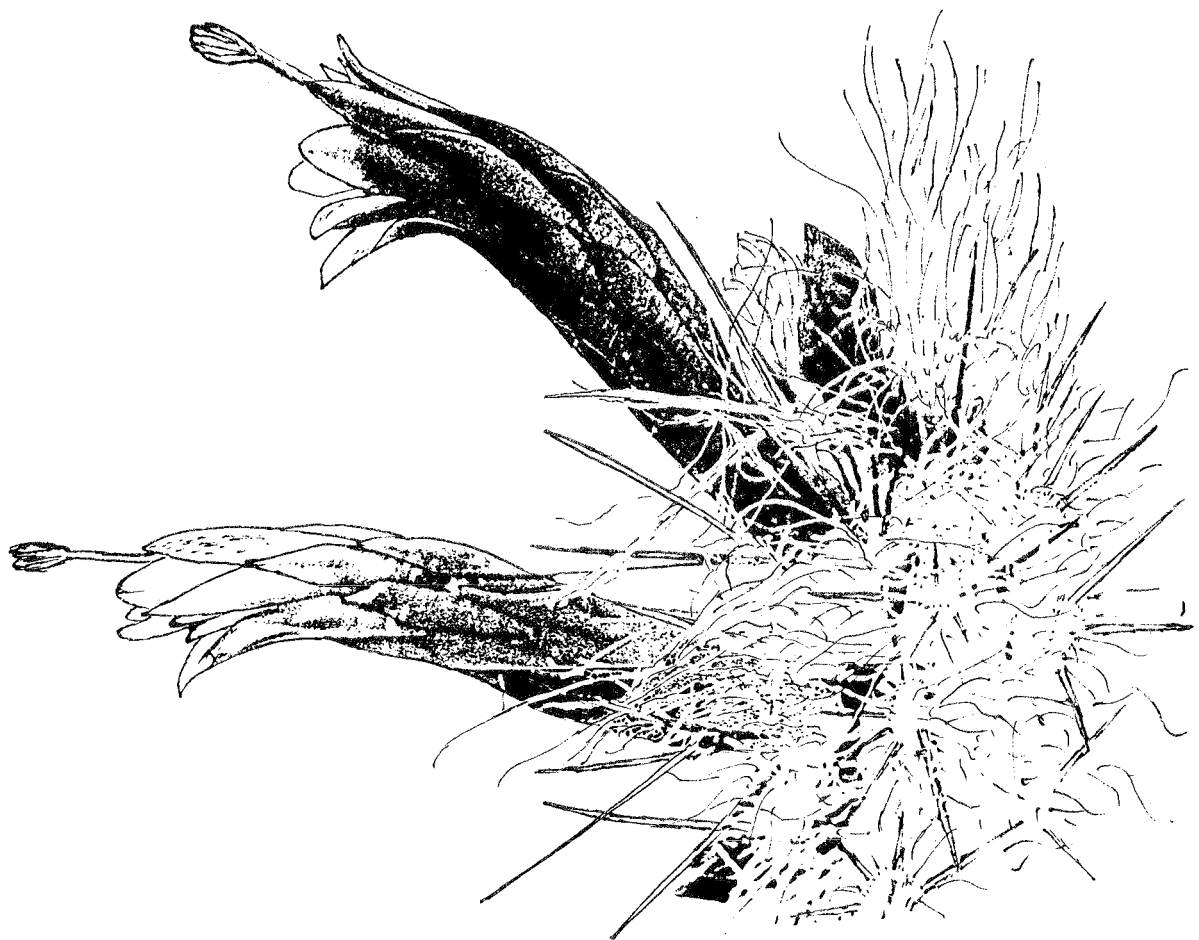


THE CHILEANS '83

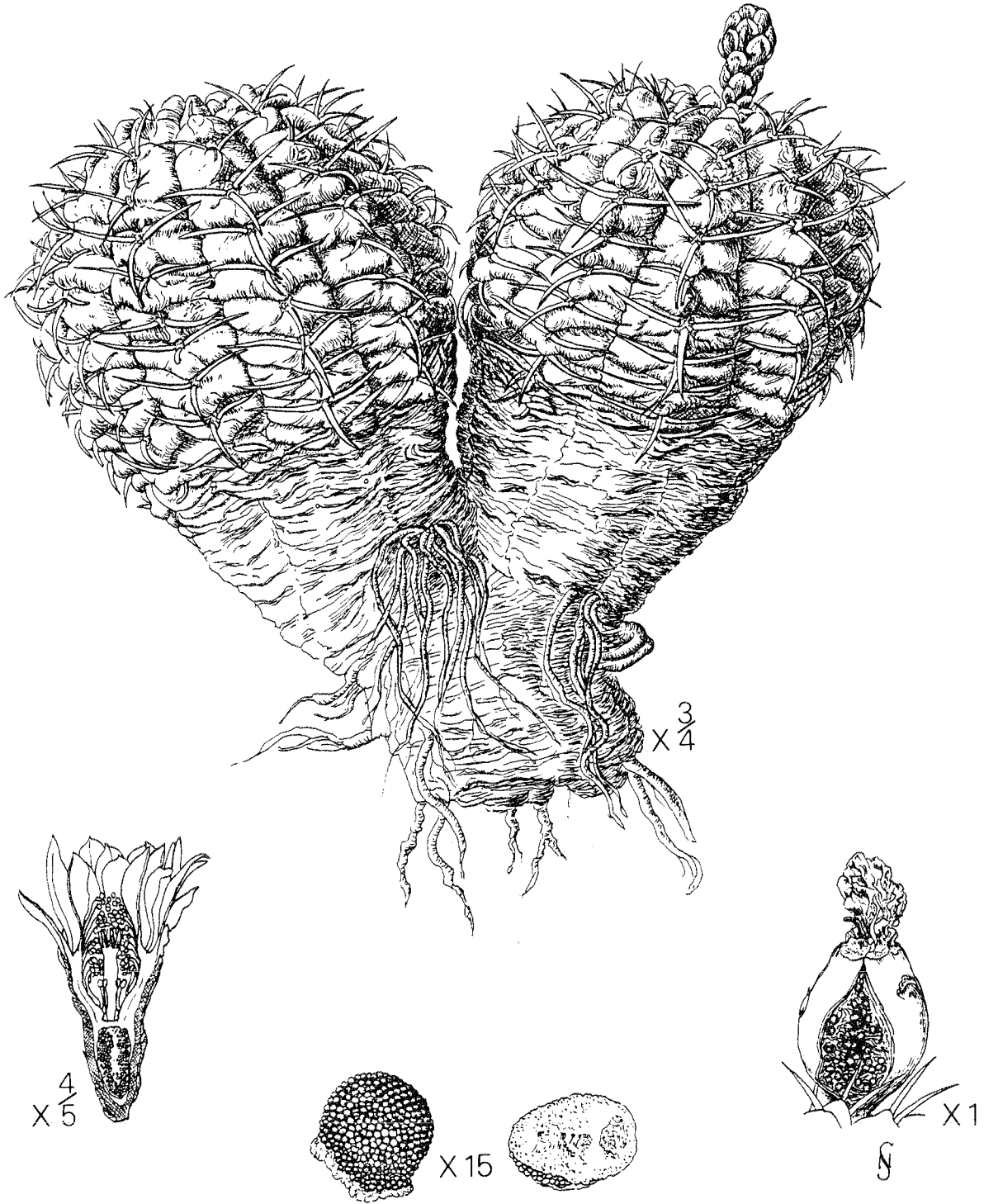
VOLUME 12 NUMBER 42



CLEISTOCACTUS FOSSULATUS

v. rubrispinus FR 100a

Collection - R. Mottram



GYMNOCALYCIUM GLAUCUM

Collection - F. FUSCHILLO

GYMNOCALYCIUM GLAUCUM FLOWERS From F. Fuschillo

When I was paying a visit to De Herdt in about 1973, I found on the staging a solitary Lau-collected plant of *Gymnocalycium glaucum* for sale. It was a double-headed plant with an enormous thickened tap root, the like of which I had never seen before on any *Gymnocalycium*. The two heads were of a similar size, about 3½ inches in diameter and the root was almost eighteen inches in length. About half to two thirds the way down the heads the body became fairly corky and the tubercles more flattened. The lower down the tubercles were, the flatter they became and about four inches from the top where the heads joined together, they were really lacking in spines. There was no real waist between these heads and the root, so taken all together it was very difficult to decide just where the root finished and the body started. The root tapered rather unevenly downwards until it became about finger thick at the very end.

Even after picking out the longest possible pot for this plant, I was obliged to cut about six inches off the bottom of this great root in order to get the plant to fit into the pot. There was already a bud on the plant when I bought it and that did come into flower. It has had one or two flowers each year since. The flower was about 2½ inches high before it opened wide; the tube was a deep blue-green colour, somewhat urn-shaped, the flower petals were off-white to faint pink with a pinky-brown midstripe which you could see most easily on the outer petals. The stamens were in two series, one row immediately above the small nectar chamber, just where the inner wall of the tube starts to open outwards; this bottom row of stamens lean against the style. Above these, there is a gap and the upper half of the tube is filled with numerous stamens — the uppermost ones curving over the top of the style so that you can hardly see the stigma when the flower is open wide.

Usually I try not to cross between species when I pollinate to obtain fruit, but with *G. glaucum* there were never two flowers out at once, so in order to get fruit and seeds for photographic purposes I had to cross the flower with *G. mazanense*. The fruit was an elongated barrel-shape, about ¾ inches tall, and a remarkably bright blue colour, with very few, wide scales which had a broad, pale, margin. The fruit eventually split vertically down one side to expose the dark seeds embedded in a stiff white pulp.

The seeds were quite small, of a size that I would regard as typical for *Microsemineae*; the tuberculate testa was almost black. When photographing seeds of this group of *Microsemineae* I find that most of them are a very deep reddish-black rather than plain black. Although the seeds from one fruit did vary slightly in size (and this could be due to some extent to their degree of ripeness) they are generally all the same shape. The seed is rather longer than it is broad and not as thick as it is broad. When viewed sideways the testa has a very pronounced Vee shape at the base; the base of the testa is neither pinched in nor flared out where it meets the hilum. The hilum is white, spongy in texture, thick, wider and broader than the testa. It is nothing like as large as the enlarged hilum on *Trichosemineae*, more like that on some *Notocactus* seeds.

... from J. Lambert (At the Chileans 1982 week-end)

My journey to Argentina turned out to be quite a success. I made a more or less circular trip by car of about 4,300 km through the whole north-west of Argentina. I was able to make numerous observations on cacti, but collecting had to be limited to virtually *Gymnocalycium*s only because of the lack of space in my luggage for any more plants. In total I brought back 79 plants, of which 74 were *Gymnocalycium*, two were *Pyrrhocactus*, two *Paroda* and one *Notocactus*. These were brought back (to Belgium) on December 13th 1981 and up to now the losses remain confined to five plants, which I feel is an acceptable figure for the acclimatisation of wild plants. The *Gymnocalycium*s which remain belong to 30 different forms (species and/or varieties) and I also brought back seeds of various species.

Our route took us from Cordoba to San Juan, then north to Villa Union; from there we crossed the Sierra Famatina by Cuesta Miranda. After collecting along the eastern foot of that Sierra, we then stopped for the night at the foot of the eastern slope of Sierra Velasco, going on the next day to the Serra de Mazan. On our way from there to Tinogasta we visited the Sierra de Copacabana where we discovered the really beautiful *Gymnocalycium glaucum*. It was not possible to take the camera with me where I found this plant; first I had to make my way through a thicket of spiny bushes, then climb over a railway embankment, cross a broad sandy strip and finally climb a very steep slope to get to the spot. There I dug up a superb specimen bare handed with only the help of a stone. The tap root of this plant was between 15 and 20 cm in length and the thickness tapered from 11 cm to nought. There was only about 5 cm of the body projecting above the surface of the ground. Jorge Piltz and I had a good laugh when we discussed our experiences in collecting this species, as he had actually found it a bit more to the south, on flat ground just along the road; so that where I took a lot of trouble, he really did some "arm-chair collecting"! This shows that the species is not confined either to flat or sloping ground.

At this habitat, the sandy strip at the bottom of the slope was not entirely devoid of vegetation but was sparsely covered by spiny bushes, most of which had been charred by a (recent?) fire. At the spot where *G. glaucum* was found it was not in solid rock, but in ground that was a conglomerate of stones of various sizes (like brick-bats) mixed with some fine soil. Perhaps it could be described as broken rock with a little sand and gravel. When I describe the Sierra de Copacabana as a steep slope, this does not mean that it is a vertical rock cliff, but that it is steep enough to force one to use hands as well as feet to climb it — the slope was probably more than forty five degrees. The surroundings support only a few low shrubs and there are many stones on the surface; it is more or less similar to the hill-slopes at Marayes, of which we showed a slide, but with less density of vegetation and an entirely different type of rock — pink granite instead of grey schistose material.

Unfortunately, I did not succeed in establishing the specimen of this plant which I had unearthed. The root had been injured during the excavation and although I used some fungicide on it, the plant rotted away after about three months. The body of the plant was not really bluish, but rather a dirty to greyish olive-green. On the other hand, blue or bluish fruits are not uncommon among *Gymnocalycium*, for example in *G. mazanense*, *nidulans*, and the *gibbosum*-complex. If you have found it difficult to set fruit on this species, there are quite a number of *Gymnocalyciums* which will not set fruit in a greenhouse without some form of artificial intervention. As we discussed at the Chileans Autumn Meeting, the difficulty is that we know very little about the natural pollinating agents in the habitat region.

Seedlings of *G. glaucum* definitely do develop a tap-root, from quite an early age. In addition, a plant which I took off a graft and established on its own roots then developed two tap roots of its own.

. from G. Hole

The subterranean parts on *Gymnocalycium* of this group are all what one would call tap-roots or underground stems. I have measured root sizes on the following plants: *G. nidulans* Lau 487, root 3½ to 4 inches long on 2½ inches diameter body; *G. nidulans* B 164, root 4-4½ inches long on 3½ inches diameter body; seedling *G. glaucum* root 3-3½ inches long on 1¼ inches diameter body. Most imports tend to have their roots either broken off or cut off during collecting; most of my plants are in this category and start to develop thickened roots in cultivation.

The flowers of this group of *Gymnocalycium* do tend to be difficult to pollinate as the stamens remain arched over the stigma when the flower is open. I can only get fruit to set on one plant out of ten in this group, even though I give the flowers some help with a brush. Last year I set seed on B 164 *G. nidulans* so I have compared this with the seed of P 136 *G. ferrarii*. The surface texture of B 164 *G. nidulans* is indeed similar to that of P 136 *G. glaucum* (*ferrarii*). However, the seed of P 136 looked to me to be the same shape as the seed of B 73 and P 80a *G. castellanosi*, though I know that the surface of P 80a is totally different to other seeds from the *mazanense* group.

. further from F. Fuschillo

If you care to look at the published description for *G. ferrarii* I think that you will find that my plant of *G. "glaucum"* matches it fairly well.

. from G. J. Swales

Whilst the two-headed plant shown on the inside front cover was in residence here, it put out two buds. One of the flowers opened a few days before the other. The first flower was sliced in half in order to draw the flower section. The two halves of the flower were then stood in a shallow dish containing a few mm of water, out of the full sun, in order to have the pollen available to try and set fruit on the second flower. It was remarkable how turgid the two halves of the flower remained and how well they kept their shape, apart from curling inwards a little at the sides, no doubt on account of the exposure of the cut surfaces.

