ cm. and are more or less rolled up.

But the *Erica* forms the main mass of the vegetation which in the most exposed places is not any higher than a *Calluna*-heath to which the whole vegetation upon the whole has a striking likeness, and to which the rich Lichen- and Moss-

vegetation, densely covering the bottom, highly contribute, many of the species found here being the same as or nearly related forms to those found in a Danish heath.

Of Mosses the common ones were: *Polytrichum piliferum* and *juniperinum, Fissidens pallidicaulis, Ceratodon purpureus, Campylopus polytrichoides, Leucodon Canariensis* etc., as will be seen several northern species, and among the rich Lichen flora there were several northern acquaintances. First of all a whole series of *Cladonia-*

Fig. 40. *Cytisus proliferus* L. var. *Canariæ* Christ growing among *Erica arborea, Myrica Faya* etc.

species, *Cladonia rangiformis* Hoffm. with forma *pungens*, a somewhat larger coarser form. *Cladonia fimbriata* (L.) Fr. having a greyish white, erect, terete, dichotomously ramified thallus; besides the typical form the var. *subulata* was to be found. *Cladonia pyxidata* (L.) Fr. with forma *lophyra* and forma *neglecta*; *Cladonia furcata* with forma *palamæa* and forma *subulata* and finally *Cladonia chlorophaea* (Floerk.) Spreng.

Of *Peltigera* the following forms were found: *Peltigera polydactylon* (Neck) Hoffm. var. *subspuria* Nyl. a fine form with chocolate to olive-brown thallus, *Peltigera canina* (L.) Hoffm. with var. *spuria* (Ach.) Sch., a somewhat smaller, more divided form of a greyish olive-coloured hue and forma *pellita* Vain. which is more dark brown, finally *Peltigera prætextata* (Floerk.) Zopf. Then there was *Ramalina farinacea* Ach.

and two *Leptogium, L. palmatum* (Huds.) Mont. forming dark green densely ramified cushions and *L. ruginosum* (Duf.) Nyl. having dark olive-green cushions on the ground. Furthermore *Nephroma parile* (Ach.) Vain. with grey, olive-brown lobed and curled thallus and *Anaptychia leucomelaena* (L.) Vain. var. *multifida* (Mey. & Flot.) Vain. with a peculiar, richly ramified thallus the main stems of which are white and from this black threads issue in all directions. Then there are *Lecidea coarctata* Nyl. and one sterile *Lecidea* spec., and finally *Erioderma limbatum* (Nyl.) Vain., with a greyish-brown, leaf-like thallus, and *Lecanora crassa* (Huds.) Ach. f. *rhyacophila* Vain. with an irregularly lobed greyish-white thallus.

Along the road in the wood the whitish-grey *Andryala pinnatifida* was common in the upper part of the wood. And on a hilly ridge swept by the wind quite on the outskirts of the wood, the interesting *Plantago arborescens* was found, forming a very dense, richly ramified broad bush about $^3/_4$ metre high, the linear leaves with long stiff hairs, the old ones remaining attached to the stems.

Fig. 41. Moist rocky walls above Agua Mansa with *Laurus Canariensis, Myrica Faya, Ilex Canariensis, Viburnum rugosum* and the large ferns *Woodwardia radicans* and *Pteris arguta.*

As mentioned above, the laurel wood here is considerably larger than that of Agua Garcia, but its extent is, nevertheless, not very considerable, being constantly limited by the great amount of felling that takes place, whereby the rarest species, of which perhaps only a few specimens are left, might mercilessly be cut down. The real laurel wood is now, judging from my two visits, limited to the broad valley and the most protected adjacent mountain slopes. On the other hand the maqui surrounding the laurel wood is of a considerable extent. If one stands on one of the mountain tops above the laurel wood, one sees the maqui clothing the steep mountain slopes everywhere from a height of about 2000 feet and upwards almost to the tops. It is most strongly developed in the lower depths of the valleys, where very likely the laurel wood also makes an attempt to grow, decreasing slowly upwards in the heights. When I visited Las Mercedes in February the *Erica* was flowering, and the innumerable small heath-blossoms gave the vegetation covering the mountain slope a tone of grey. With the *Erica* are mixed *Myrica Faya, Cytisus proliferus* and several of the small bushes mentioned above.

In addition to these two larger pieces of woodland scenery I have elsewhere on Teneriffe only seen a few representatives of the laurel-wood species or smaller

areas covered with them. Thus in Agua Mansa at a height of about 4000 feet in the south-eastern corner of the Orotava valley where the maqui has taken possession of the lower flatter areas, while the pine-wood yet covers the steep mountain slopes, I have seen a few old specimens of *Persea Indica* with huge stems spreading beyond the rocks, and of other trees from the laurel wood, *Laurus Canariensis, Ilex Canariensis* and of bushes, *Myrica Faya* and *Viburnum rugosum.* And on the

Fig. 42. Flat areas above Moya covered with a vegetation composed especially of *Rubus, Pteris aquilina, Andryala pinnatifida, Inula viscosa, Brachypodium sylvaticum* and other species.

moist rocky walls (Fig. 41) dripping with water, a luxuriant growth of *Woodwardia radicans* and *Pteris arguta, Notholœna marantæ, Anogramma leptophylla, Cystopteris fragilis* and other species is found. These are the last remnants of the beautiful laurel-wood once to be found here, as we know it from BUNBURY'S statement mentioned above. Finally in the maqui on the mountain ridge, on the western side of the Orotava valley, at a height of about 3000 feet above Corona, I have found *Laurus Canariensis, Ilex Canariensis, Myrica Faya* scattered among *Erica arborea.*

But if there are still some laurel-woods to be found in Teneriffe (and there

are several perhaps still more luxuriant than those I have seen, for instance the wood above Taganana of which SCHRÖTER gives an enthusiastic description in his »Exkursionsbericht«, p. 30—31), hardly any of the considerable laurel woods once to be found on Gran Canaria are left.

Fig. 43. Rocky walls with a very rich vegetation of *Sempervivum*, Ferns, *Selaginella* etc.

It was especially in the high, deeply cleft, wildly romantic, montainous country about Moya, on the northern side of Gran Canaria, that the laurel wood spread in ancient times. About the remnants of wood at Moya CHR. SMITH writes, l. c. p. 41: »In the morning the vicar accompanied us to Madres (l'Agua madre di Moya) $^1/_2$ league up into the barranco where the water gushed out of several, great wells shaded by large Til-trees. A desirable asylum, the only remaining remnant of the paradise which VIERA describes on Monte Doramas, where all tall trees are cut down.« And SCHENCK writes, l. c. p. 353: »Im nördlichen Teile der Insel, im Distrikt von Teror und Moya sind von dem im Zeitalter der Eroberung berühmten Walde von Doramas nur noch vereinzelte Tilgruppen und Lorbeerhecken, umrankt von *Smilax, Convolvulus* und *Hedera,* übrig geblieben, nachdem die letzten schönen Waldreste bei Moya, die noch von WEBB und BERTHELOT im Jahre 1820 besucht wurden, bald nachher vernichtet wurden.«

Now in order to find out, whether remnants of the laurel wood were still to be found, I took a trip to the little town Moya, standing on the slopes of the high mountains on the northern side of Gran Canaria at a height of about 1500 feet. From the village a bridle path leads up the mountain side to a more level plateau, the peculiar vegetation of which quickly showed that one was on the old forest soil (Fig. 42).

Fig. 44. View from the interior of the wood at Los Tilos. Mostly young trees of *Laurus* and Til but trunks of old trees are seen round about. The ground is covered with a rich vegetation of which *Myosotis macrocalycina* is the most dominant species.

In the main the vegetation consisted of *Rubus* and *Pteridium aquilinum* among which grew here and there *Andryala pinnatifida*, characteristic of the outskirts of the laurel wood, and as ground-vegetation *Brachypodium sylvaticum*. Here and there *Erica arborea* was to be found, and sometimes rather large bushes of *Inula viscosa* and *Adenocarpus foliosus*. This vegetation was suggestive of old forest soil and as I soon afterwards came across suckers of *Ilex Canariensis*, *Laurus Canariensis* and *Oreodaphne foetens*, there was no doubt that not long ago the laurel wood had flourished here. But no wood was to be seen. Round about on the hills grew some trees but they were all *Eucalyptus*, which is planted a great deal now-a-days.

Meanwhile some boys accompanying us asserted that behind a projecting moun-

tain ridge seen in the distance there would be a wood, so we directed our steps in that direction. When we reached the mountain ridge, the sight of the vegetation on the slope was considerably encouraging, for there was present a young wood in vigorous growth. The old trees had been cut down, but from the stumps a strong vegetation had grown in vigorous luxuriance. Of trees and bushes *Laurus Canariensis, Ilex Canariensis, Myrica Faya* and *Viburnum rugosum* were here to be found. Moreover *Cytisus proliferus, Webbia Canariensis* and the beautiful *Callianassa Isabelliana* was in full flower. In places where the rock appeared, there was a lower but proportionally just as luxuriant vegetation (Fig. 43). Here were found several species of *Sempervivum, Carlina salicifolia, Psoralea bituminosa, Echium,* several ferns *Asplenium Adiantum nigrum, Adiantum Capillus veneris, Ceterach aureum, Polypodium vulgare, Selaginella denticulata* and many others. But the wood for which we were longing did not make its appearance.

However, the boys encouraged us; we had only to get round one projecting mountain ridge, and then we should soon reach the wood. Finally after laboriously climbing along the steep mountain side we rounded the hill and indeed, in the narrow valley now opening to us, and actually at the bottom of the valley, there was a small remnant of the laurel wood. The place is called »Los Tilos« after the predominant tree: »Til«, *Oreodaphne foetens,* of which almost a score of very old huge specimens remained. These old trees had a short trunk, scarcely much more than the height of a man but on the other hand very thick, I am sure 2—3 metres in diameter, bearing a number of large branches spreading out to all sides, so that the trees, without reaching any especially great height, are yet very broad. The bark on the trunk and the branches is very uneven and furrowed. The leaves are comparatively small, glabrous and shining. There had till quite recently been several more of such old trees, the many, enormous stumps bearing witness to the fact. During the war especially, the wood had been mercilessly cut down, and if this abuse is not put an end to, the little bit of wood still standing may soon be no more. Some of the old stumps tried to save themselves by sending out numerous shoots; but most of them were dead.