One had to look very closely in order to determine exactly how the stamens were inserted. As is often the case in *Gymnocalycium* flowers there was a single row of stamens inserted near the base of the style, immediately above the nectar chamber and leaning up against the style. At first sight there appeared to be a gap above these stamens before the second series of stamens commenced. However, when a careful examination was made with the assistance of a hand lens and the lowermost filaments of the upper series were lifted carefully in order to find out just where they were attached, it became clear that there was not much gap at all, if any, between the lowermost stamens and the more numerous upper stamens. Indeed, the only way one could distinguish between primary and secondary stamens was by the direction in which they leaned, the lower-most leaning against the style — the remainder above leaning against the inner wall of the tube.

The thick rootstock terminated abruptly, evidently at the place where F. Fuschillo cut off the long tap-roots which had made potting-up rather a problem. A number of new roots had grown away from this surface, but most of the roots arose from further up the rootstock (or stem). From the appearance of the plant where it divided into two, I would have thought that it had grown as a double-headed seedling in the wild. If it had originally been a single-headed plant which had been damaged in some way at the growing point, then the two heads would most likely have appeared as offsets from a main stem. But there is no sign whatsoever that this has occurred.

This particular plant has three spines at almost every areole. There is certainly no evidence of the 2-3 (-4) pairs of pectinate spines quoted in Ritter's description of *G. glaucum*, nor of the 3 pairs of radial spines quoted in Rausch's description of *G. ferrarii*. If it had been a case of body and spination along without any plant history, I might even have been tempted to have suggested *G. triacanthum* as a name.

In 1976 I received a packet of seed of *G. glaucum* from F. Fuschillo which will almost certainly have come from this plant. I measured 14 of these seeds, their height averaging 1.00 mm. By height I mean when looking sideways at the seed (as drawn here) measuring not from the bottom angle of the vee shape of the base of the seed, but at right angles to a line joining the two ends of that vee. This vee shape has one arm longer than the other, both representing the hilum area seen in side view. Taking the shorter arm of the vee, the hilum there has a roughly circular depression. On some seeds, the corky tissue covering the hilum area must be fairly thin at the bottom of this depression because the dark cast of the testa can be

seen through the pale covering. I would not like to say categorically that this depression surrounds the micropyle or the funicle. Indeed I would be interested to know how various authors do decide just which of these two features is which on any particular seed.

In his observations concerning *G. ferrarii* in the wild near Mazan, I note that J. Piltz notes that "the seeds are slightly different". Do I take this to mean that he considers the seeds of the two populations of *G. ferrarii* are slightly different? Or that the seed of *G. ferrarii* is slightly different from the seed of *G. glaucum*? My own specimen of *G. ferrarii* seed P. 136 cannot be distinguished from *G. glaucum* seed! And just how different is "slightly different"?

. from H. Middleditch

The sketch of the flower section clearly shows a style which is quite stout in relation to its height and that it tapers distinctively towards the bottom to become only half as thick at the very base as the remainder. This led me to refer to the slide taken by F. Fuschillo a few years ago from this same plant and the very marked narrowing of the style at the base was to be seen there, too, quite clearly. Being rather intrigued by this feature I then went through all my slides of *Gymnocalycium* flower sections. On quite a number of the less slender styles a slight degree of narrowing at the base could be discerned. Only on flowers of *G. pflanzii* & *G. marquezii* could a degree of narrowing similar to that on *G. glaucum* be seen — here again on a flower which possessed a very stout style. On the equally stout style of *G. zegerrae* this feature was not visible, but it was just evident on the somewhat less stout style of *G. calochlorum*. This narrowing characteristic would consequently not appear to be associated with all stout *Gymnocalycium* styles; where it does appear distinctly, is it consistent? In particular, does this feature appear on flowers of *G. nidulans*, *weissianum*, *hossei* and *mazanense*? Are the "red anthers" a consistent feature of this group of plants? Does the seed on these plants differ from most of the other *Microserpineae* in size and colour?

IN SEARCH OF GYMNOCALYCIUM GLAUCUM Ritter By Brigitte and Jorg Piltz

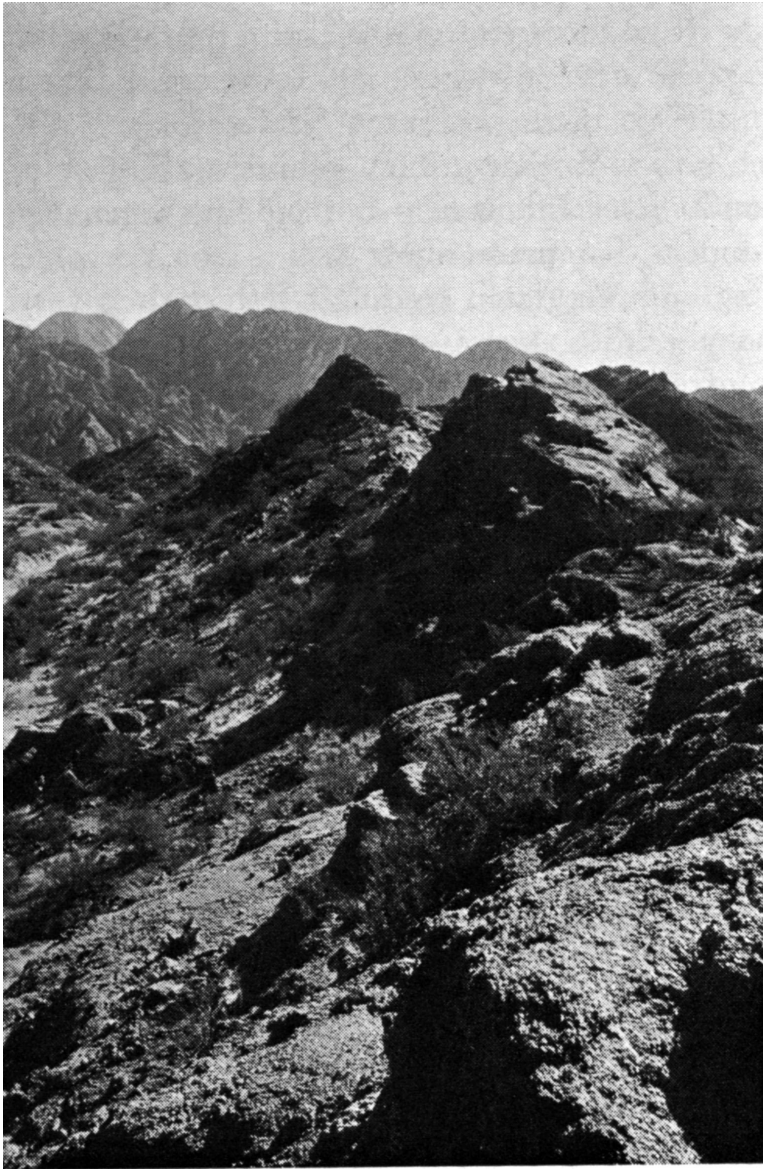
Translated from K.u.a.S. Vol. 28 No.6 1977 by F. Fuschillo

We booked in for a few days at Aimogasta from where we could search the Sierra Mazan and the eastern slopes of the Sierra de Velasco for *Gymnocalycium glaucum*. As a reference we had only the general description of Ritter "south-east of Tinogasta in Catamarca near the border with the province of La Rioja".

If one drives along the road from Aimogasta to Tinogasta, shortly after passing Alpasinche, one leaves the province of La Rioja; then there is only a short distance of 65 km. to go. The region in question is situated south-east of Tinogasta in the vicinity of the border between Catamarca and La Rioja. We therefore had a large area to choose from. Along the great wing of the Sierra de Velasco going left towards the north-west, is route 60. A few km beyond Aimogasta the asphalt road ends. Thereafter we drove along a very dusty dirt track. Apart from the *Tephrocactus* and low growing *Acacia*, there is hardly any vegetation. The "vados" cross our route at regular intervals: they carry the water from the Sierra Velasco to the Rio Salado during the rainy season, but at this time of year they carry no water. The surroundings are bare and dusty. We soon reached the northern end of the Velasco, the road curved to the west and for a short while we could see the snow covered peaks of the Famatina massif. Then, like an oasis in the desert, we saw the village of Alpasinche. We had to cross the water of the Rio de los Sauces, which flows into the Rio Salado nearby. In the shelter of the green trees the parrots were making a great deal of noise. As we went on our way, it was the same river valley, the same monotonous landscape. It is winter, yet the sun burns fairly hot from the clear blue sky.

A few km. along the road it turned towards the north in the region of Cerro Negro where we hoped to find the *Gymnocalycium* we were looking for. Here a new road to Belen is being built. The bridge over the Rio Salado (here it is named the Rio Colarado) is already finished so it saved us a paddle. The places where we searched exhibited no other cacti apart from *Tephrocacti* and *Opuntia sulphurea*. Only here and there did we find *Echinopsis leucantha* growing in the shade of small bushes. We turned around made our way towards the region of Tinogasta. On our right appeared the jagged tips of the Sierra de Vinquis and behind them the Sierra de Zepata. The road followed the course of the Rio Colarado which winds its way through the wide valley. Beyond a small settlement we left the road for our usual lunch of white bread and cola. From along the river came the cries of the parrots. Really only to fulfill our commitments we searched the immediate vicinity. We had to jump over an irrigation channel to reach the nearby rocky slopes. Immediately at the foot of the first hills we discovered, in a crack in the weather beaten granite rock, the *Gymnocalycium glaucum* we were looking for.

Next to the shimmering ochre, brown and yellow rocks which here and there sparkled with metallic inclusions, we could see the lead-grey, and sometimes the more intensive steel-blue, epidermis of the cacti. The first few examples showed the whole range of forms of the population. One had a diameter of 10 cm., few ribs (7) and grey-black spines; and other was not much larger but had 18 (!) ribs with reddish, more outstanding, spines. We later took a picture of all the transitional forms which were growing together under a bush, the largest example being nearly 20 cm. diameter and 15 cm. high with an average of 13 ribs. Noticeable on all plants were the large tap roots which we often damaged while digging them out; a more specific description will follow after longer observations. From this hill we went further into the mountains. As the rocky slopes became steeper we found a *Parodia* with sharp hooked spines. We also saw fully grown plants which were cylindrical, about 10 cm. high and 3.5 cm. diameter. These were also found growing in cracks in the rocks, and developing long tap roots to varying degrees. Alongside these were invariably an *Echinopsis* (which we believed to be *Echinopsis leucantha*), of more or less imposing size. One huge example was about 150 cm. high and 30 cm. in diameter.



SIERRA COPACABANA

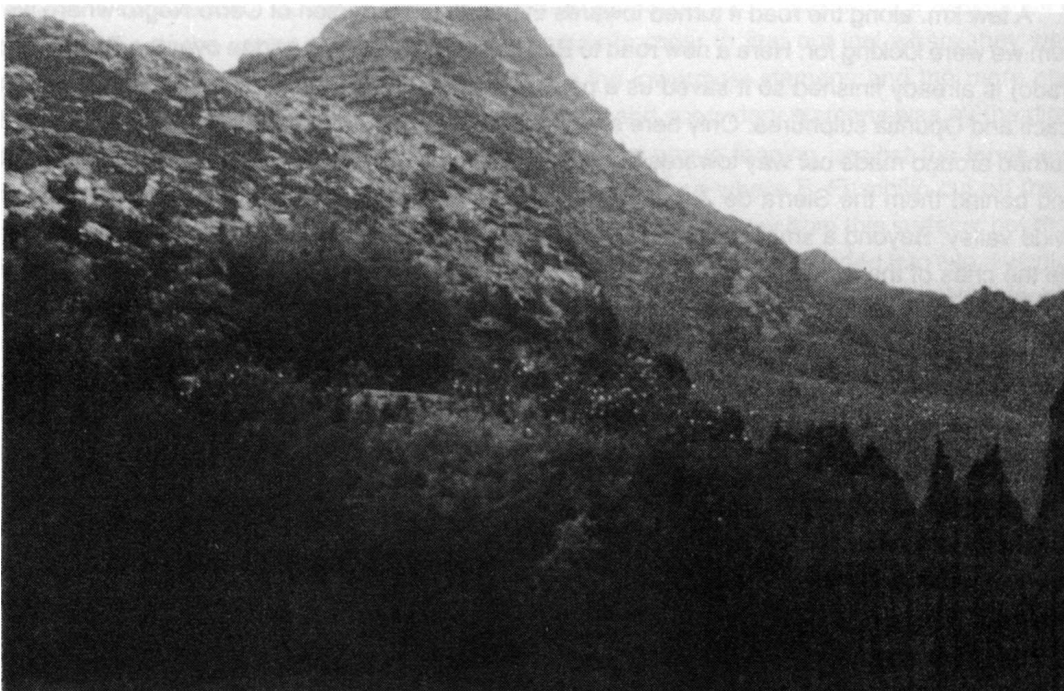
NORTH-WESTERN
EXTREMITY

Photo - J. Piltz

K.u.a.S 28.6.1977

AT THE FOOT OF
SIERRA COPACABANA

Photo - J. Lambert



Habitat - *Gymnocalycium glaucum*

We labelled our collected plants, and packed them away. That evening we arrived back in Aimogasta, tired and exhausted but well satisfied.

Comments

. From H. Middleditch

Now I find myself thoroughly confused, because the slides which Jorg & Brigitte Piltz showed to us at the 1980 Chileans week-end included one of *Gymnocalycium glaucum*, with a swollen root that must have been a foot or more in length. This plant had just been dug up from what we understood to be a sandy soil — or perhaps just plain sand might be a better description. Yet in this article, it clearly talks about finding this species in a crack in the weather-beaten granite rock! I can readily understand the swollen root for moisture conservation when growing in sand, but does it still have a swollen root when growing in cracks in the rocks?

. From G. Hole

When Jorge Piltz described his trip to the Pipanaco basin to us at the Chileans' week-end, he showed us a slide of an unearthed *Gymnocalycium glaucum* held by his daughter; the head of the plant was level with hers and the thickened root passed her waist. I am sure that the root was some 50 cm. (20 ins.) long. Jorge Piltz told us that the soil in this particular area was pure sand of about 2mm grain size. This plant was P36a *G. glaucum*.

. From J. Piltz

The reason that you have been confused about the nature of the ground in which we found *Gymnocalycium glaucum* growing is that we found the plants in different locations on the three separate visits that we made to this region, and the nature of the ground was not always the same. The first habitat location that we found was described in K.u.a.S. No.6 for 1977 and that was at the northern end of the Sierra de Copacabana. This was the place that I told Mr. Lambert about when he was planning his trip to Argentina. The illustration in that number of K.u.a.S. of this habitat location is taken in the lower part of the sierra; the view is nearly from east to west so that the mountains in the background are the higher peaks of the Sa. de Copacabana. From this point where the photograph was taken it is not possible to see the Sierra Famatina.

The Copacabana is mostly granite rock and the surface of the hills and slopes is very weathered on account of the wide difference of temperature between daytime and in the night. It can be rather dangerous to climb the slopes there because the rocks are sometimes very crumbly. When we were there in 1980 Brigitte lost her hold and as she struggled to find something to stop her fall she slid down into a *Tephrocactus alexanderi* var. *bruchii*. At the foot of the slopes there is often a sufficient amount of more or less fine weathered gritty material to cover the surface of the ground. However, most of the *Gymnocalycium* are growing in clefts in the rocks which have become filled with this finer material. At the foot of the hills and on the lower slopes there are scattered bushes perhaps about 1-2m high, with an occasional small tree (probably acacias) which are higher. Higher up on the hills there are no bushes at all.