The remaining stock of trees in the wood were younger. Most of the trees were Til, but *Laurus* was to be found among them. The photo (Fig. 44) shows part of the wood; the stumps are seen round about in the picture. On the whole the place is very idyllic, a good-sized brook running through the wood contributing to this effect. The wood, being so much thinned out, was not particularly dark in comparison with the laurel wood in Teneriffe, and by reason of this the ground vegetation vas very vigorous and dense, differing in a very marked degree, as well on account of this, as by its composition from that of the woods on Teneriffe, and on the whole reminding one forcibly of a northern beech wood vegetation. To this first of all a *Myosotis, M. macrocalycina* contributed, and also *Senecio vulgaris, Galium Aparine, Moehringia trinervia, Euphorbia Peplus* and several others. Then a little bush *Paronychia Canariensis* was to be found here, with small elliptical leaves about

13 mm. long, 3 mm. broad and densely hairy, *Rubia fruticosa* with oval lanceolate leaves about $5^1/_2$ cm. long and $2^1/_2$ cm. broad, as is seen from this microphyllous, while on lava-streams its leaves are nanophyllous only, *Stachys hirta, Raphanus Raphanistrum, Torilis infesta, Briza minor, Cedronella Canariensis, Parietaria debilis* and finally the beautilul, large *Geranium anemonaefolium.*

Here and there grew the fresh green bush *Bosia yervamora*, with more or less hanging branches, and the annual *Aichryson dichotomum.*

Of ferns were found *Athyrium felix femina* and *Athyrium axillare.* On cliffs and earthy slopes *Asplenium hemionitis* was common, and locally, growing especially in caves in the rocks, quantities of *Adiantum reniforme.* Near the outskirts of the wood a small specimen of *Semele androgyna*, the most magnificent climber of the Canarian laurel wood, was found.

Any maqui surrounding the wood I have not seen here.

This is the only laurel wood I have met with on Gran Canaria. Whether any more remnants of wood are to be found here, for instance higher up in the country in the neighbouring Mña de Doramas I do not know, but in the immediate neighbourhood I saw no other wood. However it is of course not quite impossible that other remnants of the famous laurel wood known from earlier times may be preserved at the bottom of one of the many deep valleys, but it is not very likely. In Bbown's guide-book I was told that some wood land was to be found near Teror (the place is called Los Osorios) but it was a chestnut wood. However, the ground-vegetation suggested that the laurel wood had formerly grown here.

The foregoing gives a description of the stretches of wood with surrounding maqui which I have had the opportunity of seeing on the two Canarian islands Gran Canaria and Teneriffe. Taking Gran Canaria as a whole there is, as mentioned above, scarcely any more of the original wood to be found than the little remnant at Los Tilos, while on Teneriffe there are still several beautiful stretches of wood remaining[1].

Evidently, from the foregoing description, the laurel wood and the maqui have shared the ground between them, according to the degree of moisture, and generally the transition from the dark, shady laurel wood to the light, sunlit maqui occurs quite gradually, so that nearly always a greater or smaller area of mixed vegetation is to be found. But even though this is the case, separately considered they are physiognomically as different as possible, as the following lists of species (Tables 15—16) from both localities arranged according to their life-forms most clearly show.

[1] Comp. Schenck, l. c. p. 346.

Table 15. The species of the maqui as observed at Agua Mansa, Agua Garcia and Las Mercedes.

1 M.	Cytisus proliferus L.	Nanophyl; leaves trifoliate, leaflets lanceolate, scattered haired above, densely whitish haired below, about 3 cm. long and $1^1/_4$ cm. broad. A tree about 5 m. high.
2 M.	Erica arborea L.	Leptophyl; in the most favoured places a tree up to about 50 feet high.
3 M.	Ilex Canariensis Poir.	Microphyl; considered here microphanerophyte as this species in the maqui is mostly not higher than 8 m.
4 M.	Myrica Faya Ait.	Microphyl; leaves with shining surface, glandular hairs on the lower surface. In the maqui rarely higher than 8 m.
1 N.	Adenocarpus foliosus Ait. β glabrescens.	Leptophyl; trifoliate leaves, densely haired.
2 N.	Androsæmum Webbianum Spach.	Microphyl; leaves glabrous.
3 N.	Bystropogon Canariensis L'Hérit.	Microphyl; leaves lanceolate, about 5 cm. long and 3 cm. broad, scattered haired above, whitish felted below.
4 N.	Cistus Berthelotianus Spach.	Microphyl; leaves densely haired.
5 N.	Cistus Monspeliensis L.	Microphyl; leaves linear lanceolate, about 6 cm. × 1 cm.. lackered above, haired below.
6 N.	Cytisus Canariensis L.	Leptophyl; leaves trifoliate, densely white haired.
7 N.	Daphne Gnidium L.	Nanophyl; glabrous.
8 N.	Erica scoparia L.	Leptophyl.
9 N.	Leucophaë candicans Webb et Berth.	Microphyl; leaves white-haired. The rejuvenescence may perhaps sometimes take place below 25 cm.
10 N.	Plantago arborescens Poir.	Leptophyl but near nanophyl; leaves linear, about 25 mm. long and 1 mm. broad, haired.
11 N.	Webbia Canariensis Webb et Berth.	Microphyl: leaves glabrous.
1 Ch.	Marrubium vulgare L.	Microphyl; densely haired, white felted.
2 Ch.	Micromeria hyssopifolia Webb et Berth.	Leptophyl; leaves densely haired.
3 Ch.	Micromeria thymoides Webb α rupestris Webb et Berth.	Leptophyl; leaves greyish with stiff hairs.
4 Ch.	Phagnalon saxatile Cass.	Nanophyl; leaves grey-felted on the surface above, whitish on the lower surface.
5 Ch.	Polycarpæa Teneriffæ Lam.	Leptophyl, but near nanophyl; leaves densely haired.
1 H.	Andropogon hirtus L.	
2 H.	Origanum vulgare L.	
3 H.	Rubus Canariensis Focke.	
4 H.	Rubus ulmifolius Schott.	
1 Th.	Aira caryophyllea L.	
2 Th.	Erodium Chium Willd.	
3 Th.	Rumex bucephalophorus L.	
4 Th.	Vulpia myuros Gmel.	

Table 16. The species of the Laurel wood as observed in the woods of Agua Garcia and Las Mercedes, Teneriffe and Los Tilos, Gran Canaria and completed with species from SCHENCK's list, l. c., p. 354.

		I. M. M. evergreen.
1 M. M.	Apollonias Canariensis Nees.	Microphyl; leaves elliptical, about 6 × $2^3/_4$ cm., glabrous.
2 M. M.	Heberdenia excelsa Banks.	Mesophyl; glandular hairs.
3 M. M.	Ilex Canariensis Poir.	Microphyl; but in favoured places near the limit of mesophyl; leaves glabrous.
4 M. M.	Ilex platyphylla Webb et Berth.	Mesophyl; leaves glabrous.
5 M. M.	Laurus Canariensis Webb et Berth.	Mesophyl; leaves glabrous.
6 M. M.	Notelæa excelsa Webb et Berth.	Microphyl to mesophyl; most leaves microphyl, but some few larger.
7 M. M.	Orodaphne foetens Nees.	Mesophyl.
8 M. M.	Persea Indica Spreng.	Mesophyl; hairs on the lower surface.
9 M. M.	Pleiomeris Canariensis D. C.	Mesophyl.
10 M. M.	Prunus Lusitanica L.	Mesophyl; leaves glabrous.
11 M. M.	Visnea Mocanera L. fil.	Microphyl; leaves elliptical 5 × $2^1/_4$ cm., glabrous.
		II. M. M. deciduous.
12 M. M.	Salix Canariensis Chr. Sm.	Microphyl; leaves elongated elliptical, nearly glabrous on the upper side, white felted below.
1 M.	Convolvulus Canariensis L.	Mesophyl, but near microphyl; leaves haired, ovate-cordate, about 8 cm. long and $5^1/_2$ broad.
2 M.	Gesnouinia arborea Gaudich.	Mesophyl but near microphyl; leaves elliptical about 10 × $3^1/_2$ cm., haired below.
3 M.	Rhamnus glandulosa Ait.	Microphyl; leaves haired.
4 M.	Semele androgyna Knth.	Mesophyl, but near the limit of microphyl; glabrous.
5 M.	Viburnum rugosum Pers.	Mesophyl; leaves haired.
1 N.	Androsæmum Webbianum Spach.	Microphyl; leaves glabrous.
2 N.	Andryala pinnatifida Ait.	Microphyl; leaves scattered haired on the upper side, white felted below.
3 N.	Bosia Yervamora L.	Microphyl, but near mesophyl; leaves glabrous, about 8 × $3^1/_2$ cm., larger than those from lava-stream. Not common in Laurel wood, found in the wood of Los Tilos.
4 N.	Hypericum glandulosum Ait.	Microphyl, but near nanophyl; leaves lanceolate, about 4 cm. long and 1,3 cm. broad, scattered haired.
5 N.	Leucophaë Canariensis Webb et Berth.	Microphyl, but near mesophyl; leaves elliptical with cordate base, about 8 cm. long and 4 cm. broad, densely haired above, yellow felted below.
6 N.	Rubia fruticosa Jacq.	Microphyl; leaves oval-lanceolate, about $5^1/_2$ × $2^1/_2$ cm. Upon lava-torrent the leaves are much smaller, nanophyl only.
7 N.	Rubia peregrina L.	Nanophyl; leaves with scattered short hairs. The rejuvenescence takes place at a height of about 30 cm.
8 N.	Smilax Mauritanica Poir.	Microphyl; leaves cordate. about 4 × 4 cm., glabrous.
9 N.	Urtica morifolia Poir.	Mesophyl; leaves ovate-cordate, about $8^1/_2$ cm. long and 7 cm. broad, haired.