The slide which you mention of my daughter holding a *G. glaucum* was taken at quite a different place, where we found another form of this species. We found these plants near San Blas (P 36a) in 1978 and again in 1980. At this location this species can reach an enormous size and can have very long roots; also the flowers are more white and the epidermis is more ash-grey. Mr. Till in Austria considers it to be a new species, but in my own view it is a form of *G. glaucum*. Here the plants do not grow on rocky slopes, but on the top of low mounds consisting of clay sands and gravel. The site is near the Rio de los Sauces where there are also many other dry beds of rivers which come down from the Sierra de Velasco.

Also in 1978 and again in 1980 we found *G. ferrarii* at two places near Mazan, close to the Type locality which is near Santa Teresita. Here these plants were growing in the same sort of material as in the Sierra Copacabana. But when we found the same plants in 1978 in another low sierra lying a short way to the north-east of the Type locality they were growing in alluvial fans consisting of clay sands and gravel. Both sites are in La Rioja province, to the north of Mazan and east of the Rio Salado. The adult plants in this area are smaller than *G. glaucum* from other sites and the seeds are slightly different. In my own view this species is only a form of *G. glaucum*.

When we found the growing place of *G. glaucum* in the Sierra de Copacabana in 1976, I was convinced that this was Ritter's Type locality. When I asked him, he wrote and told me: No — my *G. glaucum* grows 30 km. to the south of Tinogasta on the road from Famatina to Tinogasta! On our next visit to that area in 1980 we found plants at the location given by Ritter, just at the border between La Rioja and Catamarca in the south-western part of the Sierra de Copacabana. They were not growing in granitic rocks, but in clay-sand; they have long roots and also a typical *glaucum* flower with the red throat just as Ritter describes it; but the plants are not greyish, they are dark green and I would never have named them "glaucum". Has Ritter confused something? He mentions in his book Vol. 2, p.447 a *Gymnocalycium guanchinense* v. *tinogastaense* FR 22a; perhaps these are the plants which we found, but they are never related to *G. guanchinense*. We do all know that Ritter has made one or two mistakes concerning certain *Gymnos*.

To summarise these plants as I see them: the typical *G. glaucum* grows in the northern part of the Sa. de Copacabana (P.36); another form is to be found rather more to the south-east near San Blas (P.36a); yet another form which is the most eastern one is the plant from Santa Teresita called *G. Ferrarii* (P.136); perhaps there is yet another related form to be found between Tinogasta and Chilecito (P.218).

. From H. Middleditch

Perhaps the Lau-collected plant illustrated in this issue may be one of the large-growing, long-rooted sorts from near San Blas? The finding places mentioned by J. Piltz may be located on the map of the Pipanaco basin which appeared in Chileans No.40 p.8.

GYMNOCALYCIUM GLAUCUM By F. Ritter

Translated by H. Middleditch from Cacti in South America Vo. 2.

Body: Ash green-green, the grey tint almost obscuring the green colour. Fairly flat, in old age hemispherical. Plants of flowering age 5-12 cm broad; firm white conical rootstock of 10-12 cm in length. Ribs 10-16 blunt and broad, swollen at the areoles, 7-15 mm high, with projecting humps below the areole, cross-groove above them. Areoles thickly white felted, 7-15 mm long, 5-8 mm broad, on older specimens twice (or nearly twice) as long as broad, prominent, about 15 mm apart from each other.

Spines reddish brown when young, going grey later, pectinate in 2-3 (or occasionally 4) pairs, in addition a single one below, all robust, rigid, awl-like, curved somewhat outwards, and then back more or less against the body, generally 2-4 cm long, occasionally up to 7 cm, the middle pair the longest, the lowermost generally the shortest; rarely an extra topmost single spine, shorter, projecting. Flower close to the growing point, odourless, 35-55 mm long, with 25-45 mm broad opening, starting to open about noon (noted on two flowers of different specimens at the type locality).

Pericarpel 15-22 mm long, 8-10 mm thick, narrowing to 3 mm below, with colour tints of red, green, brown and blue, more red below, with similarly coloured scales 2-4 mm long and 3-5 mm wide with narrow white margin and terminating in a minute dark tip. Nectar Chamber cylindrical 3 mm long, 0.5 mm wide around the style, purple, closed above on account of a single ring of close-packed stamens which lean against the style.

Tube, funneliform below, the uppermost 2-3 mm cylindrical; 7-12 mm long, 6-13 mm broad at the top, interior purple, exterior colour as upper part of pericarpel, with similar scales covering about a quarter of the tube. Filaments purple brown, the basal ring 3-4 mm long, the others 5-8 mm long, insertion interrupted above the nectar chamber, denser above; filaments (anthers? — H.M.) pointing upwards, brownish-cream to pink, oval, pollen white. Style pale green, reddish at the base, 1.5 mm thick above, 12-18 mm long, of which 2-3 mm consists of 9-12 fairly blunt, pale yellow, spreading, stigma lobes which stand among the anthers.

Petals, 13-21 mm long, 5-8 mm broad, linear right at the bottom for a length of 3-4 mm and only 1.5-3.0 mm wide; rounded at the top, with or without a point, greatest breadth at about three-quarters of their length, upright below, spreading outwards above; the lowermost part of a purple colour, which continues above in a narrow central stripe, remainder of petal white; the outermost petals shorter and broad, scarcely narrowing at the base, more greenish, pink margined, transitional towards scales. Fruit 2.5 to 3 cm long, 1.5-2.0 cm. thick, 5 mm thick at the bottom and reddish, grey-green or brownish-green above, with scales like the pericarpel; fruit scar 12-15 mm broad, sunken; the fruit splits lengthways when ripe. Seeds abundant; 1 mm long x 0.8 mm broad and 0.5 mm thick. Testa black, finely tuberculate, flared outwards a little at the margin of the hilum; hilum white, basal, long, ventralwards extended somewhat downwards, somewhat projecting. Type locality: Southeast of Tinogasta, Province Catamarca, near the border with Province La Rioja.

This species is closely related to *G. mazanense*. The important differences are: the areoles are longer, later generally twice as long as they are broad (*G. mazanense* almost round), the spines are more bent back and lack central spines altogether. Somewhat more to the east lies the area where occur forms of *G. mazanense*, which in old age always bear one or more central spines, also both species are distinguishable in the colour of the interior of the tube, the filaments, the style and the petals. Discovered by me February, 1959 FR 961.

GYMNOCALYCIUM FERRARII By W. Rausch

Translated by H. Middleditch from K.u.a.S. 32.1: 1981

(Latin diagnosis provided). Solitary, depressed globular, 30-40 mm high and 90 mm diameter, greenish-grey with up to 15 cm long thickened root-stock. Ribs 10-14 perpendicular, sinuously tuberculate, chinlike protrusions below the areole, areole sunken into the tubercle, oval, up to 7 mm long, grey felted and later becoming bald. Radial spines in 3 pairs, outstanding or slightly curved, up to 30 mm long, awl-like with thickened foot, brown to black and later becoming grey.

Flower 45 mm long and 35 mm diameter; pericarpel cone-shaped up to 10 mm long, with broad pinkish-white scales on pericarpel and tube; outer flower petals rounded and saw-toothed, pinkish-white with pink midstripe, throat pink and darker inside; filaments pinkish-white, anthers red, style short and thick, white, stigma with 9-11 lobes, whitish-yellow. Type of fruit and seed similar to *G. mazanense* Backeberg.

Habitat: Argentina, Catamarca province, close to Santa Theresa, buried in sandy scree slopes. Typus Rausch 718, deposited in the Zurich City Succulent Collection.

To describe one plant from Mazan is a risk, since so many forms are known from Catamarca and La Rioja. From the neighbourhood of Mazan alone I knew of four different *Gymnocalycium mazanense* forms. Backeberg has not been involved with the real habitat locality, he has also never collected there and so phantasy is given free rein. The type described

here differs from the other forms in that it grows buried completely in rubble and without flowers it can scarcely be located. I name this plant after my frequent companion Omar Ferrari.

. from G. J. Swales

I have had a good look at all the maps which I possess but I can find no Santa Theresa between Mazan and Sierra Copacabana.

PTEROCACTUS KUNTZEI FLOWERS By Mr. and Mrs. T. Lavender

Some years ago we visited the midlands fairly often and on those visits we always endeavoured to call in at the nursery of Messrs. Lealans at Pattingham near Wolverhampton which was always a source of well cultivated plants. Among the excellent collection of mature plants were a couple of quite large Pterocactus from which cuttings were taken and rooted down for the sales bench. Not being able to resist this unusual plant, we acquired two, in three inch pots. When we re-potted them the following year, both were showing signs of forming a new tuber. Over the course of some twenty years, both plants have grown and have been potted on and are now in six inch pots and completely filling them with tubers.

The stems do not grow upright but tend to grow a little straggly and generally horizontal, parallel to the ground so that the stems grow over the edge of the pot and at the end of the growing season will cover it. From the top of the tuber to the top of the plant is about one-sixth of the breadth across the plant. Each stem is not cylindrical, but tapers towards the tip; the stems vary slightly in thickness from about $\frac{7}{16}$ inches thick in some stems to $\frac{1}{4}$ inches thick in others. The older growth is a shade of brown with no detectable green unless grown in complete shade under the bench. In full sun the new growth is almost black. There do not appear to be any ribs although the areoles are arranged in a slow spiral down the length of the stems. The distance between the areoles following along the spirals is $\frac{5}{16}$ inches on the most mature stems down to $\frac{3}{16}$ inches on other mature stems. The number of spines on each areole varies slightly on the ten areoles I checked at random, between fifteen and twenty. The spines are light straw colour except on the newer growth where there were two or three dark brown central spines which changed to the light straw colour on the older stems and on the lower part of the newer stems. The spines are adpressed except for the central spines in the new growth which are more or less erect. There are no glochids to be seen with an eye glass but on touching the spines some do leave the areole quite easily but certainly not all of them. There are signs of rudimentary leaves on the newest growth.

just as we were due to go away on holiday. So we asked a neighbour to keep an eye on the plant and to tell us what the flower was like and to observe its colour. When we returned from holiday our neighbour told us that the flower was like onion skins, a rather dowdy brownish yellow colour. Since then the plants have flowered regularly and without exception always as a terminal flower. The stem does not grow through the flower remains and usually forms new branches from areoles further down the stem; in this way the branches become fairly prolific. The stunted appearance of the flowering stem remained for a long time after flowering takes place.

We have taken many cuttings from these plants and it is sometimes necessary to prune the top growth to keep the plant in a tidy condition. We found it better to cut off the stems at joints as they do not break easily and require to be twisted off if they are not cut with a sharp knife. We have set the cuttings to root down and over a period of time they have formed small tubers in turn. We have passed on many cuttings to other collectors. The top growth was pruned pretty severely last year in preparation for moving house and we now have quite a number of cuttings rooting down. There are now six flower buds on one of the two plants, two on the other one and some of them are on this year's new growth.

. from D. Angus

Some time ago I obtained a cutting of Pterocactus from H. Middleditch, or not so much a cutting rather one of the stems which apparently fell off the plant at the barest of provocation; it rooted without any difficulty and grows fairly well but still sheds branches at the slightest disturbance. It was probably three or four years after I acquired it that it put out flowers and it has flowered pretty regularly ever since. The tuber is now quite massive. What puzzles me is where the soil has gone to that was in the space now occupied by the tuber. A friend with a collection nearby also obtained another cutting at the same time as mine but his plant grows much taller and flowered a year before mine.

. from A. Johnston

Two or three years ago I obtained cuttings of three different Pterocactus species, *P. kuntzei*, *P. tuberosus* and *P. decipiens*. They all seemed to take root without any difficulty. Only one year afterwards, I noticed that *P. kuntzei*, by now a clump of stems, was climbing out of its pot so I unpotted it and found the reason why. It had developed a lovely tuber and was pushing on the bottom of the pot. Each of the other two plants were also found to have produced tubers almost equally as large. Some people have said to me that these three are all one species, but I cannot agree for when grown together there are noticeable differences. In my experience, *P. kuntzei* grows larger stems than *P. tuberosus* whilst *P. decipiens* has slender stems. Another species in my collection is *P. fischeri* but this looks just like the plant which Geoff Bagnall has in his collection labelled *Opuntia weberi*.

Both *P. kuntzei* and *P. tuberosa* have produced flowers and they were all terminal. There were never two flowers out at once so I tried getting them to set fruit by using other pollen, but with no luck.

. from D. W. Whiteley

A plant of *Pterocactus tuberosus* was given to me by Pip Smart about five or six years ago, which he had grown from seed. I set it in a 3 inches pot. The stems tend to be deciduous some years if it is cold and the plants get very dry

and lose the new growth, or at least some of it, from the tips. This tends to leave a main stem or "trunk" from which three or four flowering branches grow. When I had had the plant for a couple of years it flowered for the first time. The flowers are quite large for the spindly branches, bearing in mind the thickness of the branches or stems of most Cactaceae, more in a scale with a "normal" flowering plant and its branches, or with the relationship of branch to flower size on a *Pereskia*.

On the first occasion that it flowered, I sliced the flower as Jeff Bagnall was interested in *Opuntiae* and wanted a slide of it. I was surprised to find that the ovary went so far down into the stem. The flower is terminal although after the flower is finished small branches develop from the top of the pericarpel just below the petals. I should say that it is one of those plants where the flower petals appear to develop straight out of the stem, there being no obvious external signs of the ovary. This is only discovered by slicing endways down the stem. Other than becoming slightly clavate, the stems show little signs of impending flowering, though clavate stems do not always mean that you will get a flower to form. As with all *Opuntiae*, the first signs are the new rudimentary leaves at the end of the stem that either turn into petals, or if checked abort and continue as rudimentary scale-like leaves. The plant has never set fruit as I only have the one.

The root is tuberous, about the size of a potato. I have rooted quite a few stems in my time but all seem to stand still for a while with all their energy going into forming this tuberous root before the stem really starts to move again. The root is really 70% of the plant as in bad years most of the top growth can be shed. Since the plant flowered for the first time it then flowered for another three years; in the following year it missed out with flowers so I repotted it and it has just flowered again straight away.

. from H. Middleditch

On examining the slide and sketch of the sliced flower from David Whiteley's plant, I am struck by the cylindrical shape of the style; I had tended to gather the impression that the flowers on *Pterocactus* were similar to those on most other *Opuntiae* insofar as the style was swollen near the base. Are there any *Pterocactus* flowers in which this feature appears? A search of the literature revealed a most surprising paucity of *Pterocactus* flower sections. There is one in "Opuntiales vel Cactales" by Castelanos and Lelong which is not only indistinct, but the artist appears to have shown a flower which has not been completely sliced through, the two halves being hinged open on the residual intact outer wall, thus adding to the confusion. A far superior sketch appears with Roberto Kiesling's review of Argentinian cacti in a 1975 issue of *Boletin de la Sociedad Argentina de Botanica* and is reproduced here. Had I not been able to compare both slide and sketch of the *Pterocactus* flower slice from Dave Whiteley, I would have been suspicious as to the accuracy of the sketch. As it is, the disparity between the two flower sections will be all too evident. So far I can find no reference in the literature to such differences. Perhaps everyone has been mesmerised by the slight differences in body habit and has not yet compared flower sections? Further observations and comments on sliced *Pterocactus* flowers will consequently be very welcome.

TWO NEW SPECIES OF PTEROCACTUS By R. Kiesling

Translated by H. Middleditch from *Boletin de la Sociedad. Argentina de Botanica* XIV (1-2) 1971

In the month of January, 1971, together with a group of cactus collecting friends, I went to the province of San Juan, where we were led by Dr. Silvio Meglioli in our search for cactus. Amongst other interesting things, we came across two species of *Pterocactus* in a vegetative condition which were believed to be unknown. We collected plenty of specimens of both, with fruit and seeds, and in one instance with an already withered flower. Through the kindness of Srta. Carola Volponi, I received herbarium material with flowers of one and later from dr. A. Ruiz Leal of the other, together with biological notes about it. I am grateful to those mentioned for their assistance and to Dr. A. L. Cabrera for the corrections which he made to this article and for the translation of the diagnoses into Latin.

Pterocactus reticulatus sp. nov. (Latin diagnosis provided)

Plants caespitose, with large tuberous root, elongated; up to 20 cm. in length by 10 cm. across, usually solitary, sometimes divided. Fibrous roots originated at well-defined levels, but more abundant in the lower section. Subterranean stems starting from the upper part of the tuberous root, of 2-10 cm. in length by 0.5 to 1.0 cm. diameter, branching at surface level, occasionally much lower, exceptionally with fibrous roots. Epidermis pale cream colour, with remains of areoles or already without them and becoming corky in the form of a membranous covering. Aerial stems greyish purple in colour, made up of a single joint, more or less globose or pear shaped, 2-3 cm. in length by 1-2 cm. in diameter. Prominent rhomboidal tubercles, up to 3 mm. high, with a groove which sharply outlines them. Areoles at the crown of the tubercles, 2mm.in length by 1-2 mm. in diameter, elliptical or elongated, with woolly felt, whitish, inconspicuous, some 6 radial spines pectinate and at times one erect central, all of some 0.5 mm. in length; glochids in the upper part, diminutive.

Flower 4-5 cm. in diameter, apical, rotate, inserted in the stem; outer parts of the perianth greenish, the interiors pearly pinkish-white. Stamens numerous, shorter than the style. Style cylindrical, pinkish-white, Stigma with 5-9 stippled lobes, dark purple.

Fruit dry, lateral, globose or obconical, with blunt flower scar; dehiscence transverse. Areoles small, similar to the vegetative ones but without spines or glochids. Seeds numerous, of plus/minus 1 cm. in diameter with the aril, 4 mm. without it, of very pale chestnut colour, arranged like the leaves in a book. Embryo bent, long cotyledons, flat. External integument spongy, internally mahogany colour, shiny, thin; perisperm central, abundant, farinose, white.

Material studied: Argentina, San Juan, Department Iglesia, Llanos de la Patria, collected by R. Kiesling 56, on

8, January, 1971, Holotype La Plata; Mendoza, Las Heras, between Uspallata and Cienagas de Yalguaraz, collected by A. Ruiz Leal 12,785 on 9th December, 1948, Herbarium Ruiz Leal; from the same location, collected by A. Ruiz Leal, 18,704 on 16th December, 1956, Herbarium Ruiz Leal.

Geographical distribution: Valleys of Pismata, Calingasta and Uspallata, to the west of the provinces of San Juan and Mendoza, on the flat or almost flat areas between 1500 and 3000m above sea level.

Habitat. Surface stony clay, superficially covered with rubble. Vegetation scarce, stunted. Winds blow all the year. Rains in summer.

Observations: 1. In the flowers and in the immature fruit their apical location is clearly evident, then a neck is formed and subsequent growth of the stem leaves the fruit in a lateral position, numbering up to four on the same stem. In the other species of this genus, the fruit always remains apical.

2. In the type locality grow other species of the same genus, possibly a variety of *P. tuberosus*, and a quite small number of specimens with intermediate characteristics, probably hybrids.

3. Flowering in December: the flower lasts for two days, anthesis from before the middle of the day up to 15.00 hours, closing up until the following day.

In this way, the species of *Pterocactus* increase to eight, and may be differentiated according to the following key:-

- A With central spines flat, like a shaving, on the whole stem or at least on the upper part.
- B Joints globose or obpiriform. P. australis
- BB Joints cylindrical. P. fischeri
- AA With all the spines of circular section.
 - C Joints globose to obpiriform, sometimes somewhat elongated.
 - D Stems with spines loosely arranged, leaving the epidermis in view; spines at least 0.5 cm long.
 - E Fruit apical. P. araucanus
 - EE Fruit lateral. P. reticulatus
 - DD Stems very spiny, spines of 0.5 cm long which do not leave the epidermis visible or only slightly. P. hickenii
- CC Joints clearly cylindrical.
 - F Stems very spiny, of uniform colour.
 - G Areoles very woolly, spines at least 2 mm long. P. megliolii
 - GG Areoles without wool, spines more than 4 mm long. P. valentinii
 - FF Stem slightly to very spiny, epidermis violet with dark green streaks. P. tuberosus.

PLANT REACTIONS TO MOVEMENTS OF THE SOIL IN NEUQUEN OUTSIDE THE ANDES By Jorge Morello

Translated by H. Middleditch from Revista Agronomica Noroeste Argentino 2:1:1956.

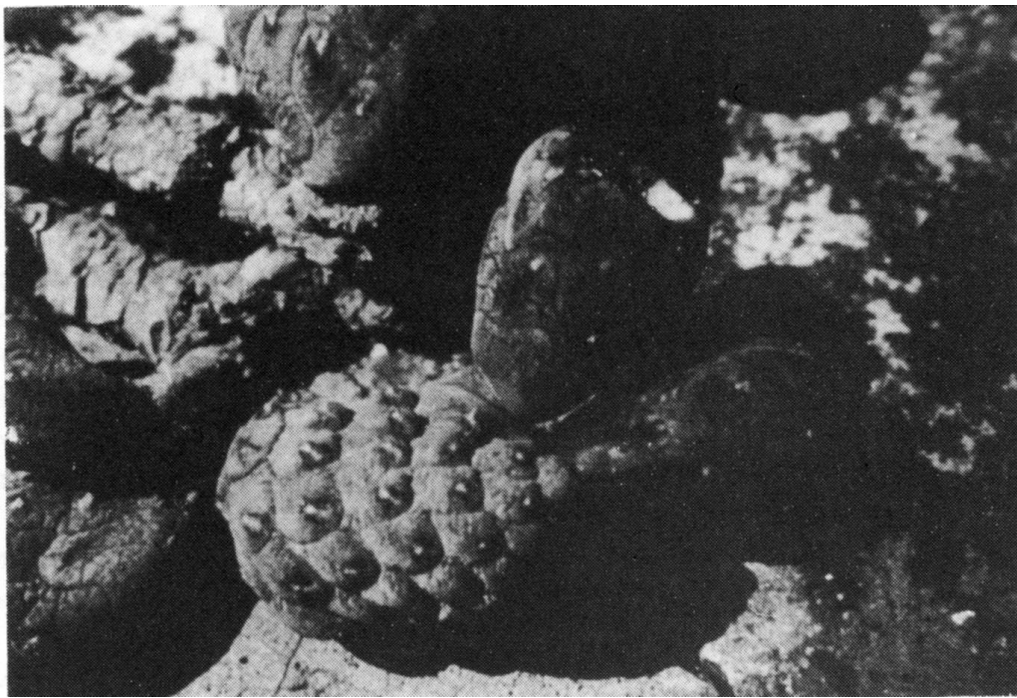
In recent years various works have appeared which consider the causes and consequences of the destruction of the soil in this region. The dangers of erosion and sedimentation have been readily assessed, but little is known about the reactions of the natural vegetation in the face of the profound change which comes about in their habitat when the original level of the soil is lowered (erosion) or rises (sedimentation).

Neuquen outside the Andes affords particularly appropriate locations for such studies; one may see there all degrees of erosion and sedimentation, phenomena which amount to the same thing for the vegetable kingdom — death after a shorter or longer period. The large basin of Anelo which lacks any outflow and is located between the rivers Colorado and Neuquen, and the plateaus and hill ranges located between the rivers Neuquen and Limay, exhibit extensive areas with a landscape honeycombed with gulleys, canadones and defiles, masses of mud accumulating at the points of lowest height, skeletal surfaces and sand dunes either stationary or in motion.

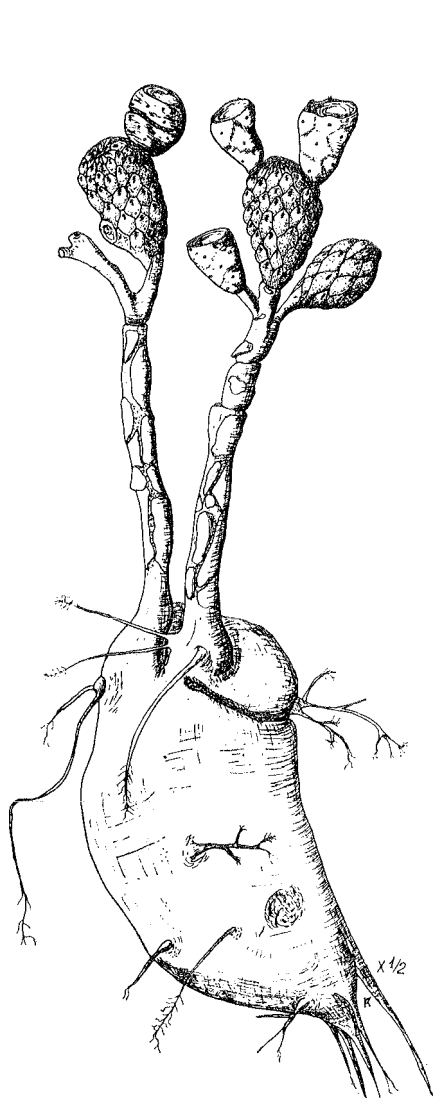
In 1951 Aur had already identified the central sector of Neuquen outside the Andes as a zone of advanced erosion, attributing that condition to overgrazing and tree felling, which exaggerates the normal effects of the winds of the "Fohn" type which come from the Cordilleras. There are places where the movement of the soil has completely destroyed the vegetation covering, and in others there remains the danger that this will occur sooner or later. The bare surfaces steadily extend themselves and the dead remains of plants confirm this advance. One of the more important tasks before any work of conservation, is to understand precisely how the vegetation (the conservation agent for the soil) reacts in the face of erosion and sedimentation.

When movements of the soil begin, the vegetation naturally undergoes profound changes in order to readapt to the new conditions of life. Some of these changes such as the alteration in the shape of the canopy, reduction in the total leaf area, rooting into the new levels, etc., are visible. Other changes, such as the modification of the transpiration regime, are measurable. If the movements of the soil continue, such attempts at readaption fail and the plant dies.

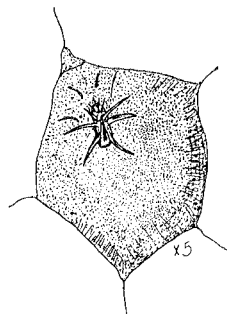
These investigations are the result of two studies in the province of Neuquen, one in September-October of



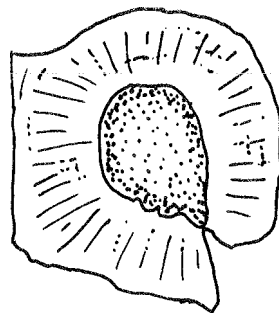
Uprooted in habitat - Photo Kieseling



Stem with
closed flower



AREOLE

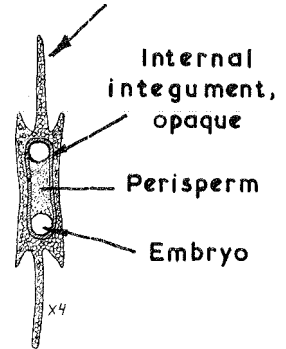


SEED



STEM & FRUIT
Start of waisting

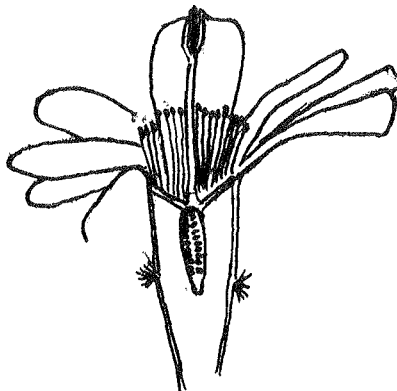
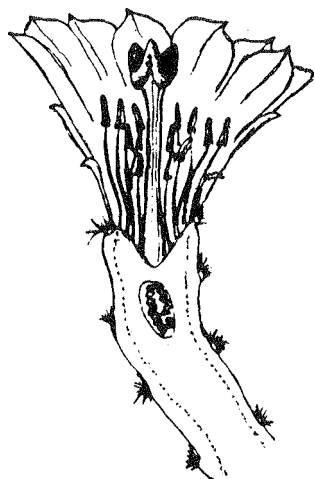
Outer integument,
±spongy, translucent



Vertical section through
centre of seed

PTEROCACTUS RETICULATUS

KIESLING - Boletín de la Sociedad Argentina de Botánica XIV.1-2.1971



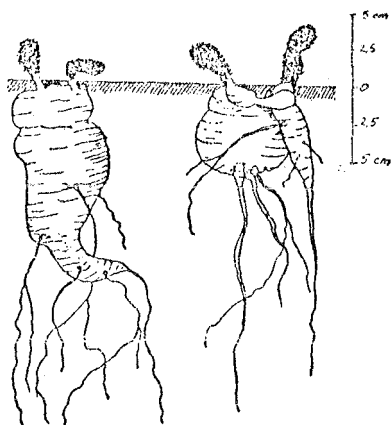
**PTEROCACTUS
TUBEROSUS**

Flower section

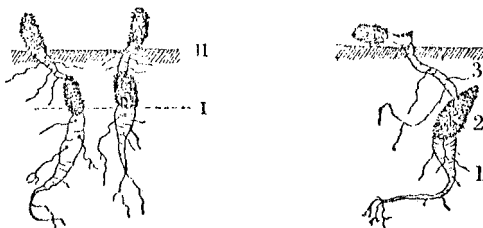
Collection - D.W. Whiteley

Pterocactus tuberosus

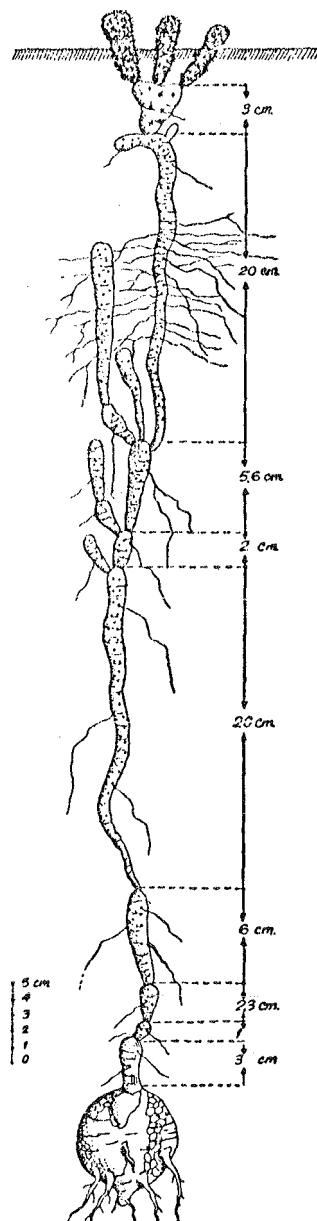
BOL. SOC. ARG. BOT. XVI.3.1975



Pterocactus growing in static soil level



**Pterocactus growing through one
layer of sediment**



**Pterocactus growing through a series
of layers of sediment of different
thicknesses**

1952 and the other in January-February 1953. These investigations established that in dry and level territory the aerial erosion could be greater than that due to flowing water, but in the bardas, mesetas and sierras of Neuquen, the factor of slope acquires an unusual importance and with that, the influence of erosion by water.