10 N.	Webbia Canariensis Webb et Berth.	Microphyl, glabrous.
1 Ch.	Callianassa Isabelliana Webb et Berth.	Microphyl; leaves linear-lanceolate, about 12 cm. long and 1,5 broad, haired below and upon the midrib. Often near the limit of nanophanerophyte as the rejuvenescence takes place rather high up, 15—20 cm. or even more above the earth.
2 Ch.	Cedronella Canariensis Webb et Berth.	Leaves trifoliate, terminal leaf largest = microphyl; leaves with scattered hairs on the upper surface, densely haired below.
3 Ch.	Geranium anemonæfolium L'Hér.	The rosette is gradually raised, as the plant grows older, above the earth and very likely the stem in some individuals may reach a length of more than 25 cm. Leaves laciniate, scattered haired mostly along the ribs.
4 Ch.	Hedera Helix L. var. Canariensis Webb et Berth.	Mesophyl. As the Canarian Ivy mostly lies along the ground it is here considered as Ch.
5 Ch.	Paronychia Canariensis Juss.	Nanophyl; leaves about 13 mm. long and 3 mm. broad, densely haired.
6 Ch.	Phyllis Nobla L.	Mesophyl; leaves elliptical about $13 \times 3^1/_2$ cm., scattered haired.
7 Ch.	Senecio appendiculatus Schultz Bip.	Mesophyl, but near microphyl; leaves ovate-cordate, 8 cm. long and $7^1/_2$ broad, white felted below. The rejuvenescence might most probably at times take place above 25 cm.
1 H.	Brachypodium Sylvaticum Roem. et Sch.	
2 H.	Canarina Campanula Lam.	I presume that the long sappy shoots die away every year and that the rejuvenescence takes place from the upper end of the thick roots or from a short stem in the earthcrust.
3 H.	Galium ellipticum Willd. α villosum Webb et Berth.	
4 H.	Ixanthus viscosus Griseb.	I regret that I have not examined this plant at its growing place. I presume it is a hemicryptophyte but it is not inconceivable that it is a nanophanerophyte.
5 H.	Luzula Canariensis Poir.	
6 H.	Myosotis macrocalycina Cosson.	
7 H.	Ranunculus cortusæfolius Webb et Berth.	
8 H.	Rubus Canariensis Focke.	
9 H.	Rubus ulmifolius Schott.	
10 H.	Scrophularia Smithii Hornem.	
11 H.	Senecio cruentus D. C.	
12 H.	Senecio Tussilaginis D. C.	
13 H.	Silene nutans L.	
14 H.	Veronica serpyllifolia L.	
15 H.	Viola canina L.	
16 H.	Viola odorata L. var. Maderensis Webb.	
17 H.	Viola sylvestris L.	
1 G.	Arisarum vulgare Targ.	
2 G.	Tinea intacta Boiss.	

3 G.	Iris fætidissima L.	
4 G.	Peristylus cordatus Lindl.	
5 G.	Romulea Columnæ Seb. et Maur.	
1 Th.	Aichryson dichotomum D.C.	} Both with succulent leaves.
2 Th.	Aichryson punctatum Webb et Berth.	
3 Th.	Briza minor L.	
4 Th.	Drusa oppositifolia D. C.	Judging from specimens in the herbarium = Th. I have not found this plant myself.
5 Th.	Euphorbia Peplus L.	
6 Th.	Galium Aparine L.	
7 Th.	Luzula purpurea Link.	
8 Th.	Moehringia trinervia Clair.	
9 Th.	Parietaria debilis Forsk.	
10 Th.	Rhaphanus Raphanistrum L.	
11 Th.	Senecio vulgaris L.	
12 Th.	Stachys hirta L.	
13 Th.	Torilis infesta Hoffm.	
14 Th.	Viola tricolor L.	

Besides the above-mentioned species, the following are mentioned in SCHENCK's list: *Arbutus Canariensis* Veill., *Bencomia caudata* W. and B., *Catha cassinoides* W. and B., *Crambe strigosa* L'Hér., *Euphorbia mellifera* Ait., *Jasminum Barrelieri* W. and B., *Pittosporum coriaceum* Ait., *Senecio Murrayi* Bornm., and *Vicia cirrhosa* Chr. Sm. That these species are not added to the foregoing account is partly owing to the fact that some of them are not found on Teneriffe or Gran Canaria, and partly and particularly, that they are not generally to be met with in the laurel wood proper but rather in favourable places in the barrancos. On the whole most of them are very rare.

On the base of these lists of species the following biological spectra are obtained.

Table 17. Biological spectra of the laurel wood and the maqui.

	Number of species	Percentage of species under each life form									
		S	E	M M	M	N	Ch	H	G	H H	Th
Laurel wood.....	70	..	..	17	7	14	10	25	7	..	20
Maqui.....	28	..	..	..	14	40	18	14	..	..	14
Normal spectrum....	1000	2	3	8	18	15	9	26	4	2	13

From these it appears that in the maqui the nanophanerophytes are to be found in the highest percentage, more than a third of the total number of species belonging to this class. The microphanerophytes account for 14 %; among these are reckoned *Erica arborea* and *Ilex Canariensis* which in favourable places become

mesophanerophytes, but in the real maqui hardly reach more than a height of 6 metres. Altogether the phanerophytes in the maqui amount to 54 %, and show a considerably higher percentage in the maqui than in the laurel wood, where the phanerophyte percentage only reaches 38. But to make up for this, 24 % of these are mega- and mesophanerophytes, while in the maqui the nanophanerophytes are predominantly present. The chamæphytes, too, are rather numerous in the maqui, with more than 18 %, while in the laurel wood these only reach 10 %. To make up for this the hemicryptophyte percentage is considerably higher in the laurel wood than in the maqui. Of the geophytes, according to my distribution of the species, there are none in the maqui against 7 % in the laurel wood, but I do not dare deny that some of the species mentioned as from the laurel wood only, for instance *Romulea Columnae*, should perhaps be also among the species of the maqui. Finally the therophyte percentage (14 %) of the maqui is less than that of the laurel wood (20 %). That the climate is drier in the maqui appears from the fact that the nanophanerophyte percentage rises, while the megaphanerophytes quite disappear.

And when we examine the influence of the climate on the size of leaf this comes to view in a very clear way when we compare the size of the leaf in the two types of vegetation.

Of the 20 species of phanerophytes and chamæphytes found in the maqui

8 species are leptophyllous = 40 %
3 — - nanophyllous = 15 %
9 — - microphyllous = 45 %

Of the 34 species of phanerophytes and chamæphytes of the laurel wood, one species, namely *Salix Canariensis*, is deciduous and on account of that left out of consideration and one species, *Geranium anemonæfolium*, having laciniate leaves, is not added either; of the remaining 32 species

2 species are nanophyllous = 6 %
15 — - microphyllous = 47 %
15 — - mesophyllous = 47 %

From this it is evident that while about half the species in the laurel wood are mesophyllous, the maqui has no mesophyllous species whatever. Microphyllous species are present in both areas to about the same extent; of nanophyllous species there are only 6 % in the laurel wood, while in the maqui there are 15 %, and of leptophyllous species there are none whatever in the laurel wood, though these are present in the maqui to the amount of 40 %.

The influence of the far drier climate of the maqui as compared with the laurel wood is, as is evident from the foregoing, very distinctly visible in the size of the leaf.

But examining the species of the laurel wood more closely, one soon notices

that the dry macaronesian climate also to a great extent affects even this vegetation occupying the most favoured areas of the islands. Even in the winter dry periods may occur. For instance, when in the month of January I visited the wood of Agua Garcia, it was very dry then, and to name an example, *Trichomanes radicans* was quite shrunk up among the dry moss. And during the hot seasons dry periods are much more common and affect the vegetation much more. SCHIMPER writes, l. c. p. 338: »Zur Zeit unseres Besuches[1], auf der Höhe der Trockenzeit, waren die Blätter des Viñatico trotz seiner feuchten Standorte, zum Beweis für weniger günstige Wasserzufuhr, zum grössten Teil rot und gelb geworden und bedeckten überall den Boden.«

As I have already mentioned and as is well known, the species of the Canarian laurel wood are evergreen; the deciduous *Salix Canariensis* and *Sambucus Palmensis* do not strictly speaking belong to the laurel wood proper, at any rate to its outskirts only. All the woodforming species have leaves of the laurel-type, they have as is seen from SCHIMPER's drawings (l, c., p. 342—3) nearly the same shape, oval or elliptical, with entire or slightly dentate margin. All of them have leathery, sclerophyllous leaves, stiff and thick, with a glabrous and often very shining upper side. On the other hand the underside, in which alone the stomata are to be found, is mostly hairy, indicating that protection is necessary.

According to CLAUDITZ (l. c.) the following species have a more or less dense cover of hairs on the underside of the leaf: *Persea Indica, Notelœa excelsa, Heberdenia excelsa, Pleiomeris Canariensis, Rhamnus glandulosa, Phyllis nobla, Viburnum rugosum, Myrica Faya,* and *Gesnouinia arborescens.* And of other xeromorphic characters, it may be mentioned that the epidermis is thick, that the stomata are often deeply sunk, that in many species oil cells are to be found, sclerenchymatous cells are common and also oxalate of lime.

And when we finally consider the question of growth and in connection with it that of bud-formation, here, too, there is a very distinct periodicity in accordance with the favourable, moist, and unfavourable, dry, seasons. It is the want of sufficient moisture in the summer that stops the growth, the temperature even in the coldest months not being so low that assimilation cannot continue unhindered. And on the other hand, the rainy season has scarcely begun before the trees, even in January and February, when the temperature is lowest, resume their growth and this is continued in the early summer until the drought becomes too strong and stops it. The leaves, and in connection with them the internodes, which during the time of strongest growth reach the maximum of size and length, gradually decrease in size towards the conclusion of the growth period. By and by the leaves get small, scale-like and enclose the resting bud, and the internodes become short. With some species we find only a few scale-like leaves, in others more, and in *Laurus Canariensis* and *Prunus Lusitanica* we have many imbricated scales.

As these conditions have a considerable interest in connection with the study

[1] 22. Aug. 1898.

of the adaptation of the laurel wood to the climate in the following pages, I have given short descriptions of the species I have met with.

Persea Indica Spr.

When the unfavourable season approaches, the leaves which are last formed before the growth ceases become somewhat smaller in size. But nevertheless there is always a very abrupt transition from the leaves in the top of the branches to the couple of scales enclosing the bud. The scales are hairy on the outside. The outmost one of these is the largest and encloses most of the bud. As the topmost leaves are bent upwards, the base of the petioles, being rather broad, contributes to the protection of the bud. When the growth begins again, the internodes between the leaves in the bud are stretched, and the scales enclosing the bud and the ones next to it, soon fall off. One or two of the leaves which follow are small, but after that normal size of leaf is gradually reached. The fully developed leaves reach a length of 17—18 cm. and a breadth of 6 cm.

Fig. 45. *Persea Indica* Spr.

Oreodaphne foetens Nees

resembles *Persea Indica* (Fig. 46). At the beginning of the unfavourable season the leaves get smaller; however there is a rather abrupt transition to the two or three small scale-like leaves which surround the bud. On the outside these leaves are hairy. When growth begins again, the internodes between the leaves are stretched, while at the same time the leaves start growing. The outermost scales soon fall off, and the leaves following increase gradually upwards. The fully developed, oval leaf reaches a size of about 10 cm. in length and 5 cm. in breadth.