In the rainfall records of the region (Picun Leufu, Estancia Pantanito, Plaza Huinul, Anelo) there is to be seen a maximum concentration of rains in autumn-winter, a characteristic which occurs from the Rio Colorado southwards. This predominance of rainfall in the cold season is hardly favourable for the plants, which require a greater amount of water in the growing season. On the other hand, it allows the flowing water (run-off) to have a severe effect in winter, precisely when the covering of annuals has disappeared leaving the soil unprotected. In none of the places studied do the rains exceed 130 mm annually: Picun Leufu – 83.9 mm; Estancia Pantanito – 111.1 mm; Plaza Huinul – 126.1 mm; Neuquen – 127 mm. Despite the scantiness of the annual rainfall, an idea of the erosion by flowing water is given by the speed and violence with which the rain falls only in downpours which can amount to between one third and one quarter of the annual total. At Anelo in 1947 the annual rainfall reached 42.1 mm; in five hours on 14 May of that year 17.4 mm of rain fell — some 41.3% of the total. In 1949, with an annual total of 133.3 mm, 37.8% of the rainfall fell in two downpours of 4 and 5 hours duration respectively – 33.4 mm on 15 June and 17.7 mm on 16 June. On the Estancia Pantanito located some 20 km to the south of the village of Picun Leufu, the annual total for 1950 reached 82 mm, of which 30 mm (36.7%) fell on 25-26 May, 25 mm (30%) fell on 16-17 October, 20 mm (24.3%) fell on 10 December, the remaining 7 mm (9%) fell on 7 June. In the same place there were six falls of rain in 1951 and six again in 1952, none of more than 8 hours duration. Of these twelve downpours, half were of more than 28 mm.

On the outskirts of the town of Neuquen, I have watched a downpour of 16 mm fall in the space of one hour; its effects were disastrous. The mud which descended from the bardas (in the whole of Patagonia outside the Andes the remnants of high flat-topped hills or mesetas with steeply sloping margins and much serrated by erosion, are called bardas) appeared to be capable of laying down in the bottom of the basins or in front of any obstacle, a bed of 7 to 10 cm of sediments (3'' to 4'' – H.M.) this 7 to 10 cm being measured on an extensive flat area. At the same time drainage gulleys of up to 60 cm (2' – H.M.) in depth and of variable width, will appear. The town of Neuquen, built in the confined track of the wild waters which come down from the bardas northwards towards the Limay, is perfectly familiar with this phenomenon. At every heavy fall of rain, it is necessary for emergency teams of workmen, together with the collaboration of the army, to reconstruct the streets and to remove from the plazas and parks the thick layer of sediment which threatens to destroy the vegetation.

Winds: The air movements in Neuquen outside the Andes are governed by the same controls as the majority of the dry regions; heating of the surface of the ground which generates vertical air currents, slight diminution of the wind speed in the vicinity of the ground, tendency of the air heating up by contact with surfaces to form whirlwinds, etc. The following were recorded as typical characteristics, but common to the rest of Patagonia outside the Andes.

The winds are of the fohn type, that is to say descending air masses which leads to increasing their temperature and so to acquiring the capacity to contain more humidity, resulting in dry and warm winds.

In all seasons of the year, winds from the west quadrant are dominant. Based upon the total number of observations at Anelo, which are taken three times per day, the annual percentage frequency is:- 31.5% of winds are from the west, 20% from the SW; 3.7% from the SE. This relationship does not apply throughout the year and the change which most stands out is a marked decline in the frequency of SW winds from March to September, which reaches a minimum in June. The SE winds increase their frequency from September to November. Those from the West predominate almost throughout the year except in February and December when they are surpassed by those from the south.

Calms are only recorded in 6% of the observations, but it is certain that their frequency would be increased by nocturnal anemometric readings, because they do not give a true idea of the daily march of wind speeds. During the months of September and January we had anemometric readings from hour to hour, including the night, at Anelo and at Fortin de Piedra. The results demonstrate that on 63% of the days the wind had started to blow between 9.30 a.m. and 9.55, that is to say after the first of the regular observations by the meteorological office. Such was the regularity of the phenomenon that, when starting to work at the side of the plants, we were aware that we would be able to work up to about 10 o'clock and that from then it would be necessary to continue the task under the protection of a tent, in order to avoid interference from the wind. The third meteorological office reading at 21.00 hours contributes still more to giving a mistaken impression of the wind velocities, since in some 60% of instances, there are calms at this hour or else the velocity has greatly diminished.

The records from the meteorological station at Cipolleti showed the highest percentage of wind at 15.00 hours. Our own hourly observations at Anelo which were typical of the daily wind speed regime, indicated the highest daily wind speed at about 1600 hours. At Anelo, there were seven days with winds reaching over 60 km/hr during the month of January. Data from Plaza Huinul showed that during 79 days of the year winds blew at speeds in excess of 59 km/hr; no month had less than 5 days with winds of 50 km/hr or more. If we consider that a grain of sand of 0.2 mm diameter can be carried along by wind speeds of 18 km/hr, which do blow for over 21% of the days of the year at Plaza Huinul, and also that there will be much stronger winds, these together afford us an idea of the importance of wind action in blowing away the soil.

In exposed places in Neuquen outside the Andes it is possible to note the following effects of the wind upon the perennial plants:-

1. Canopies inclined to leeward.

2. Canopies erect but asymmetrical, with maximum growth towards the E and N, almost without branches towards the W and S.
3. In *Suaeda divaricata*, a furrow cut in the bark which faces to windward.
4. Eccentric annual growth rings with maximum thickness to leeward, clearly visible in *Suaeda divaricata*, *Larrea divaricata*, *Larrea cuneifolia* and *L. nitida*; also in willows on the river banks.
5. On *Suaeda divaricata* and *Larrea nitida*, we observed asymmetric growth of the underground root system with maximum numbers and greatest length of lateral roots to windward, opposite to the aerial asymmetry.
6. Young plants growing from seed only seen on the leeward side of the mother plant.

There are four main plant communities which cover the area concerned: Alongside permanent rivers and their tributaries grow *Salix humboldtiana* (willow) up to a height of 3 m or more. On saline soil with groundwater between 3 m and 10m below ground level, grows an association whose major components are *Suaeda divaricata*, *Atriplex lampa* and *Larrea nitida*. On the lower slopes and plains, where groundwater lies at more than 10 m and less than 16 m below the surface, is found an association of *Larrea divaricata*, *Prosopis alpataco*, *Bougainvillea spinosa* and *Schinus polygamus*. Higher up the slopes and on the mesetas is found an association of *Larrea cuneifolia* and *Monttea aphylla*. Here water is at an inaccessible depth or completely lacking. Almost all water drillings bored in areas occupied by this vegetation have failed to find a usable water supply.

Soil movements change the composition of plant communities as different species vary in their resistance to the same amount of erosion or deposition. *Suaeda divaricata* will be the first to die, then *Atriplex lampa* and maybe only *Larrea nitida* will survive. A deposit in excess of 40 to 50 cm in thickness, produced in one layer by a torrential downpour, is mortal for almost all perennials. Deposition may be due to either wind-blown or water-borne soil. Physical changes are initiated in a bush which suffers from deposition. In *Larrea nitida* the upper parts of the branches die off, new roots emerge from the buried lowermost branches; new twigs grow with nodes much further apart and carry larger leaves. A specimen living in a static soil level can differ so much from one which suffers the effects of deposition that a botanist who comes across only the extreme types would have no doubts about regarding them as different species or varieties.

Small patches of moving sand dunes do occur in Neuquen outside the Andes; these are usually between 4 m and 8 m in height and move between 3 m and 5 m each year. One of the most resistant species to partial submergence in sand, or in a layer of mud, is *Larrea divaricata*. A number of other plants are capable of growing upwards as fast as the soil accumulates, including *Pterocactus tuberosus*. This cactus is common in hollows and at the base of sandy slopes; it has a relatively large tuber, sometimes spherical, others napiform, from which roots emerge which can reach 40 cm in length. Specimens which grow in static soil levels possess their underground parts at depths which do not exceed 40 cm. The tuber has a water content which varies between 80% and 84% of its total weight when fresh (this data obtained from specimens which had endured two months without rainfall). Simultaneous analysis of the water content of the soil close to the rhizomes of the plants yielded 0.4 to 1.0% of the dry weight of the soil.

The species produces abundant seeds, but its most effective method of reproduction is vegetative. Each cladode (stem) separated from the mother plant shows the capability for putting out roots on being buried in the sand, and then one is modified into a tuber. In the sandy ground we have come across all the intermediate forms from cladode to tuber, which may be summarised as follows:- when a stem becomes buried by sand, the spines fall off the areoles, it becomes smooth and pale brown in colour, begins to enlarge disproportionately, losing the original cylindrical form; from the areoles, already spineless, adventitious roots arise. If a growing plant is covered up by sand, the body becomes transformed into a tuber and emits a new offset at ground level. The old body becomes incapable of emitting roots and transforms itself into an underground water storage organ. If the succession of coverings continues slowly but steadily, the new offsets are buried as rapidly as they grow; and in this process of covering and growing, all the buried sections display the ability to send out roots and lose their spines.

In comparing specimens from static soil level with those which have been buried, a notable feature is that initially the offsets are quite similar to each other (the shortest measures 0.5 cm and the largest 4 cm), whilst the latter are much more irregular in size (shortest 1 cm, longest 20 cm). The junctions between the joints are extremely fragile and the wind or the animals often break them off, leaving the hollows sown with detached heads. Specimens which grown in the static soil levels never have more than 4 to 6 heads over the tuber, whilst those which have been buried can have chains of as many as 18 heads. In this case, the soil which covers the plants acts as a protecting cushion against dismemberment. In such cases the total length of the plant can attain 80 cm (excluding tuber) whereas those growing at a static soil level do not exceed 15 cm in length.

(The article goes on to review in detail other specific examples of the effect of surface erosion and deposition, together with factors affecting recovery and conservation of affected areas.)

A NATURALIST ON DESERT ISLANDS By P. R. Lowe

When first sighted, *Blanquilla* appears low, flat, barren and uninteresting. Nothing indeed could have looked less promising as we got our first impression of it. But as the yacht ploughed on and the distance gradually lessened, matters began to improve. The uniform drab or almost tawny yellow which looked so dreary and uninviting from a distance, gradually crystallised into more definite shapes and colours. Large patches of grey deepened into green, or were picked out here and

there with smaller patches of deeper green still. The greens in their turn became recognisable as savannas and woodland, the greys as large stretches of cactus scrub.

As we drew closer still, and individual objects became clearer, our surprise grew, for Blanquilla presented an appearance which is practically unique as far as the Caribbean sea and its islands are concerned. Except for a fringe of coconuts in one restricted spot, there was not a hint of the tropics in the whole scene. One seemed to be nearing an island of rolling grassy downs; while here and there, perched on the tops of rounded knolls, or nestling snugly in the folds of sheltered little dells, appeared small isolated coppices or very circumscribed woods of vivid green. From this distance, it might have all passed for a little bit of Devonshire. The land sloped gradually upward from the shore, undulating or carved out into ridge and gully, till it gained a central plateau dotted with more clumps of low trees and bushes and thinly covered with grass. Later on we discovered that distance gave a somewhat flattering tone to the scene, which a profusion of cactus, growing everywhere over the island, quickly did its best to dispel on nearer acquaintance. Thick and impenetrable as the cactus scrub proved to be in places, however, there were still large areas where one could wander and even ride fairly at ease, and even some where, with a little effort of imagination, one could almost call the thinly growing grass "turf".

A belt of thick trees, perhaps a mile wide and four long, is situated along the whole length of the eastern side of the island. This long belt of woodland forms a rather striking feature of Blanquilla; and the explanation of its existence seems to be worth noting. Seen from the central plateau of the island, it begins abruptly and is as well defined as if it had been planted by the hand of man, stretching away north and south along nearly the whole eastern edge of the island. Except for the small isolated coppices a few square yards in area (which have been mentioned above) dotting the surface of the high ground in the central parts of Blanquilla, there is not a tree to be seen there, so the contrast between this artificial looking plantation and the arid stretch of barren wilderness had struck us as being most peculiar. The peculiarity was all the more marked since the belt of forest sprang from ground which was on exactly the same level as the rest of the plateau, with absolutely nothing, as seen from a distance, to mark the existence of any different geological formation, or the presence of any obvious cause favouring the growth of trees. Yet a different formation there proved to be and one which explained at a glance the curious belt of vegetation; for on entering the wood we passed immediately, almost stepped in fact, from a granite formation to a nearly bare coral limestone rock, which rang and clinked under our iron-shod feet like metal. Every here and there one came across small areas and pockets of good-looking soil; but for the most part the bare rock was either jagged and rough, making an abominable surface to walk on, or was as flat and smooth as a pavement. Yet trees, bushes, and even flowering plants flourished on it to an extent out of all proportion to those found elsewhere on the island. It extends all along the eastern side of the island, but towards its southern border, it ceases abruptly within about half a mile of the sea, between which and the edge of the coral platform, the ground slopes rapidly down and is occupied by an undulating surface of much-weathered granite (Biotite), covered with a thick growth of cactus of several varieties — *Cereus*, *Echinocactus*, *Melocactus*, *Opuntias*, etc.