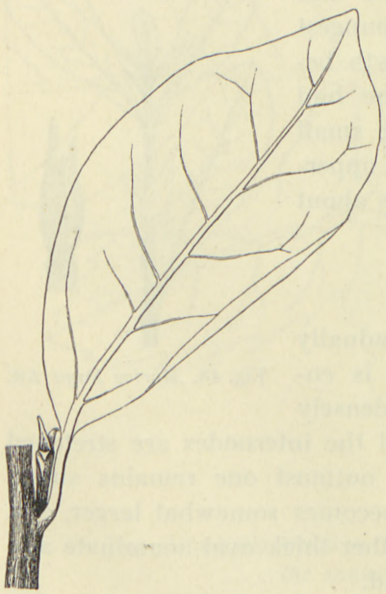

Fig. 46. *Oreodaphne foetens* Nees.

Heberdenia excelsa Banks

has a similar bud to that of the two foregoing species (Fig. 47). When the shoot completes its growth the leaves suddenly become small, scale-like and enclose the bud to the protection of which the upturned petioles of the topmost leaves also contribute. When the spring rain again calls the growth into being the internodes between the leaflets in the bud are stretched. With strong shoots 5—6 or even more small leaves are developed up the branch and can grow somewhat, becoming green, and remain attached for a long time. On less vigorous branches fewer leaflets (2—3) are developed and they soon fall of. At the top of the branches the internodes get shorter, while at the same time the leaves reach the normal size. In this way the leaves are gathered in a rosette at the top. While there is a regular transition from the scales to the leaves, the transition from the leaves to the scales is on the contrary abrupt.

Fig. 47. *Heberdenia excelsa* Banks.

The normal leaves are about 14 cm. long and 5—6 cm. broad.

Myrica Faya Ait.

When the growth stops, the leaves get smaller and smaller, closely packed and upturned, enfolding the youngest leaflets more or less closely (Fig. 48). When the growth begins again, the internodes between the leaflets in the bud are stretched, the leaflets grow somewhat, remaining small below and becoming gradually larger upwards, the uppermost first reaching the normal size of the leaf. This is about 5 cm. long and 2 cm. broad.

Fig. 48. *Myrica Faya* Ait.

Rhamnus glandulosa Ait.

Little by little as the growth lessens, the leaves gradually get smaller, and during the resting period the bud is enclosed by 2—3 small scale-like leaves. These are densely haired on the outside. When the growth is resumed the internodes are stretched and the leaves begin growing. However, the lowest outmost one remains small, about 2 cm. long and $1^1/_2$ cm. broad. The next one becomes somewhat larger, and by degrees the normal size of leaf is reached. The rather thick oval acuminate and dentate leaves are about 6 cm. long and $3^1/_2$ cm. broad.

Ilex platyphylla Webb et Berthelot.

The comparatively small bud is enclosed by a few short-hairy, green scales (Fig. 49). When the dry season arrives, the decrease of the growth appears in the fact that the uppermost 1—2 leaves get somewhat smaller; nevertheless the transition to the bud is abrupt. When the growth, after the period of rest, begins again, the internodes between the scales are somewhat stretched. These fall off and leave a few insignificant scars (Fig. 50). The next leaf has almost at once the normal size. The leaves live at least 3—4 years. Owing to this and the fact that side-branches are not generally developed, the frequently rather long unramified branches have the appearance of one year old shoots. Only by examining them closer one notices the almost invisible scars of the scales of the bud. The large, beautiful, shining leaves are about 14 cm. long and 10 cm. broad.

Fig. 49. *Ilex platyphylla* Webb et Berth.

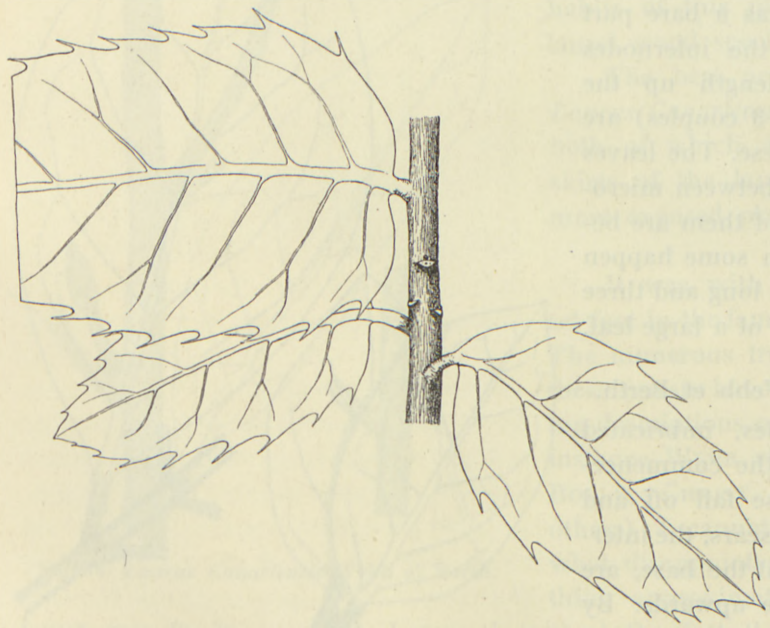

Fig. 50. *Ilex platyphylla* Webb et Berthelot. The transition between the annual shoots.

Ilex Canariensis Poir.

When the unfavourable season approaches, the leaves gradually decrease in size, and when the growth stops, the bud is enclosed by 2—3 tiny, thick, green scales (Fig. 51). When the growth begins again, the lowest scales soon fall off, leaving scars and rather short internodes. The leaves and internodes slowly increase in size upwards, until normal size is reached. It is as a rule microphyllous but on vigorous

Fig. 51. *Ilex Canariensis* Poir.

shoots it may happen that the leaves pass over the limit and become mesophyllous.

Viburnum rugosum Pers.

During the rest the bud is enclosed in a couple of scales, which on their outside are densely haired (Fig. 52). The bud is packed in between the strongly hairy upward turned petioles of the topmost pair of leaves; the lamina of this pair of leaves is considerably smaller than that of the normal leaves. When the growth begins the scales fall off and leave two opposite scars with short internodes immediately above the uppermost pair of leaves from last year's shoot. The normally developed leaf is about 8 cm. broad and 15 cm. long.

Notelæa excelsa Webb et Berth.

The buds are small with a few glabrous scales (Fig. 53). The scales leave nearly annular scars at the base of the branch, and one or two pairs up the stem, after which the normal leaves begin. Thus each branch has a bare part at the bottom, and as the internodes gradually decrease in length up the branches, the leaves (2—3 couples) are gathered at the top of these. The leaves are on the dividing line between micro- and mesophyllous, most of them are below it, but now and then some happen to be just above. Nine cm. long and three cm. broad is the measure of a large leaf.

Laurus Canariensis Webb et Berth.

has well developed scales, imbricated and hairy (Fig. 54). At the commencement of the growth these fall off and leave some closely placed scars, the internodes being quite short at the base, are stretched more and more upwards. By this process the young leaves are lifted high up above the older ones from last year. Before the growth comes to an

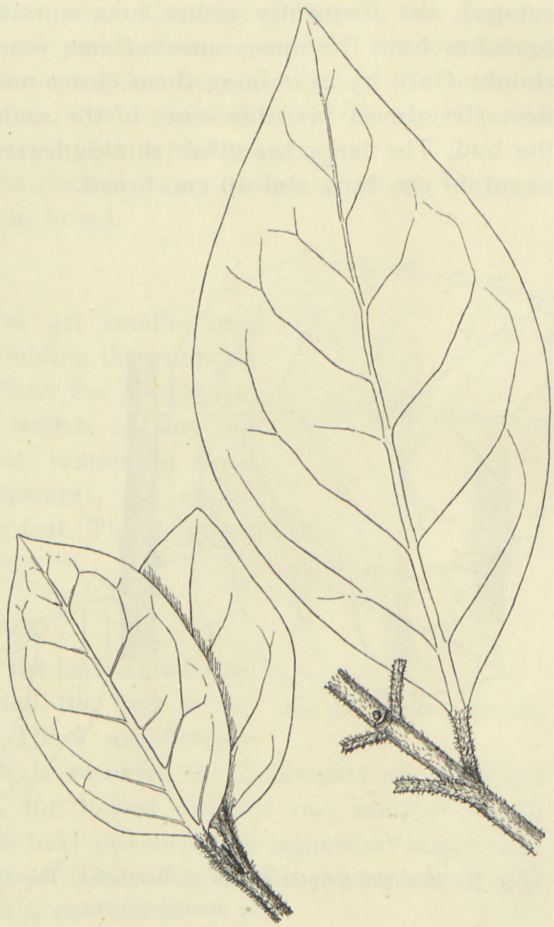

Fig. 52. *Viburnum rugosum* Pers.

end the leaves decrease in size. The well developed leaves are about 10 cm. long and 5 cm. broad.

Prunus Lusitanica L.

has, like *Laurus Canariensis*, well developed, imbricated scales. The scales leave distinct, densely placed scars at the base of the branches. The internodes between the scales are stretched very little only. The transition between scales and leaves is rather abrupt. The leaves are large at once from the base of the branches and are placed apparently alternately along the branch. The leaves are about 10 cm. long and $3^1/_2$ cm. broad.

Fig. 53. *Notelæa excelsa* Webb et Berth.

From this survey it appears plainly that even in the case of *Persea Indica*, which has generally taken possession of the dampest localities, a marked periodicity is present, just as its buds during the rest are protected by a few not very densely placed scales. To the habits of this plant several more of the laurel wood species conform.

Fig. 54. *Laurus Canariensis* Webb et Berth.

The best protected buds we find in *Laurus Canariensis* and *Prunus Lusitanica*, both of which are common on the outskirts of the laurel wood and in drier or more exposed places.

It was with great expectations that I set foot in the famous Canarian laurel wood. The numerous travellers who have visited these forests have almost all given fascinating descriptions of their luxuriance (see for instance Webb et Berthelot, d'Urville, Bolle, Christ, Schroeter, Rikli and others). I cannot deny that I was somewhat disappointed. Although of course nothing approximating to the tropical rain forest was to be expected, I cannot conceal the fact that I had expected a considerably greater luxuriance and richness.

Some years ago I had the privilege of visiting the montanic rain forest of Ja-

maica, and with their overwhelming abundance and richness in species still fresh in my memory, these woods seemed a faint reflection. To be sure it cannot be denied that scattered here and there very great luxuriance is to be met with. Thus, for instance, the effect of the mighty old *Persea Indica* in Agua Garcia, with their colossal trunks and dense leafy canopy, was imposing. Here, of course, also a great luxuriance was noticeable especially when one had just come from the dry, hot regions of the lowland. But on the whole the character of the laurel wood also is in no slight degree affected by the dry Macaronesian climate.