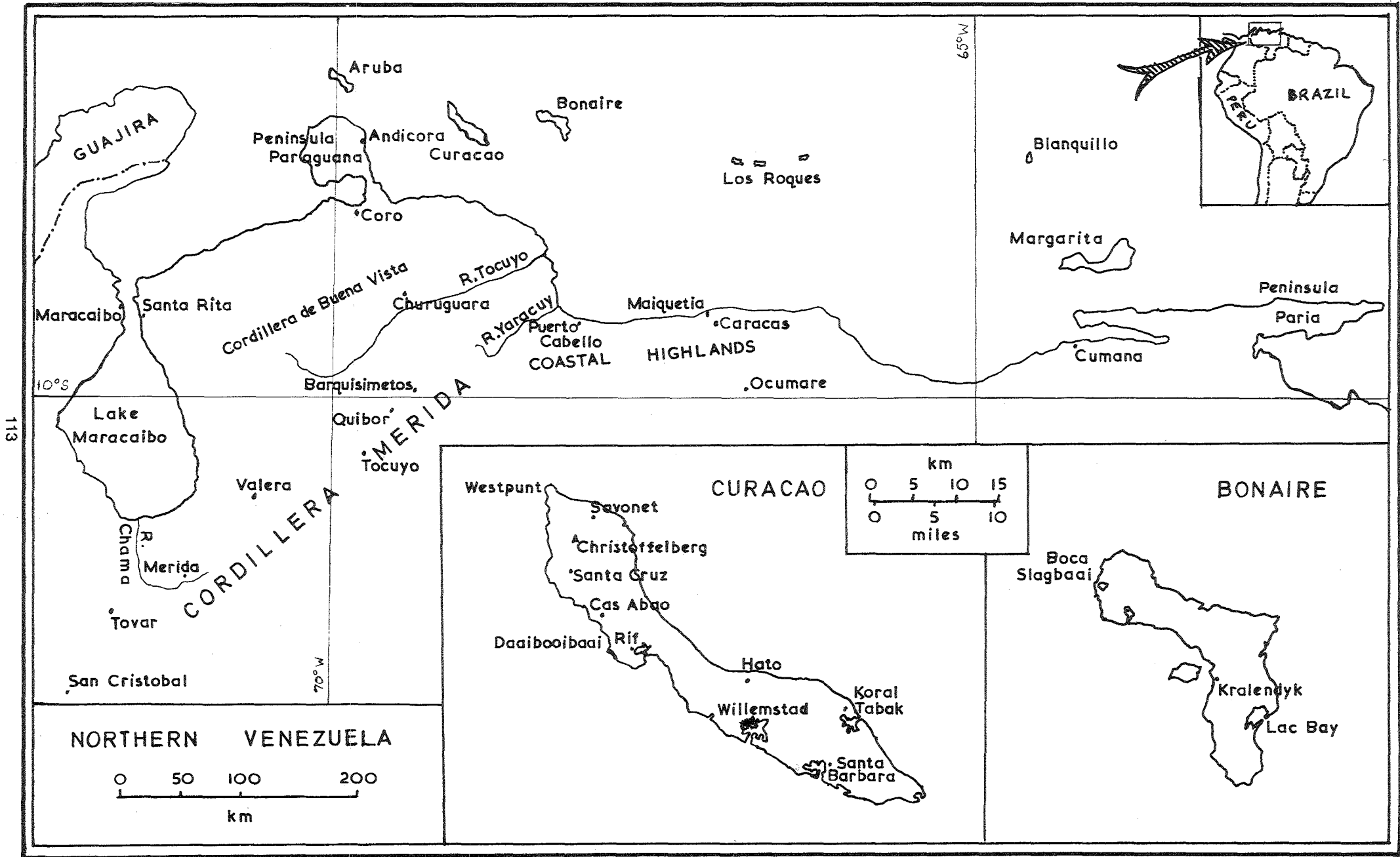
Some of the trees which we noticed growing on this platform of coral were of quite respectable growth, attaining a height of sixty feet or more; but for the most part it was covered with a thick bushy growth of *Acacias* and *Guaicum*. The very first bird we saw when we had once set foot on the shore was a humming bird, and the second was a parrot. With the exception of the small black finch, the resident land birds of Blanquillo agree in being similar to corresponding species or subspecies found in the islands of Curacao, Bonaire and Aruba, which lies 264 miles distant to leeward. They are all species which have been derived from the mainland or from the windward group of West Indian islands, but from their prolonged isolation in these outlying islands they have become modified into sub-species, climatic races or geographical forms, whichever you prefer to call them. But very often an island may be almost as interesting for what it does not contain, as for what it does; and in this connection, we were surprised to find no examples of eight genera of birds, all of which are quite common on the coast of the mainland. It was all the more surprising as there seemed to be no obvious reason, as far as vegetative and other reasons were concerned, for their absence; the flora of Blanquilla presenting remarkable similarities both to the above mentioned islands and to some parts of the coastal belt along the mainland. But if mere isolation or distance has been the cause of the absence of these birds from Blanquilla, it assuredly could not have had any influence in the case of islands like Curacao, Bonaire and Aruba, which on a clear day are in sight of the mountains on the mainland. Yet on these islands there are five of the foregoing genera of birds completely absent.

William Dampier writes about his visit in 1682 that "It is a flat, even, low uninhabited island, dry and healthy; mostly savannah of long grass and hath some trees of *Lignum Vitae* growing in spots, with shrubby bushes of other wood about them. It is plentifully stored with *Guanos* (iguanas) which are animals like lizards, but much larger". Blanquilla still swarms with iguanas. They are of a very dark colour, some being almost black. Every little copse contains at least four or five of them, which on the approach of an intruder remain absolutely motionless in the branches. These iguanas make nothing of climbing the very tall tree-like cactuses (*Cereus*) which grow among the *Acacias* and *Guaicum* trees in every little coppice. The first time we went to Blanquilla, our stay was limited to one day, but we managed to secure 53 specimens of birds, 20 to 30 lizards, several iguanas, and a field mouse.

A VISIT TO CURACAO By W. Reppenhagen

A slide show reported in the G.O.K. Bulletin for November 1977. Translated by F. Fuschillo.

Perhaps it was the desire to see cacti in habitat which led our Mr. Reppenhagen to flee from his home patch and take a short cactus trip across the large pond. He intended to finish his trip on the island of Haiti, but his plan for the



113

M.59

GUAJIRA

Aruba

Bonaire

Peninsula Paraguana

Andicora

Curacao

Los Roques

Blanquillo



Margarita

Peninsula Paria

Paria

Cumana

Maracaibo

Santa Rita

Cordillera de Buena Vista

Churuguara

R. Yaracuy

Maiquetia

Caracas

HIGHLANDS

Puerto Cabello

Ocumare

10°S

Barquisimeto

Quibor

Tocuy

Lake Maracaibo

Valera

R. Merida

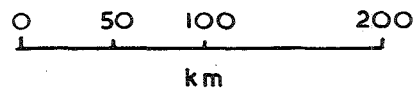
Tovar

CORDILLERA MERIDA

San Cristobal

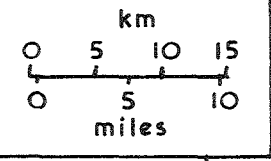
70°W

NORTHERN VENEZUELA



Westpunt

CURACAO



BONAIRE

Savonet

Christoffelberg

Santa Gruz

Cas Abao

Daaibooibaai

Rif

Hato

Willemstad

Koral Tabak

Santa Barbara

Boca Slagbaai

Kralendyk

Lac Bay

journey was changed because of the short stop at Curacao. It was a four-hour wait before flying on to Haiti. In the fields beyond the runway were seen large columns of cacti; this was a good enough reason for our cactus-fan to use the rest of his valuable time to work his way into the spiny jungle beyond the airport on Curacao island. This first informative visit to the bushes above the airfield and the first impressions of it were the main reason for Mr. Reppenhagen to return to Curacao for a few days to look at the cacti.

The original inhabitants of the island, who lived in caves, no longer exist. Today the island is Dutch with a population of 160,000, a mixture of numerous nationalities and races. It is 65 km long and 11 km across at its widest; there is nothing grown on the island, the fruit and other items of food come from Venezuela (whose coast is 60 km away) and sold in the floating market straight from the boats. The water supply for the island comes from the large seawater refinery which supplies fairly expensive water. The larger part of the population work for the largest oil refinery is South America. The temperature ranges between 20° and 30°C. The largest mountain is the Christoffelberg which is 350 m high.

Where and what are the cacti? Approximately 500 m from the coast line, on terrace-like rocky plateaux, which are mostly of coral chalk, is an undescribable spiny wilderness. *Opuntia curassaovica* with beautiful yellow flowers grows in large quantities. *Ritterocereus griseus* which seems to rule the place, reaches out of the spiny wilderness up to 4 m and higher. *Pilosocereus lanuginosus* are up to 3 m high; young plants are a very nice blue. *Subpilocereus repandus* is only to be found in Curacao; the plant has a silvery grey epidermis. It is not seen very often, perhaps because the fruit is completely spineless, stays green and grows as large as hens' eggs.

Everywhere, even in the higher areas, *Melocactus communis* is massive; these plants vary markedly in spination, the spine colour varies from brown to red and the length of spines also varies. In higher locations grow umbrella acacia, their crowns always point to one side because of the continuous winds. On the damper ground grown *Acanthocereus*; Bromeliads also appear here, and Orchids on the trees. Also very interesting are the terrestrial Bromeliads with round leaves and white flowers. Mr. Reppenhagen had hoped to find *Mammillaria* here but it could not be found, although it grows on the mainland in Venezuela.

CURACAO By A. C. Wieseman

Translated by H. Middleditch from *Succulenta* 58.8:1977.

My trip to Curacao had two objectives, firstly a visit to my brother, secondly for succulents. Since it was also my holiday I had ample time to admire and study everything. Because I was a novice at collecting cacti I did not know the names of the plants at the time I was on Curacao. By asking everywhere I managed to find out most names, although there are not so many species to be found on Curacao, it was well worth the trouble for me. The Melocacti especially and the sole species of *Mammillaria* which grows on Curacao were quite beautiful. In addition there were various species of *Cerei* as well as a few species of *Opuntia*. Fortunately my brother who resides there (himself no cactophile) knows exactly the spots where many cacti occur.

To start with we went to Santa Cruz where Melocacti are everywhere; *Melocactus macrocanthos* in particular was present in great numbers. There were so many things that absolutely amazed me such as the crowns of the Melocacti. There were small plants with cephalia which were larger than the plant body, but there were also huge plants without cephalia (these were about 30 cm in diameter) and there were also plants that had not just one crown, but no fewer than five. I found all this very strange and was able to find no explanation for it. Because I have heard much about the root system, of Melocacti, I undertook an investigation and certainly most of the tales are true. I attempted to dig out a *Melocactus* of 31 cm in breadth, but I gave up for it was an endless task. The roots were sometimes 20 m long but I did not investigate the depth.

Further on I also came across a few plants with yellow spines but I do not know if these were a separate species or just a variety. It was also very common for the plants to be growing in full sun and for these to be reddish coloured. This colouring arises from the plant developing an anthocyanin pigment. At the time that I was there (18.12.76 to 19.1.77) the Melocacti as well as a great many other plants were in flower. The flowers on Melocacti are almost not to be seen, that is to say they hardly project at all above the cephalium. The flowers of *Melocactus macrocanthos* are red and hardly open at all. Not only flowers but also fruit were present on most plants. The latter were to be seen in different colours and shapes and above all in different sizes.

The most common species is the *Opuntia* that has run wild there. Where-ever one goes, one finds *Opuntias* and they grow over everything, over rocks as well as in the lava debris areas. An *Opuntia*-like species is also encountered which is sometimes known as the genus *Consolea*. This is a spineless form of *Opuntia* which forms large pads and the species which grows on Curacao flowers red. Most *Opuntias* growing there flower yellow, although I have seen one plant which flowered red. Something like four species of *Opuntia* grow there.

The *Cereus* species which are to be found there are most impressive on account of their size. The blue coated *Cereus* was in my view the finest; I do not know its name, but its appearance is as follows: yellowish white spines, long at the top of the plant, similarly yellowish-white bristly hair, the flowers appear from a pseudocephalium and are long funneliform, reddish; often branching at the base of the plant.

I found a photograph of one other species of *Cereus* in the book by Sir Oliver Leese "Everything about Cacti and Succulents" on page 119 and he names it only as a *Cereus*. At a cactus fair in Zaandam I got to hear from someone that

the other sorts were *Pilosocereus* or *Pachycereus*-like. I also learnt there that the sole *Mammillaria* which grows in Curacao is *M. simplex*. This was described as *M. mammillaris* by Craig in his "Mammillaria Handbook" p. 106, although Haworth named it as *M. simplex* in 1812.

In addition there occur there some succulents such as Agaves, Yuccas, Euphorbias, Bromeliads and also some *Sedum*-like species of which one species grows very close to the sea. Of the Euphorbias, the following species occur there: *E. lactea*, *pulcherrima*, *splendens*, and *tirucalli*. Both *E. lactea* and *E. tirucalli* are used as hedges. The beauty of the Agaves was that they were in bloom. They could be clearly recognised around the landscape by their meters-long flower stalks. The three species which occur there are *A. americana*, *A. angustifolia* and *A. sisalana*.

Most of the cacti are to be found spread over the whole of the island with the exception of the Melocacti and *Mammillaria*. These latter occur only in specific areas such as Rif, Santa Cruz, on the hills around Daaiboobaai and on the San Pedro plain. The very finest are on the land of Dr. Maal, but that has been a closed locality for some time on account of the rubbish left there by the local inhabitants. The smuggling away of Melocacti is also a problem; it has occasioned a great deal of harm to the stands of these plants, for they have been shipped off in loads of great numbers. Not only have the small plants been taken away, which the authorities feel is not so serious, but older plants have become the victims and have been handled appallingly; they are ripped straight out of the ground — plants which normally have roots of several meters in length, and so they certainly can have very little future.

. from C. Rodgers

On the question of variation in Melocactus fruits; yes when I visited Curacao and Bonaire there was a noticeable variation in fruits between different plants, but not between fruits on the same plant. At one extreme the fruits were dark red, large, fleshy and bulbous, contrasting sharply with light pink, narrow fruits at the other extreme. It is possible that this could simply reflect fruits at different stages of ripening — I would not really know. In retrospect it is a pity that we did not record data on fruit dimensions and colour.

. from J. Forrest

I have not noticed any difference in Melocacti fruits on the same plant, but between species there are noticeable differences; some fruits are almost 2 cm long and 1 cm in diameter. Unfortunately I have no two plants of the same species with cephalia! However I recently visited Edelman's nursery in Holland and was able to see several hundred Melocacti with cephalia but I do not recall any variation between fruits on the same species. Those Melocacti were all seed raised in the Canaries and were all un-named, but resembled *M. communis* and *M. neyeri*.

. from D. Angus

Although I have only had fruit on *M. matanzanus*, I would agree that fruits are not always the same shape and colour. It probably depends upon when you look at them, for they both change shape and lose colour very quickly after they appear. They fade from a deep red to a washed out pink and also change from a symmetrical turgid shape, probably by shrinkage and loss of moisture.

. from G. J. Swales

Although the writer states that the reddish colouring of Melocacti growing in full sun arises from an anthocyanin pigment, it is in fact a betacyanin pigment.

. from J. Arnold

Size and shape of fruits on Melocactus do differ. Most of my Melocacti produce thin tubular fruits whereas some others such as *M. delesertianus* produce almost globular fruits. The slender tubular fruits seem to elongate outside the cephalium whilst still attached within it, as evidenced by the fact that some force is usually required to extract them and you can usually feel and hear them detaching. If they are left on the cephalium they become flattened but are not pushed out. However, the elongated fruit on *M. neyeri* does get pushed out so that they either lay on top of the cephalium or fall down the sides of the plant. This extrusion may be due to the extremely rapid growth of the cephalium on this plant and the consequent compression on the fruit whilst it is still firm. On the other hand the more globular fruits can be lifted out of the cephalium and they do not have to be pulled to detach them.

Difference in the size of fruits on any one plant is considerably more noticeable with the globular fruits than with the tubular sort. When the fruits first appear they are bloated and firm; they will "pop" if you squeeze them. Within a very short while however, they will become dehydrated and the walls dry out to paper thickness.

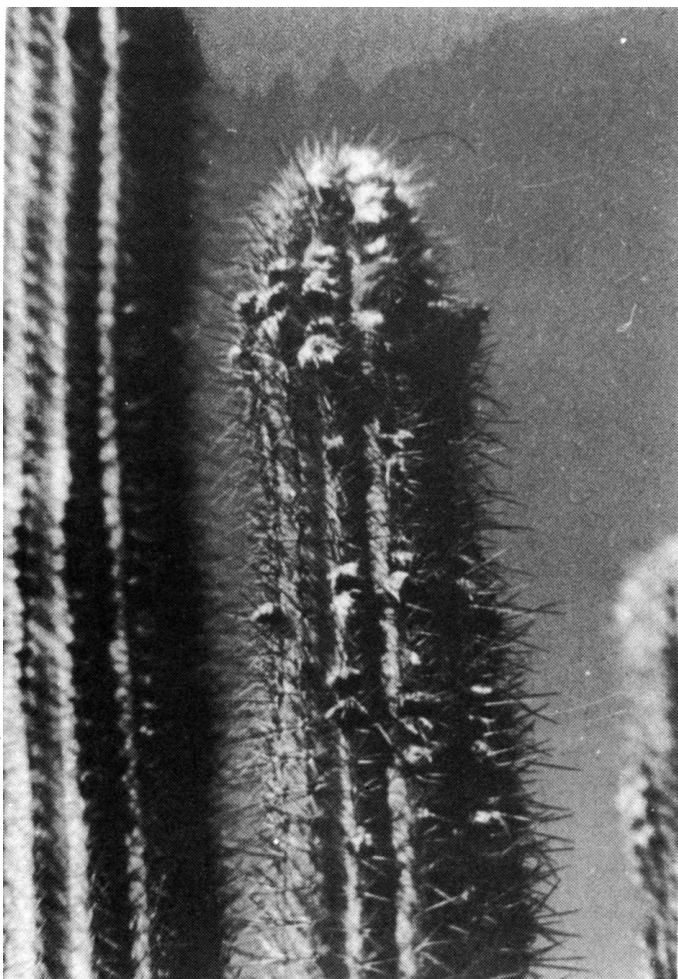
CURACAO AND BONAIRE From C. N. Rodgers

The islands of Curacao and Bonaire are favoured with only a light and variable rainfall which is inadequate to support the luxuriant tropical vegetation found on most other Caribbean islands. In the brief period whilst we were on Curacao we drove through a typical landscape of scrubby bush, the odd dry scraggy tuft of grass and bare ground between. The scrubby bush was open, easily penetrable in most parts except where *Opuntia* growth is so dense as to make walking uncomfortable. There was certainly no regular ground covering of grass and the ground consisted largely of stony surface either of igneous rocks or limestone which originated as uplifted fringing coral reefs.