So I also quite share SCHIMPER'S view when he expresses himself as follow (l. c., p. 217): »Auch diese Waldparzellen haben Bewunderer gefunden, welche ihre Ueppigkeit derjenigen der tropischen Urwälder mindestens gleichstellen. Der Reisende, welcher diese letzteren aus eigener Anschauung kennt, wird den Vergleich irreführend und die Bewunderung des canarischen Lorbeerwaldes wenigstens auf Tenerife überschwänglich finden. Nichtsdestoweniger, jedoch aus ganz anderen Gründen, gehört derselbe zu den bemerkenswertesten Formationen der Welt.«

The Pine-wood.

I shall not here enter upon a description of the Canarian pine-wood, and its marked adaptations to the conditions of life in these dry regions, nor shall I deal with the extent of the pine-wood of the Canary Islands. That has been spoken of so often, for instance by WEBB and BERTHELOT, MEYER, CHRIST, SCHENCK and SCHIMPER and many others, that it would merely be a repetition. I shall only briefly say that when it is able to grow on the often naked, dry rock, exposed to the parching influence of the wind and sun, this must surely be chiefly due to the fact that its very long needles are excellently adapted to gather up from the mist the fine particles of water which presently fall as drops from the needles to the ground. Thus the soil under the trees may become quite wet, while the ground outside remains entirely dry during the foggy periods. I had a good opportunity of seeing this at Agua Mansa, where during one of my visits, a dense mist suddenly enveloped everything. But the phenomenon is well known, being mentioned for instance by MEYER, l. c. p. 188 and 222. Some idea may be obtained as to what this gathering of moisture may amount to from the very interesting experiment which MARLOTH carried out on Table Mountain in South Africa[1]. He placed two rain-gauges, one uncovered, and one covered with Restionacé-reeds. The uncovered rain-gauge showed nothing from the 21st of Dec. to the 15th of February, whereas in the covered one the quantity of water gathered from the mist corresponded to a rainfall of not less than 74.87 inches. As now the innumerable long thin needles of the Canarian tree will act quite in the same manner as the Restionacé-reeds, only on a very enlarged scale, one can understand that it is possible for the Canarian pine to thrive in these

[1] I have not been able to see MARLOTH'S paper, but I only know it from a quotation of J. HUTCHINSON, The rain tree of Hierro, Canary Islands in Kew Bulletin, 1919, p. 162.

barren and dry places, and also that it is possible for it often to reach an amazing size and luxuriance.

Upon the whole the Canarian pine shows great adaptability as to its habitat. Its true home is on the northern side of Teneriffe from about 1100 m. to about 2000 m., and on the south side from 1200 to 2500 m., the damp localities in the lower heights being left to the laurel wood. But in places, for instance in the en-

Fig. 55. View of the pine-clad mountains above Agua Mansa. Behind the pine at the right side the fog is coming down.

virons of Icod, it goes right down to the sea, while on the other hand it is also able to grow in elevated regions, where snow and cold frost reign during the winter months. At the Guajara pass above the town of Chasna it reaches its highest place of growth, namely 2436 m. In the Cañadas, the plateau which surrounds the Pico de Teyde, it is unable to grow.

I have had the opportunity of making acquaintance with the Canarian pine-wood (Fig. 55) during a few short visits to the environs of Agua Mansa. The locality is situated at a height of about 4000 feet, in the south-eastern corner of the valley of Orotava, at the foot of the high border mountains.

When one walks from Agua Mansa up into one of the many valleys which

furrow the wooded slopes, the trees are seen to be rather scattered. There is plenly of room among the individuals. As far as its roots reach, each tree holds absolute sway, absorbs all the moisture and nourishment from the soil, and does not tolerate any rival, although the seeds of the Canarian pine readily germinate.

Therefore there is generally no undergrowth whatever in the real, dry pine-wood, and the ground is likewise denuded of moss. It is only in the more open places and on the outskirts of the wood, that undergrowth is to be found.

Fig. 56. High *Erica*-Maqui near Agua Mansa with a single pine-tree here and there.

First of all the *Erica* maqui is to be met with here surrounding the wood. Much of the area now found densely covered with the *Erica* has been covered formerly with pines. Now, after the cutting down of the wood, the *Erica* has taken possession of the ground. It is especially out on the more even slopes that the trees have been hewn down. Here and there a single pine-tree still rises above the maqui as a remnant of the former wood (Fig. 56). Large stretches of the evenly sloping Orotava valley, are covered from a height of about 800—1000 metres with a dense maqui. At one time the maqui has, I feel sure, reached considerably further down into the valley, but has gradually been cleared away in order to give room for agriculture and pasture. In the lower part the maqui is vigorous, reaching on an average

the height of a man on horseback, or about 4—5 m. It consists chiefly of *Erica arborea*, but *Myrica Faya* is common, giving in the sun the effect of dazzling torches among the dark heather owing to its strong reflection of the light.

The *Myrica* goes up to about 1200—1300 m., above which *Erica* is left alone. Only here and there a pine rises up above the maqui, or one finds a single *Cytisus proliferus* or a little bush of *Adenocarpus* among the heather. Gradually, as one ascends, the heather gets lower and lower, and is at last hardly a foot high. At a

Fig. 57. View of the mountain slopes above Agua Mansa showing the upper limit of the *Erica*-maqui and a little above it a splendid, solitary pine.

height of about 1500 m. its uppermost limit is to be found (Fig. 57). The red, gravelly soil is then quite naked. Only here and there the small *Erodium cicutarium* L'Hér. grows in the gravel, or some quite low bushes of *Micromeria Julianoides* W. et B. But a few large pine-trees are yet to be found, demonstrating the fact that we are still within the territory of this tree. The tree which grows farthest up in this part of the island is a remarkably well developed specimen; it is to be seen in the accompanying photo (Fig. 57).

On the outskirts of the wood, and in its open places, a thicket vegetion is often to be found, consisting of *Rhodocistus Berthelotianus* and *Cistus Monspeliensis*

together with *Daphne Gnidium* and *Webbia Canariensis*. Besides these there is *Leucophaë candidans* endowed with white downy leaves. On a steep mountain slope above Agua Mansa this plant has entirely taken possession of the territory, so that the slope, seen at a distance, has a greyish-white appearance.

Fig. 58. Rock-walls in clefts above Agua Mansa covered with *Greenowia aurea* W. et B.

When passing in the lower part of the pine-wood and coming into one of the damp valley clefts, one immediately meets with some of the species from the laurel wood, for instance *Ilex Canariensis, Viburnum rugosum*, indeed in a specially damp place, there was even an old *Persea Indica* with its massive but short trunk, clinging to the rock. In such damp places, in narrow valley's where there is running water, the vegetation may become overwhelmingly vigorous, the rocky wall being covered with perfect cascades of *Woodwardia radicans* and *Pteris arguta* and other ferns. In one such narrow cleft the steep walls were covered with the innumerable rosettes of the beautiful *Greenowia aurea* (Fig. 58).

In the list (Table 19) below I have collected the species belonging to the pine-wood partly by means of my own observations, and partly with the aid of SCHENCK's survey (l. c., p. 378) of those species and arranged them according to their life-forms. Several of these species occur very locally and have not been found at Agua Mansa.

Table 18. The species of the pine-wood arranged according to their life-forms.

1 M. M.	Pinus Canariensis Chr. Sm.	Microphyl.
1 M.	Cytisus proliferus L.	Nanophyl.
2 M.	Erica arborea L.	Leptophyl.
3 M.	Myrica Faya Ait.	Microphyl.
1 N.	Adenocarpus viscosus W. B.	Leptophyl.
2 N.	Androsæmum Webbianum Chois.	Microphyl.
3 N.	Cistus Monspeliensis L.	Microphyl.
4 N.	Daphne Gnidium L.	Nanophyl.

5 N.	Echium candicans L. f.	Mesophyl.
6 N.	Inula viscosa Ait.	Microphyl.
7 N.	Leucophaë candicans W. B.	Microphyl.
8 N.	Psoralea bituminosa L.	Microphyl, but near nanophyl.
9 N.	Rhodocistus Berthelotianus Spach.	Mesophyl.
10 N.	Rubia peregrina L.	Nanophyl.
11 N.	Ulex europæa L.	Leptophyl.
12 N.	Webbia Canariensis W. B.	Microphyl.
1 Ch.	Greenowia aurea W. B.	Mesophyl.
2 Ch.	Greenowia rupifraga Webb.	Mesophyl.
3 Ch.	Marrubium vulgare L.	Microphyl, but near nanophyl
4 Ch.	Micromeria Julianoides W. B.	Leptophyl.
5 Ch.	Petrophyes brachycaulon W. B.	Leptophyl.
1 H.	Calamintha menthæfolia Host.	
2 H.	Piptatherum coerulescens P. B.	
1 G.	Asphodelus ramosus Desf.	
2 G.	Cytinus Hypocistis L.	
1 Th.	Anthoxanthum aristatum Boiss.	
2 Th.	Bromus tectorum L.	
3 Th.	Erodium Chium Willd.	
4 Th.	Erodium cicutarium L'Hér.	
5 Th.	Helianthemum guttatum Mill.	
6 Th.	Juncus bufonius L.	
7 Th.	Lotus angustissimus L.	
8 Th.	Vulpia myuros Gmel.	

The following species are furthermore mentioned by SCHENCK as belonging to the pine-wood: *Aeonium barbatum, Aeonium cæspitosum, Aeonium Smithii, Aeonium strepsicladum, Buffonia Teneriffæ, Centaurea arguta, Convolvulus Benhoavensis, Greenowia Aizoon, Micromeria lachnophylla, Rosa canina, Umbilicus Heylandianus* and a few others. Most of these species appear at such a height that they must more correctly be reckoned as belonging to the subalpine region. Others have only been found in a single place on any other island than Teneriffe. Also *Juniperus Cedrus* is omitted from the list, partly because it occurred above the pine wood or at the uppermost limit of it, partly it is nearly extinct as a wild plant. In Teneriffe and Palma BURCHARD mentions (l. c., p. 296—7) having seen specimens of this rare tree.

On the base of this list the following biological spectrum (Table 19) is obtained.

Table 19. Biological spectrum of the Canarian Pine-wood.

	Number of species	Percentage of species under each life form									
		S	E	M M	M	N	Ch	H	G	H H	Th
Canarian pine-wood .	33	..	..	3	9	37	15	6	6	..	24
Normal spectrum....	1000	2	3	8	18	15	9	26	4	2	13

The phanerophytes, altogether reaching 49 %, are in the majority, and among them again the nanophanerophytes; after the phanerophytes the therophytes have the highest percentage (24 %). The chamaephytes have only 15 % and the hemicryptophytes and the geophytes 6 % each.

Of the 21 species of phanerophytes and chamaephytes found in the pine-wood

5 species are leptophyllous = 24 %
3 — - nanophyllous = 14 %
9 — - microphyllous = 43 %
4 — - mesophyllous = 19 %

As compared with the figures from the laurel wood the size of leaf is seen to be markedly smaller in the pine-wood. Here 24 % are leptophyllous species, while this group is entirely wanting in the laurel wood. The figures for the nanophyllous species are respectively 14 % and 6 %, for the microphyllous species 43 % and 47 %, thus a small increase in the laurel wood, where we finally have 47 % mesophyllous species, while in the pine-wood only 19 % are present.

As will be seen from the figures, the far drier climate in the pine-wood very clearly is evidenced.

Summing up the results of the foregoing examination, I have given in the table below (Table 20) an entire survey of the biological spectra of the examined associations.

Table 20. Survey of the biological spectra of the associations examined.

	Number of species	Percentage of species under each life form										
		S	E	M M	M	N	Ch	H	G	H H	Th	
Sandy beach	23	..	..	..	4	13	35	4	..	..	44	Sub-tropical low land region.
Dunes	14	..	..	..	..	29	14	7	7	..	43	
Rocky shore	37	5	..	..	..	19	30	13	..	..	33	
Dry flats and hills	41	..	..	..	..	22	34	12	..	..	32	
Rocky slopes	95	1	..	..	1	13	18	8	4	..	55	
Lava-streams	47	2	..	..	2	34	15	6,5	6,5	..	34	
Maqui	28	..	..	..	14	40	18	14	..	..	14	Montanic region.
Laurel wood	70	..	..	17	7	14	10	25	7	..	20	
Pine-wood	33	..	..	3	9	37	15	6	6	..	24	
Normal spectrum	1000	2	3	8	18	15	9	26	4	2	13	

From this it appears that in the associations of the low land region we have a markedly therophyte-climate, the therophyte percentage being highest in the association of the rocky slopes, somewhat smaller in the sandy beach associations and lowest in the associations of the lava-streams, rocky shore and dry hills and flats

In these it is especially the nanophanerophyte % and the chamaephyte % which are increased, coming near to the therophyte %.

In the montanic region on the other hand the therophyte % has been very much reduced, we have no more the subtropical therophyte-climate. The phanerophytes are now the dominating group on account of the more favourable conditions of humidity. In the laurel wood we have 17 % mega- and mesophanerophytes, 7 % microphanerophytes and 14 % nanophanerophytes. In the pine-wood the less favourable conditions are distinctly observable in the decreasing percentage of the mega- and mesophanerophytes and the increasing percentage of the nanophanerophytes; and in the maqui the mega- and mesophanerophytes have quite disappeared and the microphanerophyte % and especially that of the nanophanerophytes has increased.

In the laurel wood after the phanerophytes the hemicryptophytes follow with the highest percentage (25) coming near to that of the normal spectrum and thus intimating the cold-temperate hemicryptophyte-climate.

And finally in Table 21 I have given the biological spectra of the subtropical lowland region and the montanic region based upon the entire number of species mentioned by me in the associations examined.

Table 21.

	Number of species	Percentage of species under each life form									
		S	E	M M	M	N	Ch	H	G	H H	Th
Lowland region	176	1	..	..	2	17	19	10	4	..	47
Montanic Region	115	..	..	11	7	21,5	14	19	6	..	21,5
Normal spectrum....	1000	2	3	8	18	15	9	26	4	2	13

Even if the figures can only be considered as approximately correct on account of the small number of species which have been operated with, especially with regard to the lowland region, I nevertheless presume that the figures will not differ so very much from those which may be derived from the entire flora. In the dry lowland region the therophyte climate is marked out by the high percentage of therophytes. The percentage of chamaephytes (19 %) is also in good accordance with that found in similar areas. But the phanerophyte percentage (2 % M and 17 % N) is somewhat higher and the hemicryptophyte and geophyte % somewhat lower than that which is mostly found in other dry regions.

In the montanic region the therophyte % is much reduced. Here the phanerophytes (39,5 % altogether) are the dominating class, 11 % of them being mega- and mesophanerophytes.

List of the most used Literature.

Bannerman, David A., The Canary Islands, their History, Natural History and Scenery. An Account of an Ornithologist's Camping Trip in the Archipelago. London 1922.

Barker-Webb, P., et S. Berthelot, Histoire naturelle des Iles Canaries. Tomes I—III, Paris 1836—1850.

Bolle, C., Die Canarischen Inseln. I—III. in Zeitschrift für allgem. Erdkunde, N. F. Bd. X 1861, Bd. XI, 1861, Bd. XII, 1862.

— Botanische Rückblicke auf die Inseln Lanzarote und Fuertaventura. Engler's Botan. Jahrb., XVI, 1892/3.

Bornmüller, I., Ergebnisse zweier botanischen Reisen nach Madeira und den Canarischen Inseln. Engler's Botan. Jahrb. XXXIII, 1904.

Bory de St. Vincent, Essais sur les Iles Fortunées et l'antique Atlantide, Paris An 1803.

Brown's Madeira, Canary Islands and Azores. A practical and complete guide etc. by A. Samler Brown. 11th edit. London 1919.

Buch, Leopold von, Physikalische Beschreibung der Canarischen Inseln. Berlin 1825.

Bunbury, Charles I. F., Remarks on the Botany of Madeira and Teneriffe. Journal of the Proceedings of the Linnean Society. Botany. Vol. 1. London 1857.

Burchard, Oscar, Mitteilungen zur Ökologie einiger sukkulenten Gewächse der Kanarischen Inseln. Engler's Bot. Jahrb., 49. Bd., 1913, Beiblatt, p. 44.

— Dendrologische Wanderungen auf den Kanarischen Inseln. Mitteilungen der Deutschen Dendrologischen Gesellschaft, 1911.

Cannon, W. A., Notes on root variation in some desert plants. The Plant World. Vol. 16, Tucson 1913.

Christ, H., Vegetation und Flora der Canarischen Inseln. Engler's Bot. Jahrb., Bd. 6, 1885.

— Eine Frühlingsfahrt nach den Canarischen Inseln. Basel 1886.

Clauditz, Josef, Blattanatomie canarischer Gewächse mit Berücksichtigung von Standort und Klima. Inaugural-Dissert. Hildesheim 1902.

Engler, A., Die Pflanzenwelt Afrikas. Bd. 1, 2. Engler, A., und O. Drude, Die Vegetation der Erde, IX.

Fitting, Hans, Die Wasserversorgung und die osmotischen Druckverhältnisse der Wüstenpflanzen. Zeitschrift für Botanik. 3ter Jahrg. Jena 1911.

Hann, Julius, Handbuch der Klimatologie. Bd. III. Klimatologie. II. Theil. Klima der gemässigten Zonen und der Polarzonen. 3te Aufl. Stuttgart 1911.

Humboldt, Alex. von, Reise in die Æquinoctial-Gegenden des neuen Continents. Erster Theil. Stuttgart und Tübingen 1815.

Krause, Kurt, Beiträge zur Kenntnis der Flora von Aden. Engler's Bot. Jahrb., Bd. 35, 1904—05.

Maximow, N. A., Physiologisch-ökologische Untersuchungen über die Dürreresistenz der Xerophyten. Jahrb. für wissenschaftl. Botanik. Bd. 62, 1923.

Meyer, Hans, Die Insel Tenerife. Leipzig 1896.

Pitard, I., et L. Proust, Les Iles Canaries. Flore de l'Archipel. Paris 1908.

Raunkiær, C., Types biologiques pour la Géographie botanique (Bull. Acad. Roy. Sciences et Lettres de Danemark No. 5, 1905).

— Livsformernes Statistik som Grundlag for biologisk Plantegeografi. Bot. Tidsskrift. vol. 29. København 1908—09. Translated in Beih. z. Bot. Centralblatt, Bd. 27, 1910, Abt. II, p. 171: Statistik der Lebensformen als Grundlage für die biologische Pflanzengeographie. Livsformen hos Planter paa Ny Jord. Mémoires de l'Acad. roy. Sc. et Lettres de Danemark 7. ser. Section des Sciences, t. VIII, København 1909.

— Om Bladstörrelsens Anvendelse i den biologiske Plantegeographie. Bot. Tidsskrift, vol. 34. København 1916.

Rikli, M., Lebensbedingungen und Vegetationsverhältnisse der Mittelmeerländer und der atlantischen Inseln. Jena 1912.

Salter, I. H., Regional distribution of the native flora in Teneriffe. Memoirs and Proceedings of the Manchester Literary and Philosophical Society. Vol. 62, 1917—18.

Schacht, H., Madeira und Tenerife mit ihrer Vegetation. Berlin 1859.

Schenck, H., Beiträge zur Kenntnis der Vegetation der canarischen Inseln. Mit Einfügung hinterlassener Schriften A. F. W. Schimpers. Deutsche Tiefsee-Expedition 1898—99. Bd. II, 1. Teil, 1907.

Schröter, C., Eine Exkursion nach den Canarischen Inseln. Zürich 1909.

Professor Christen Smiths Dagbog paa Reisen til de Canariske Øer i 1815 ved F. C. Kiær Christiania Videnskabs-Selskabs Forhandl. 1889.

Thomas, H. Hamshew, Some observations on plants in the Libyan desert. Journal of Ecology, vol. IX, 1921.

Vahl, M., Madeiras Vegetation. København 1904.

— Notes on the Summer-Fall of the Leaf on the Canary-Islands. Botanisk Tidsskrift, 26. Bind, København 1904.

Volkens, Georg, Die Flora der ægyptisch-arabischen Wüste auf Grundlage anatomisch-physiologischer Forschungen. Berlin 1887.

Warming, Eug., und P. Graebner, Eug. Warming's Lehrbuch der ökologischen Pflanzengeographie. Berlin 1918.

Appendix.

Lichenes Teneriffenses

anno 1921 a F. Boergesen collecti.

Scripsit

Edv. A. Vainio.

Usnea subcomosa (Ach.) Vain. (Vain. Addit. Lich. Antill., 1915, p. 5, Lich. Siam., 1921, p. 33).

Stratum myelohyphicum crebre contextum, KHO lutescens. In ramulis arborum ad Agua Manza (195 p. p.). Ster.

U. perplexans (Stirt.) Vain., Addit. Lich. Antill. p. 6.

Stratum myelohyphicum crebre contextum, KHO lutescens deindeque rubescens. In ramulis arborum ad Agua Manza (209 p. p., cet.), etiam circa 5000′ s. m. Ster.

U. barbata Hoffm. (f. ***dasypoga*** Ach. p. p.).

Stratum myelohyphicum crebre contextum, KHO lutescens deindeque rubescens. Thallus pendulus, crebre verruculosus. In ramulis arborum ad Agua Manza (195 p. p.). Ster.