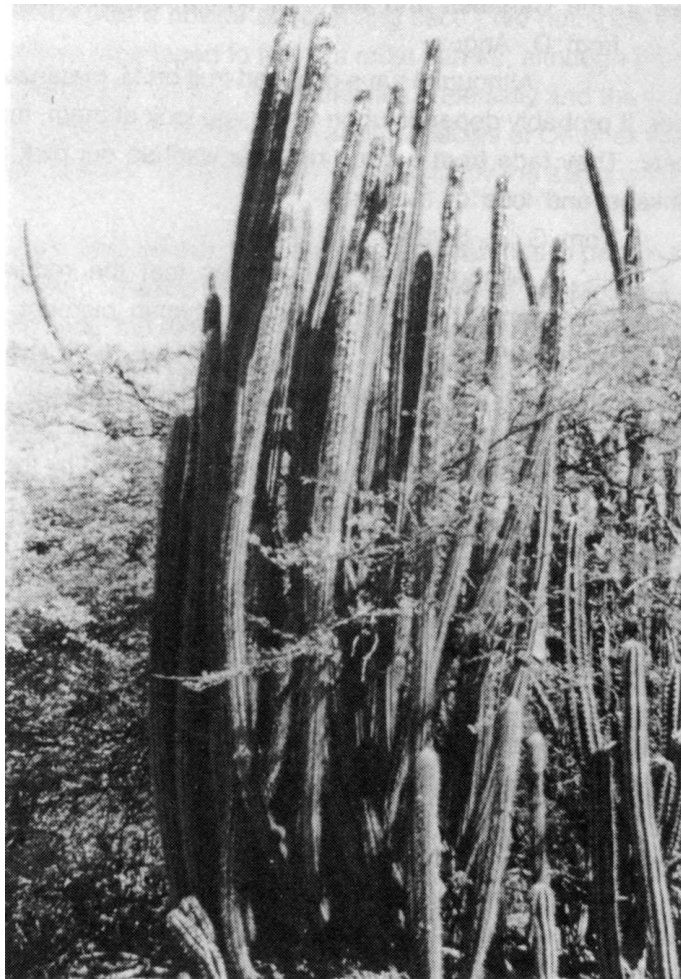
Almost the whole of the four days which we spent in Curacao was in the northern part of the island at the



Woodland on hillslopes of Christoffelberg - Curacao
Melocacti in foreground



PILOSOCEREUS LANUGINOSUS
Curacao



PILOSOCEREUS LANUGINOSUS
Bonaire

On CURACAO and BONAIRE

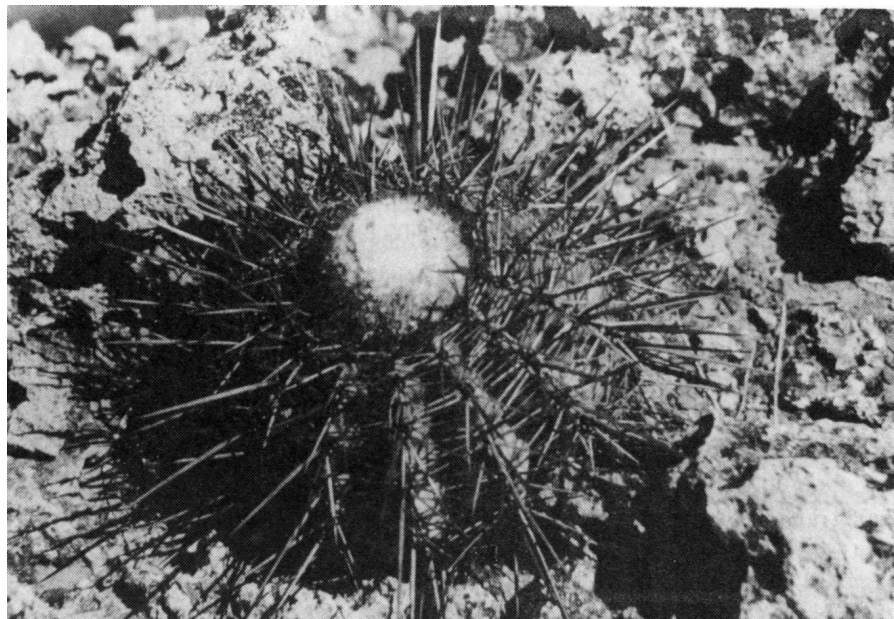
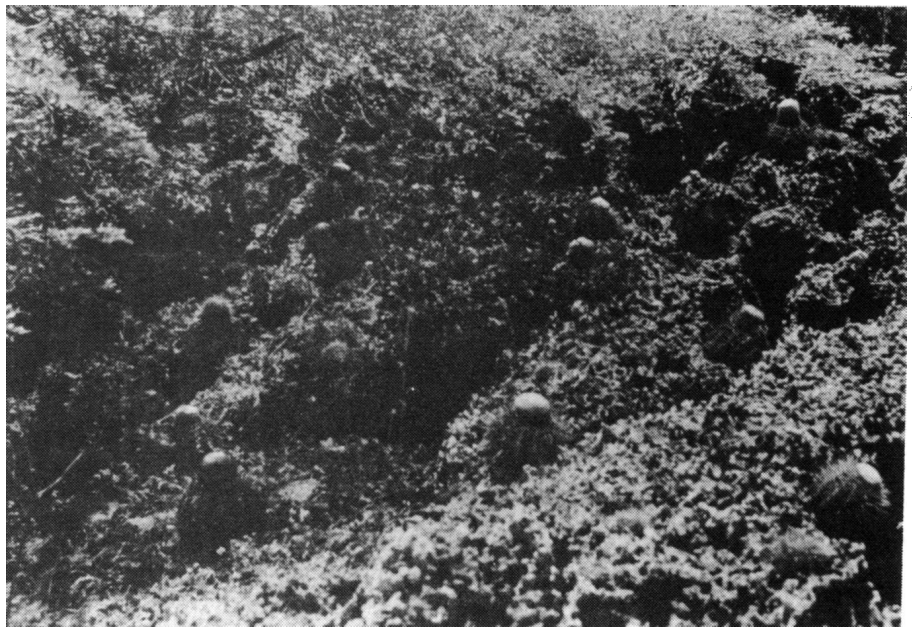
Photos - C. N. Rodgers



MELOCACTUS
MACRACANTHUS

with visiting
humming bird.

MELOCACTUS
colony on
hill slope.



MELOCACTUS
MACRACANTHUS

growing on bare
limestone rock.

On BONAIRE ISLAND

Photos - C. N. Rodgers

Christoffel National Park, which has been set aside to protect the remaining wildlife. In this semi-arid park most of the vegetation is low thorny scrub forest broken by small rocky hillocks on which Melocacti are to be found. As one ascends the sheltered western slopes of Christoffelberg mountain, however, the microclimate changes markedly, becoming much more humid, with vegetation resembling that of a tropical montane forest. Epiphytic orchids and bromeliads are common at around 800ft., at which height *Cephalocereus lanuginosus* becomes more abundant and replaces *Stenocactus griseus* and *Cereus repandus* as the dominant cactus species.

Between approximately 900 and 1100ft. altitude, we found *Acanthocereus pentagonus*, apparently the only locality where it grows on Curacao. We did find *Melocactus* growing on all parts of the mountain, even close to the summit. There were dense patches of *Opuntia* over much of the area. Yet only 6 to 8 km. from the peak of Christoffelberg was Westpunt where the almost bare ground supported some scrubby bushes and large colonies of *Melocacti*.

Most of our time, however, was spent not on Curacao, but on the neighbouring island of Bonaire, where we camped for four weeks. Of this time, 3½ weeks was spent in the north-western part of the island in the beautiful Washington-Slagbaai National Park. This is a very hilly area, scattered with inland salt lakes which are surrounded by limestone terraces. The vegetation was taller, thicker, and more lush than on Curacao, and whilst this did differ across the island it showed a more gradual transition. The same cactus species were to be found however. The *Melocacti* were particularly interesting in that, whereas on Curacao the typical growing site was in stoney red earth on the slopes of small hillocks, on Bonaire they were growing almost without exception on limestone terraces in no form of soil whatsoever, simply on the bare rock. The "earth" beneath and around the terraces is certainly very different and does provide a different habitat for plants other than *Melocacti*, such as shrubs or thorny bushes.

The southern part of Bonaire, which we visited briefly, contrasts sharply with the north, being extremely flat and quite barren. The vegetation here is sparse, consisting mainly of very low growing scrubby bushes and large colonies of *Melocacti*. The columnar cereoids were entirely absent from this part of the island.

The humming bird which can be seen visiting a *Melocactus* flower in the accompanying photograph has been identified by the Biological Institute on Curacao as *Chlorostilbon mellisugus*, known as the common emerald.

. From C. A. L. Bercht

At the time I was in Curacao in June, 1978, I was not able to observe any flowers or fruit on the *Melocacti*; perhaps that particular season was not very good but I think that it may have been due more to the failure of the rains to arrive at their usual season for the previous two or three years. There was hardly a green blade of grass to be seen outside the gardens, but I do believe that even in more normal years there are very few places where the grass grows so well that it could be used for pasturage. There are no cattle on the island, but a number of goats which are half-wild and make a nuisance of themselves by invading the little green gardens. Apart from the gardens of those Europeans who have been living on the island for some years, the only cultivation is that of the Portugese Jews who supply the food shops from their vegetable plots. There are no orchards on the island for it is too dry and all fruit has to be imported from the mainland of Venezuela.

To the south-east of Willemstad, the ground is pretty arid with sparse grasses and herbs separated by bare ground with here and there — often in less exposed locations — a bush or small tree. Where the *Melocactu* choose to grow there are no trees. Also in this part of the island there are areas with large *Cerei*, *Opuntia wentiana* and some shrubs. On the south coast near Willemstad there is a mangrove forest. From Willemstad towards the north of the island the vegetation changes, gradually becoming somewhat greener, with rather more trees and shrubs. To the north of the narrowest party of the island and there are even more trees and the surrounding of Christoffelberg are quite different from the rest of the island; especially round Christoffelberg and Savonet there are patches which could almost be described as forest. There are no *Melocacti* growing under these trees. Where the trees grow a little more openly one finds *Acanthocereus tetragonus* and also examples of *Pilosocereus lanuginosus* which grows only on this part of the island. It is possible that this area is a remnant of the vegetation which was originally more widespread on the island and that it has been radically altered by deforestation. None of the trees are thorny but most of the bushes carry thorns, so that walking through them can be painful but they do not usually grow so close together as to make this impossible.

In general there are but two types of ground in Curacao, one formed from volcanic rocks, each rock having a great many hollows and holes in it, as if it had been aerated; the other type of ground consists of brownish-red sand which also contains a lot of rocky material. The hill slopes of West Punt and Santa Barbara (Taffelberg) are of this latter type and *Melocacti* grow in abundance there, together with some sparse grass and an occasional small bush. There are larger rocks on the Westpunt slopes than in Santa Barbara. In addition to these two locations, *Melocacti* are also to be found at Koral Tabak, but not in such profusion and also apparently suffering from greater lack of moisture; *Melocacti* were also to be found at numerous other places but not in such numbers as at the three foregoing locations. Usually the *Melocacti* grow where there is little or no shade from bushes or from the columnar cacti.

The island of Bonaire seems to have retained more of its natural vegetation, for there is less inhabited or cultivated ground, and also a much greater area of forest than on Curacao. Around the shores of Lac Bay there is an extensive mangrove forest. Flamingoes are found on this island, but not on Curacao.

The Melocacti from Curacao and Bonaire are not the easiest to keep in cultivation. In winter time they have to be kept in a temperature above 15°C and perhaps even higher. The best method of cultivation is to graft on to *Trichocereus spachianus*.

. From C. N. Rodgers

The observations by C. A. L. Bercht include a reference to the volcanic rocks on Curacao of aerated appearance and indeed my own article dealing with *Melocactus macracanthos* in C.S.J.G.B. 42: 2/3/81 said that these plants were commonly found growing on volcanic rock on Bonaire. In fact, these rocks are not volcanic but are limestone terraces.

A MELOCACTUS FORMS A CEPHALIUM From J. Forrest

About 12 years ago I purchased a *Melocactus bahiensis* from Fuge of Bristol. It was a seedling plant about 1½ inches across and cost me about five shillings at the time. This plant has always been kept on a bed of sand heated by a soil warming cable so that the soil temperature is maintained at 65/70°F. This particular section of staging is enclosed on three sides and in the winter an additional glass door closed the front opening.

I had always been under the impression that the cephalium was formed on a *Melocactus* by some of the new areoles fairly close to the crown first appearing as normal areoles and then starting to put an extra growth of numerous long hairs. But last year I noticed that in the crown of this *Melocactus bahiensis*, a new areole with a different growth of long hair was appearing right in the growing point. As it moved away from the growing point it became quite obvious that it was producing the dense growth that makes up a cephalium. The next new adjacent areole then started to put out the same sort of growth and before very long there was a miniature cephalium at one side of the growing point. It is possible to see that the tubercles are arranged in spirals and it was each new areole on one particular spiral that was producing the cephalium growth. Shortly it was joined by areoles on the neighbouring spirals so that by the end of only one month it had become a very one-sided cephalium. But in a matter of a few more weeks, new areoles all round the growing point had put out a cephalium and then it began to look much more like the sort of cephalium that I would expect to see on a *Melocactus*.

This year the plant is now in possession of a cephalium which is some two inches across and it has flowered very well throughout this summer. However, it is most interesting to see that the plant body has continued to grow — it is now broader than the 5 inch square pot in which the plant is growing. This additional growth has come not from the growing point but by expansion of the whole body. The spines have also grown longer and thicker and the plant now resembles a wild collected plant. This is not the first time that I have noticed my *Melocactus* grow larger in the body even when they are carrying a cephalium. A plant of *Melocactus mazatlanensis* has almost doubled the size of its cephalium this year but I am sure that the body has also grown larger without the numbers of ribs or areoles changing in any way. Both *M. lurinensis* and *M. unguispinus* (both of which came from Jebelmann as imported plants in 1974) have put out a cephalium in cultivation, too.

. from R. Mottram

It is indeed astonishing just how rapidly a cephalium does develop once it appears. On four inch plants of both *M. seabrensis* and *M. concinnus*, the cephalium reached over two inches across within a period of 12 months after its first appearance.