U. Atlantica Vain. n. sp.

Thallus elongatus, long. usque ad 4 decim, pendulus, basin versus crass. circ. 0,5—2 mm., dichotome et sympodialiter ramosus, teres, laevigatus aut partim ramis apicalibus soredioso-verruculosis, stramineus, partim demum articulatus. Stratum myelohyphicum laxe contextum, KHO non reagens. Axis chondroideus tenuis, jodo non reagens. Thallo stramineo, magis laevigato, cet. differt ab *U. articulata* (Ach., Sm.). In ramulis arborum ad Agua Manza (195 p. p., cet.), etiam circa 5000′ s. m. Ster., sed bene evoluta et sat abundanter crescens.

Alectoria implexa (Hoffm.) Nyl. f. *cana* (Ach.) Nyl.

In ramulis arborum ad Agua Manza (195 p. p., cet.), etiam circa 5000′ s. m. Ster.

A. chalybeiformis (L.) Vain. var. ***prolixa*** (Ach.) Vain.

In ramulis arborum ad Agua Manza (195 p. p.). Ster.

Ramalina Bourgaeana Mont.

Supra saxa vulcania ad Taoro-Humboldt in Orotava. Fert.

R. farinacea (L.) Ach.

In truncis arborum ad Agua Garcia (265 p. p.). Ster.

Parmelia (Amphigymnia) coralloidea (Mey. et Flot.) Vain. Etud. Lich. Brés. I p. 33.

Thallus superne isidiosus, KHO superne fulvescens, intus non reagens, $CaCl_2O_2$ intus rubescens. Ad terram in Teneriffa. Ster.

P. (Menegazzia) tubulosa (Schaer.) Bitter Ueb. Variab. Laubflecht. (1901) p. 448.

In ramulis arborum ad Agua Manza, circa 5000′ s. m. Ster.

Stereocaulon Vesuvianum Pers.

Supra saxa vulcania prope Taoro-Humboldt in Orotava. Fert.

Lecanora (Squamaria) crassa (Huds.) Ach. f. ***rhyacophila*** Vain.

Thallus squamis adscendentibus, superne stramineo-flavescentibus, subtus albidis aut ad ambitum albidis et medio cinerascentibus aut fuscescentibus obscuratisve. Ad saxa vulcania et ad detritum saxorum prope Taoro-Humboldt in Orotava. Parce fert.

L. (Lecania) glaucopsora (Nyl.) Vain. *Lecanora holophaea* Nyl. var. *glaucopsora* Nyl. Fl. 1868 p. 164; Hue Addend. I (1886) p. 112; Cromb. Mon. Lich. Brit. I (1894) p. 392. Larbal. Lich. Caesar. Exs. II (1869) n. 79.

Thallus verrucosus, verrucis contiguis aut dispersis, 1,3—0,2 mm. latis, glaucescenti-albidis, KHO fulvescentibus, hypothallo nigricante aut indistincto. Apothecia lecanorina, leviter prominentia, lat. 0,7—0,9 mm, saepe crebra, basi leviter constricta, disco plano, fuscescente aut olivaceo aut aeruginoso-nigricante, haud pruinoso, margine sat tenui aut modice incrassato, leviter aut haud prominente, integro aut rarius subcrenulato, thallo concolore. Hypothecium albidum, hyphis erectis, gonidiis nullis. Parathecium indistinctum. Hymenium circ. 0,040 mm. crassum, jodo caerulescens. Epithecium olivaceo-nigricans, KHO non reagens. Paraphyses crass. 0,002—0,0015 mm, apice vix incrassatae. Sporae 8:nae, distichae, decolores, ellipsoideae aut subfusiformes, 1-septatae, long. 0,010—0,015, crass. 0,005—0,006 mm. Ad saxa vulcania in Orotava. Habitu similis est *L. holophaeae* var. *glaucopsorae* Nyl. (n. 29344 in herb. Nyl.), quae autem ad detritum arenosum in rupe granitica in ins. Caesarea (Jersey) a Larbalestier collecta est. — Valde dissimilis est *L. holophaeae* (Mont.), quae thallo late squamoso, adscendente, instructa est (*Solenospora* Mass.).

L. (Eulecanora) Orotavensis Vain. n. sp.

Thallus areolatus, areolis 0,2—0,5 (—0,8) mm latis, vulgo angulosis aut crenulatis, parce etiam subeffiguratis, supra hypothallum nigrum dispersis, planis, sat tenuibus, albis albidisve, KHO superne et intus lutescentibus, $CaCl_2O_2$ non reagentibus, soraliis parvis albidis saepe demum instructis. Apothecia (tantum sat novella et parce visa) lecanorina, basi constricta, prominentia, lat. 0,6—0,8 mm, disco concavo planove, fuscescente nigricanteve, haud pruinoso, margine sat tenui, prominente, integro aut leviter crenulato, thallo concolore. Hypothecium subhymeniale decoloratum, circ. 0,040 mm crassum, hyphis irregulariter contextis conglutinatisque, strato myelohyphico, in parte superiore parce gonidia continenti, impositum. Hymenium jodo caerulescens. Epithecium fuscum, KHO rubricosum. Paraphyses arcte cohaerentes, membranis gelatinosis, apicibus 0,003 mm crassis, haud gelatinosis.

Sporae (parce rite evolutae) 8:nae, decolores, ellipsoideae, simplices. Supra saxa vulcania ad Taoro-Humboldt in Orotava. Jam thallo sterili facile recognoscitur.

L. cinereocarnea (Eschw.) Vain. Étud. Lich. Brés. I (1890) p. 80.

In ramulis arborum ad Agua Manza (195 p. p.). Fert.

Ochrolechia Upsaliensis (L.) Arn.

Apothecia et thallus nec KHO nec $CaCl_2O_2$ reagentia. In ramulis arborum ad Agua Manza (195 p. p.). Fert.

Pertusaria Teneriffensis Vain. n. sp.

Thallus modice incrassatus, ad ambitum subcontinuus rimosusque, ceterum areolato-diffractus, areolis angulosis, circ. 0,5—0,8 mm latis, convexis aut planis, impure albidis, parum nitidis, KHO extus intusque lutescens deindeque rubescens, jodo non reagens, soraliis circ. 0,3—0,8 mm. latis aut vetustis etiam majoribus, demum vulgo prominentibus, sed haud podicellatis, sat crebris aut dispersis, hypothallo albido, parum distincto. A *P. lactea* Nyl., *P. leucosora* Nyl. et *P. amarescente* Nyl. reactione thalli differt, sed iis facie externa omnino similis. Una cum *Diploschisti stromatophoro* Vain. et *Lecanora glaucopsora* (Nyl.) Vain. supra saxa vulcania ad Taoro-Humboldt in Orotava. Ster.

P. inconveniens Vain. n. sp.

Thallus impure albidus, soraliis parvis instructus, KHO cum $CaCl_2O_2$ extus rubescens, intus leviter reagens, $CaCl_2O_2$ solo non reagens, KHO extus distincte lutescens aut partim parum reagens, soraliis bene lutescentibus, jodo non reagens. Ceterum facie externa omnino similis speciei præcedenti. Supra saxa vulcania ad Taoro-Humboldt in Orotava. — In *P. amarescente* Nyl. sec. specim. orig. thallus KHO non reagens, sed KHO cum $CaCl_2O_2$ aurantiacus. In *P. lactea* Nyl. thallus jam $CaCl_2O_2$ solo rubescens.

Theloschistes flavicans (Sw.) Müll. Arg. f. ***glabra*** Vain. Étud. Lich. Brés. I p. 114.

In ramis arborum ad Agua Garcia. Ster.

Xanthoria parietina (L.) Th. Fr.

Ad saxa vulcania prope Taoro-Humboldt in Orotava. Fert.

Anaptychia leucomelaena (L.) Vain. var. ***multifida*** (Mey. et Flot.) Vain. Étud. Lich. Brés. I p. 129.

Supra *Peltigereas* ad terram arenosam inter *Ericas arboreas* circa 4000′ s. m. in Las Mercedes (611 p. p.). Ster.

Peltigera canina (L.) Hoffm.

Supra muscos rupium circa 4000′ s. m. ad Agua Manza (208). Fert.

F. ***pellita*** Vain. (nova f.).

Thallus superne tomento arachnoideo, crebro, fuscescente, bene evoluto, obductus, colore cervino-fuscesens, subtus albidus, rhizinis concoloribus, paullo minor, quam in forma normali *P. caninæ*. Ad muscos destructos in Las Mercedes (413 p. p.). Ster.

Var. ***spuria*** (Ach.) Schaer.

Ad terram humosum inter *Ericas* circa 4000′ s. m. in Las Mercedes (611 p. p.). Fert.

**P. praetextata* (Floerk.) Vain. Lich. Caucas. (in Természetrajzi Füzetek XXII, 1899) p. 306.

Thallus partim isidiosus, superne ad ambitum arachnoideo-tomentosus. Ad muscos destructos supra terram humidam in Las Mercedes (413 p. p.). Ster.

P. polydactylon (Neck.) Hoffm. var. ***subspuria*** Nyl. Cat. Madère Lich. (Bull. Soc. Bot. Fr. XV, 1868) p. 188; Vain. Étud. Lich. Brés. I (1890) p. 181.

Supra muscos ad terram humosam et arenosam humidam et supra terram nudam inter *Ericas arboreas* circa 4000′ s. m. in Las Mercedes (413 p. p., 416 p. p., 417 p. p., 612 p. p.). Fert.

Opisteria parilis (Ach.) Vain. Lich. Exp. Vegae Pitlekai (Arkiv Bot. 8, 1909) p. 93.

Supra plantas destructas ad terram inter *Ericas* circa 4000′ s. m. in Las Mercedes (611 p. p.), una cum *Anaptychia leucomelaena*. Ster.

Pseudocyphellaria aurata (Ach.) Vain. Étud. Lich. Brés. I p. 183.

In ramis arborum ad Agua Garcia (265 p. p.) et Las Mercedes (606 p. p.). Fert.

Lobaria immixta Vain. (n. sp.).

Thallus sat irregulariter iteratim laciniatus lobatusque, subpendulus, apicibus retusis emarginatisve aut obtusis, axillis rotundatis aut obtusis, superne reticulato-costatus scrobiculatusque, superne cinereo-glaucescens, humidus virescens, vulgo leviter nitidus, sorediis destitutus, demum margine plus minus isidiosus vel minute isidioideo-laceratus, isidiis lacinulaeformibus applanatisque, difformibus crenulatisque, long. circ. 0,3—0,7, lat. 0,2—0,3 mm, medulla alba, subtus, inter bullas glabras albas, canalibus reticulatis, circ. 2,5—0,5 mm latis, pallidis aut ad basin demum subfuscescentibus, crebre tomentosis, tomento brevi, pallido aut basia versus laciniarum demum fuscescente, rhizinis aliis nullis, KHO cum $CaCl_2O_2$ intus rubescens, sed his solutionibus solis non reagens. Conidangia thallo immersa (in lamina thalli). Gonidia pleurococcoidea, globosa, tantum simplicia visa, diam. vulgo 0,008 mm. — Facie externa subsimilis *L. pulmonariae* (L.) Hoffm. præsertimque *L. Oreganae* (Tuck.) Vain., quae posterior KHO cum $CaCl_2O_2$ non reagens et prior medulla thalli his solutionibus unitis lutesens deindeque vitellinus (acidum stictinicum continens). Coll. Mandon (Lich. Mader.) n. 26, a Nyl. in Cat. Madère Lich. p. 188 nominatus »*Sticta pulmonacea* var. *hypomela Del.*«, in herb. Nyl. continet duas species: *Lobariam pulmonariam* var. *papillarem* (Cromb.), medulla solutionibus supra indicatis lutescente, et *L. immixtam* Vain. bene fertilem, medulla iisdem sol. rubente. — Ad ramos arborum in Las Mercedes (606). Ster.

Erioderma limbatum (Nyl.) Vain.

Thallus substrato late adnatus, subradiato-laciniatus lobatusque, laciniis circ. 10—5 mm latis, subconcavis, apicibus et marginibus adscendentibus, superne floccoso-subarachnoideo-tomentosus, cinereo-glaucescenti- et cervino-variegatus, apicibus breviter pilosis, marginibus et demum etiam medio sorediosus, sorediis cinereis, medulla alba, subtus fuscescens et crebre sat breviter fusco-tomentosus, ad ambitum anguste albidus et subnudus, cyphellis nullis. Gonidia nostocacea, glomeruloso-intri-

cata, aeruginosa. Habitu subsimile est *Peltigerae scutatae* (Dicks.) Leight. Ad plantas destructas supra terram humosam humidam in Las Mercedes (413 p. p.). Ster.

Leptogium (Euleptogium) caesium (Ach.) Vain. Étud. Lich. Brés. I p. 225. *L. cyanescens* Nyl. Syn. Lich. p. 131, excl. apotheciis, quae ad *Physma byrsinum* (Vain. Lich. Philipp. III, 1921, p. 44) pertinent (*L. cyanizum* Nyl. in Cromb. Lich. Challeng. Exp. p. 227).

In ramis arborum ad Agua Garcia (265 p. p.). Ster.

L. palmatum (Huds.) Mont.

Supra muscos destructos ad terram inter *Ericas arboreas* circa 4000′ s. m. in Las Mercedes (612 p. p.) et inter *Cladoniam rangiformem* supra terram circa 4000′ s. m. ad Agua Manza (213 p. p.). Ster.

L. (Leptogiopsis) ruginosum (Duf.) Nyl. in Cromb. Mon. Lich. Brit. I p. 74. *L. Brebissonii* Mont. in Webb et Berthel. Hist. Nat. Canar. (1840) p. 130 sec. Müll. Arg. Lich. Beitr. (Fl. 1882) n. 372 huc pertinet, sed observante Nyl. l. c. ab eo recedit, et specimen in silva Briquebec a Del. lectam, a Mont. citatum, thallo subtus tomentoso a *L. ruginoso* Nyl. differt.

Ad terram humosam circa 4000′ s. m. in Las Mercedes. Ster.

Cladonia furcata (Huds.) Schrad. f. *palamaea* (Ach.) Nyl.

Ad terram humosam circa 4000′ s. m. in Las Mercedes (417 p. p,). Fert.

F. ***subulata*** Floerk.

Ad terram humosam circa 4000′ s. m. inter *Ericam arboream* in Las Mercedes (212 p. p., 612 p. p.). Fert.

Cl. rangiformis Hoffm. f. ***pungens*** (Ach.) Vain.

Ad plantas destructas et terram humosam arenosamque circa 4000′ s. m. in Las Mercedes (415 p. p., 417 p. p., 612 p. p.) et ad Agua Manza. Fert.

Cl. pyxidata (L.) Fr. var. ***neglecta*** (Floerk.) Mass.

Ad terram humosam humidam in Las Mercedes. Fert.

****Cl. chlorophaea*** (Floerk.) Spreng.

Ad terram humosam humidam circa 4000′ s. m. in Las Mercedes (417 p. p., 412 p. p.). Fert.

Cl. fimbriata (L.) Fr. f. ***subulata*** (L.) Vain.

Ad terram humosam humidam circa 4000′ s. m. inter *Ericas* in Las Mercedes (408 p. p., 417 p. p., 611 p. p., 612 p. p.). Fert.

Cl. verticillata Hoffm. ****Cl. Krempelhuberi*** Vain. Lichenogr. Fenn. II (1922) p. 102 (Mon. Clad. Univ. II p. 187, III p. 259). Thallus squamis subtus KHO lutescentibus.

Var. ***subcervicornis*** Vain. Lichenogr. Fenn. II p. 103 (Mon. Clad. Univ. II p. 197, III p. 259).

Ad terram arenosam supra rupem vulcaniam prope Taoro-Humboldt in Orotava. Parce fert.

Cl. foliacea (Huds.) Schaer. var. ***alcicornis*** (Lightf.) Schaer.

Ad terram arenosam supra rupem vulcaniam prope Taoro-Humboldt in Orotava. Parce fert.

Lecidea macrocarpa (D. C.) Th. Fr. f. ***contigua*** (Fr.) Vain.

Ad saxa vulcania prope Taoro-Humboldt in Orotava. Fert. — Etiam plures aliae species *Lecidearum* steriles aut nimis parce collectae in hac collectione adsunt.

Roccella Teneriffensis Vain. (n. sp.).

Thallus long. 3—6 (—22) centim., lat. 1,5—2,5 (1—12) mm, compressus, glaucescente-albidus, epruinosus aut partim vix distincte pruinosus, rigidus, soraliis marginalibus, rotundatis, crebris aut parce confluentibus passim instructus, laevigatus aut demum transversim aut irregulariter aut reticulatim crebre vel partim increbre nervosus, KHO superne flavescens, intus non reagens, $CaCl_2O_2$ soraliis rubescentibus, ceterum non reagens, sed his solutionibus unitis superne flavescens, medulla jodo non reagente. Medulla placentae et basis thalli alba. Proxima est *R. fuciformi* D. C., quae medulla jodo caerulescente ab ea differt. Ad saxa vulcania in Orotavo (8, cet.). Ster.

R. fuciformis (L.) D. C. f. ***ensiformis*** Vain.

Thallus angustior, lat. 1—2 mm, basin versus teres aut subteres, ceterum compressus, soraliis marginalibus, raro parcissimeque supra laminam evolutis, simplex aut rarius furcatus vel dichotome repetito-ramosus, subpallidus aut livido-cinerascens, partim levissime pruinosus, KHO superne flavescens, intus non reagens, $CaCl_2O_2$ soraliis rubescentibus, ceterum non reagens, his solutionibus unitis superne flavescens, medulla jodo sordide violascente. Medulla placentae et basis thalli alba. Forsan est autonoma species, sed reactionibus cum *R. fuciformi* congruens. In *R. fuciformi* thallus est latior, etiam basi compressus aut subcompressus, sorediis in margine et in medio laminae thalli dispositis. Proxima sit *R. fuciformi* var. *immutatae* Steiner (Flecht. Mader. Kanar. p. 28, in Österr. Bot. Zeitschr. N. 9, 1904), quae soraliis $CaCl_2O_2$ non reagentibus ab ea differt. Immixta *R. Teneriffensi* Vain. ad saxa vulcania in Orotava. Ster.

R. Boergesenii Vain. (n. sp.).

Thallus long. circ. 25—50 mm, crass. 0,7—1,5 (—0,2) mm, teres vel teretiusculus, livido-pallescens vel cinereo-fuscescens aut basin versus glaucescenti-albidus, haud distincte pruinosus, rigidus, soraliis rotundatis, 0,5—2 mm latis, albis vel cinerascentibus instructus, laevigatus aut demum leviter rugosus, KHO non reagens, $CaCl_2O_2$ extus non reagens, intus rubescens et medio non reagens (his solutionibus unitis eodem modo reagentibus), soraliis $CaCl_2O_2$ rubescentibus, medulla jodo intense caerulescente. Medulla placentae et basis thalli jodo caerulescens (intense). Facie externa similis est sterilibus *R. phycopsi* Ach. et *R. Arnoldi* Vain. Immixta *R. fuciformi* f. *ensiformi* Vain. et *R. Teneriffensi* Vain. ad saxa vulcania in Orotava Ster.

Diploschistes aggregatus Vain. (n. sp.).

Thallus crustaceus, sat crassus aut modice incrassatus verrucoso-inaequalis, rimosus aut areolato-diffractus, verrucis rotundatis et circ. 0,5—0,3 mm latis aut subreniformibus, cinereo-albicans, haud distincte nitidus, $CaCl_2O_2$ superne et intus rubescens, KHO superne flavescens, intus levissime lutescens, jodo tantum infra apothecia caerulescens, ad ambitum hypothallo albo parce conspicuo. Apothecia parcius

simplicia, vulgo stromatoideo-aggregata et plus minus confluentia, interdum etiam discis confluentibus. Discus profunde immersus, lat. 0,5—0,8 mm, subconcavus, caesio-nigricans, tenuiter pruinosus, margine paratheciali tenui, integro, albo, superficie subdetrita, margine exteriore thallino, apothecia 4—1 (—8) includente, sat crasso, leviter inaequali irregularique, thallum modice superante, basi haud aut parum constricta. Parathecium fuscescens, tenue, partim superne interneve deficiens interruptumve. Hypothecium fuscum, circ. 0,060 mm crassum, partim (in eodem apothecio) albidum, strato medullari thalli, jodo dilute caerulescenti, gonidiis destituto, impositum. Hymenium circ. 0,170 mm crassum, jodo non reagens. Epithecium fuscescens. Sporae 8:nae, distichae, subellipsoideae, apicibus obtusis, murali-divisae, cellulis numerosissimis, septis primariis transversis 5—6, primum diuque decolores, demum nigricantes, jodo caeruleo-nigricantes, long. 0,025—0,033, crass. 0,011—0,016 mm. Proximus est *D. bryophiloidi* (Nyl.) Vain. (Fl. 1878 p. 345, Lich. Paris n. 129), qui apotheciis minoribus simplicibusque ab eo differt et ad muscos et terram crescit. — Una cum *Pertusaria Teneriffensi* et *Stereocaulo Vesuviano* ad saxa vulcania prope Taoro-Humboldt in Orotava. Fert.

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