. from D. Angus

Some years ago I raised a *Melocactus mazatlanensis* from a small seedling into quite a decent sized plant until it decided to pass out for no apparent reason. Since that time I have raised quite a few *Melocacti* from seed but these plants have had to put up with all the vagaries of temperature and draughts in the general body of the greenhouse so that they have tended to have a limited life. Now I have my *Melocacti* and other less hardy plants standing in a large plastic tray containing a soil warming cable covered with gravel. So far the results have been pretty satisfactory but I am thinking of adding a draught screen round the tray for winter.

During the early summer I was browsing round Whitestone nursery when I saw a nice looking plant of *Melocactus neyeri*, and decided to buy it, now I seemed to have a better chance of keeping it in cultivation. This plant seems to have settled down now and has flowered quite profusely during the course of this year. In fact it must have flowered almost every week during a period of five months — it is very seldom a week has gone by without a flower. The flowers appear very rapidly — even if there is nothing to be seen about 12.30 to 1.00 p.m., the flowers will be open by about 3 p.m. and will be withered by dusk. The withered remains of the flowers which appeared in early summer are now, in the autumn, right out at the sides of the cephalium so that the outer edge of the cephalium must be compressed a terrific amount. The fruit only appears from around the outside of the cephalium. One thing puzzles me — if I pull a fruit out of the cephalium then it is usually about twice as long as the height of the cephalium, so how does it get to be as long as that? Incidentally, both the flowers and the fruit appear in spirals like a catherine wheel, rather like J. Forrest describes the appearance of a cephalium.

. from A. W. Craig

Flowers on the *Melocacti* seem to be self fertile as they produce fruit without any help at all from me and the fruits always seem to be full of seed. The germination is also very good from the seed — there are no bare patches in my trays of *Melocactus* seedlings so it looks as though the germination rate is virtually 100%. The cephalium pushes out dozens of fruits — on a good warm day as many as 30 or 40 fruit pods can appear. Since there is no sign of the fruit (apart from the

withered flower remains) before it is pushed out of the cephalium, how can so many fruits of that size be hidden within the cephalium? There seems to be a lot of fresh air inside the fruit although this is not very obvious when handling a detached fruit as it seems to get flattened in the process. Is it the cephalium which is so dense that it squeezes the fruit out when the small berry tries to expand, or does the fruit simply elongate sufficiently to project out beyond the cephalium?

. from P. Bint

The only seedling *Melocactus* which I have brought to maturity at this time is a *M. bahiensis* which I purchased many years ago now for the princely sum of half-a-crown. Whereas I have always had it in a greenhouse maintained at no less than 50°F. it has never been on a heated bed. Three years ago it displayed all the well-known signs that it was going to produce a cephalium, firstly the increase in number ribs and then at the season's end a thickening of "spination" in the crown. I must admit that it did not show itself noticeably one-sided at any time. The following season saw a rapid increase in size of bristly growth. Normal continuation was stunted at this point by the plant losing its roots. It has flowered but to date has not produced any seed pods. The same experience (apart from loss of roots) has been noted with a field grown *M. griseoloviridis* — ex-Canary Isles — but obtained before it started to form a cephalium. I never thought about expansion of the plant body after cephalium formation but on reflection common sense says this must be the case otherwise how could the cephalium increase in diameter? It starts as something a centimetre or so across and can finish up three or four inches across. It is well known that cephalia are modified areoles — hence the ability to produce flowers; examination of a cephalium from a *Melocactus* that died showed that it was pill box shaped with normal nutrient channels reaching each areole in the same way ordinary areoles are supplied.

My experience in regard to flowers and fruits are simple; many flowers are produced, they are self-fertile but many flowers do not become fertilised and therefore produce no fruits. I have the above mentioned defunct cephalium by my side at the moment, somewhat wizened after so long off the plant, but still able to provide information, although unfortunately I cannot remember the name of the plant. There must be over 100 flower remains left in it that never produced fruit. The bristle length on this cephalium averages 20 mm which in many cases is plenty long enough to hide a developing fruit. Whilst a cephalium is growing on a healthy plant I do not think that we can tell how deep it is from external appearances. What is there to prevent the internal structure from being concave to give a much greater depth? Also it could easily be possible that the final growth of the pod could be extremely rapid — perhaps accounting for the apparent "fresh air" within it, as mentioned by A. Craig. Certainly at this stage the pods are not crammed with seed.

Those fruits that do appear come at a remarkably rapid pace. In my experience many fruit pods are produced towards the centre of the cephalium; one example is a second *M. bahiensis* which at present has many pods at least half way between the edge and the centre of the cephalium, which is at least two inches across. This is also the case on my *M. guitartii*. I have had experience of pulling out long fruits; on *M. guitartii* they can be over 5 cm in length, but I cannot really say how deep the cephalium is.

. from H. Middleditch

That seems to me to be quite an odd thing to say, that one of the first signs of cephalium production is an increase in the number of ribs. Perhaps an occasional new rib might fortuitously appear near the start of the cephalium just like other cacti can start growing a new rib or two, part-way up the body. Surely this is not really a characteristic of cephalium formation on a *Melocactus*?

. further from D. Angus

But if you like to look at my *M. neyeri*, you can see that there are new ribs in six places round the edge of the cephalium, very short in length and quite close to an existing rib, not half way between two old ribs. Also if you look round the periphery of the cephalium you can see spine clusters growing in between ribs — and these really are spines, not just robust bristles, spines about half the height and half the thickness of the cephalium, or you could say that the outside of these extra areoles are right on the outside part of the cephalium. And there is not just one of these extra areoles between each rib, but two or three.

. from J. Forrest

Now the question has been raised I have been looking at my *Melocacti* and I confirm that extra ribs are produced just before the cephalium is formed. On *Melocactus glaucescens* a new rib has been formed between every pair of existing ribs; these new ribs are clearly visible just outside the base of the cephalium and fill the gap between the previous ribs. I have also noticed how fast the flowers appear out of the cephalium of a *Melocactus*. There can be no sign of flowers at six in the morning but then there can be four or five flowers open by nine.

. from K. Preston (1983 Chileans' Week-end)

In the Rimac valley flowers were visible on *Melocactus* before noon and in the Santa valley they were certainly open in the afternoon.

. from C. Rodgers (1983 Chileans' Week-end)

On Bonaire Island the flowers on *Melocactus* opened round about four o'clock in the afternoon during our stay there.

. from J. Arnold

A number of my small and medium sized Melocacti have formed a cephalium in cultivation, most of them that I have grown from seed myself; the fastest was *Melocactus neyeri*, which went from seed to cephalium in five years. After a number of plants accomplished this feat I began to know what to look for. It seemed to me an invariable rule that once the plants reached a certain size they would slow down in growth for a period of time and do not send out new areoles and spines. Just before this occurs they form extra ribs at the apex, sometimes as many as three but usually one or two. I have always assumed that this enabled the plant to spread at the top without the body growing.

The cephalium appears to begin with a tuft of spines but I have never been able to detect the spiral form of growth noted by J. Forrest, because once the longer spines or bristles are formed in the top, these grow outwards leaving the cephalium proper inside them. In my collection the cephalium will most often begin to form in July to August and within a month or so may be an inch across. The cephalium must grow at a fantastic rate because it compresses the outer layers very firmly. There are growth rings on a cephalium showing the number of years they have grown — this can be seen very clearly on my *Melocactus matanzanus*.

In my experience the flowers last rather longer than observed above. Certainly flowers can still be open at 7.00-8.00 p.m. on warm evenings. The flowers do appear in symmetrical rings; you do not get one appearing in the middle and another at the edge of the cephalium, for example. Not all my Melocacti flowers are self-fertile — certainly not *M. azureus* or *M. levitistatus*. It does seem to me that as a plant matures the spines become bleached and thicken up. After some years of carrying a cephalium, a seed raised plant does certainly begin to resemble a collected specimen. There are probably few seed raised plants which have had a cephalium for 20 years or more and so a true comparison is obviously difficult.

ON THE HUNT FOR CACTI IN PERU From R. K. Hughes

Ever since reading the Penguin Classics from Herodotus onwards, I have always had a desire to travel and also had an interest in ancient history. In 1963 I first went abroad to Marathon in Greece, travelling by the Orient Express to Athens. I went back to Athens in 1964, then in 1965 I did a week in Athens plus a week in Beirut; in 1966 I had two weeks in Beirut then a trip to Idaho, U.S.A. in 1967. In 1968 I left my job to do the London/Calcutta overland trip by bus, then went on to Australia via Bangkok and Singapore. At that time, the tour organisers were introducing a Lima to Rio trip as well. Of course having just done my trip of a lifetime, this new trip could only be a future dream. After 14 months in Sydney I returned home in 1970 and managed a trip to Morocco in 1971. In 1974 I did a trip to Scandinavia, getting 350 miles north of the Arctic circle. In 1975 it was to Kenya just over the equator; in 1976 to Egypt, sailing for six days down the Nile in an open boat. My 1977 trip was intended to be to southern India, but before this was finalised a new trip came on offer — three weeks in Peru and Bolivia. Reckoning that I would never get the cash for the Lima-to-Rio trip I decided to take the short tour.

On this first trip to the basic southern tourist circuit was followed, with stops in Lima, Ayacucho, Cuzco (with trips to Pisac and Ollantaytambo), Puno on Lake Titicaca, La Paz with a trip to Sorata, then a quick flight back to Lima where a visit was paid to Pachacamac at the mouth of the Lurin valley, before the return flight to the U.K. This was in May and almost all the flowering was over on the cacti but I was able to collect quite a few fruits. Except for the *Neoraimondia*, all the seeds gave very good germination when they were sown back in my greenhouse. Travelling with an organised group over such great distances in a limited time meant that any chances to photograph and examine cacti had to be snatched when the opportunity arose.

Having had the experience of one trip to Peru, I was tempted to think about making another visit on my own. What probably tipped the balance was to find that I could fly there for a surprisingly reasonable price by travelling via Miami and Aero-Peru, so I decided to make another visit two years later, this time in November. On this occasion I took twelve rolls of 36 exposure film, two more than I had taken on my first trip when it had to be rationed out between cacti, Inca ruins, landscape views, etc.

When I arrived in Peru I was delayed unexpectedly for two days in Lima because my luggage had been left behind in Miami. Even with the cost of the expensive Lima hotels which I had to meet whilst waiting for my luggage to arrive, the basic cost of travel, food and accommodation from London back to London was £634 for a four week visit. Whilst held up in Lima, I took a bus to Santa Eulalia (via Chosica) to see the local cacti. When I claimed my baggage I was able to travel on to Tarma via La Oroya. Then I took a bus to Huancayo, which is about half way to Ayacucho. There were two days to wait here over the week-end before I could get the next bus onward. On the Sunday morning I was sitting in the main square when I had my bag stolen. In a moment I had lost all my camera equipment, eleven rolls of film, air tickets, etc. I was able to buy a Kodak 126 camera to use for the remainder of the trip and I decided that rolls of 20 shots of black and white film was more economical than 12-shot rolls of coloured film.

After reaching Ayacucho, I then went back to the site which I had visited previously, the Wari tombs, and also made a short trip along the road towards Huanta. From Ayacucho I went on to visit Pisac and Ollantaytambo again, also Puno on the shores of Lake Titicaca. From Puno I crossed the western chain of the Andes to Arequipa. From Arequipa the express bus took me rapidly back to Lima which enabled me to have a quick visit to Chosica before my return flight. During this trip I found the tourist offices in each town to be very helpful, but they are closed on Saturday and Sunday. English is usually

spoken there, which is a rarity in Peru. I did find that my inability to converse in Spanish was a great hindrance to survival. Another problem was getting on the buses, for these are usually booked for two or three days ahead. The only other way of travelling is by lorry which means waiting at the correct place on the correct day, usually from 6.00 a.m., but it was extremely difficult to find out which was either the correct day or the correct place.

On this trip I was able to take my own time in looking for cacti. When there were no fruits to be seen, so that seed was not available, I looked for small offsets or for segments of cacti lying rootless on the ground. Back at home, most of the offsets were planted up as they put out roots. In the darkest and coldest part of the year I had to keep them in the living room for warmth but this meant that they got less light: I lost a few and the rest became rather drawn. But this look gradually disappeared after they went into the greenhouse. Because spring was late, the seed sowing was delayed; some of them came up well whilst for others there was a fair wait to see some germination. It is possible that seed collected from plants in flower may have needed extra time to ripen. The most successful germination was from old dried seed pods such as *Espostoa melanostele* from near Chosica and the *Trichocereus* collected near Ayacucho. Some of the seed was examined and photographed under the electron microscope.

Despite (or because of) all the troubles I had encountered, I hankered after a possible return trip in order to get the pictures I had lost. At the end of 1981 there were still some good offers (from British Caledonian this time) so I went back to Peru for the third time. On this occasion I went straight from Lima to Huancayo, then in turn to Ayacucho, Cuzco — with a third visit to Pisac, then on to Puno and Ilave. From Puno I was able to share a colectivo going across to Arequipa and then take a bus to Ilo on the coast to visit David Whiteley's correspondents. From Moquegua I made a bus trip through to Torata, where I arrived at 11.00 a.m. and had to leave again at 4.30 p.m. Back at Lima there was just time for a fleeting visit to Chosica before my departure flight back home. Once again there was the struggle to bring offsets and cuttings through the winter and the seed to get ready for sowing.

When travelling from Lima up the Rimac valley past Matucana and onwards towards La Oroya, the railway crosses the first ridge of the Andean chain at Ticlio. A snow storm raged as we made the crossing and when it cleared there were great clumps of hairy *Tephrocactus* to be seen along this route to Oroya, and again between Oroya and Tarma. Similar mounds were found near Huancayo and again two hours out from Huancayo on the road to Pampas; also about 15 miles northwest of Huanta, before the road left the mountains above Mayoc, as well as near Cuzco and also near the road which we followed from Achacachi towards Sorata.

The first plants that I was able to examine were near Huancayo, which lies at 3,272 m altitude (10,500 ft.) The rich farmland around the town was given over to cultivation which extends to the mountains and up the slopes wherever it was not too rocky or too steep. First I took a bus to the top of the hill on the edge of the town. Then it was a tough climb first across farm fields to a forest of young *Eucalyptus* trees. On up through the trees with no shade from a hot sun. Above the tree-line I stopped to rest and view the next section, a region of bare rock or baked clay cut only by a green line along a small irrigation stream. Above this section I found the area of ichu grass that spread as far as the eye could see to the top of the mountain. The slope was steep, making upward progress possible by zig-zag route only. I started climbing at 9 a.m. and reached the maximum height on Cerro San Cristobal at 2 p.m. The only difficulty was the endless ascent which I estimated was close on 1,000 m (about 3,000 ft.) from the valley to the slopes I reached below the peaks.

This valley is the most fertile in Peru so that I had not expected to find peasants poor enough to be at this height, but I climbed up behind a rocky knoll between two cultivated slopes where some cows were grazing on the sparse grass. Here and there grew some very low scattered shrubs and also clumps of a *Tephrocactus* which I took to be *T. floccusus*. The first plant I came across is shown in the illustration here. Altogether I looked at 11 large groups or clumps and 18 small groups. Some of these were easily seen, others were more or less hidden among the clumps of grass and dwarf shrubs. Mostly the clumps were between one and two feet in diameter; the largest one I saw there was three feet across. There were many dead areas within the clumps and also between the clumps. The hair was white and the spines yellow. Dark green leaves were seen coming into growth on some plants whilst dead flowers and unripe seed pods were found on others. One plant hidden in the grass was close to a small stream which was marked by a line of green herbaceous vegetation growing well.

Having had a look at all the clumps, the hairiest and largest head that I found was 2½ inches in diameter, standing 5 inches above the soil. Others had more sparse hair, perhaps only half as much, an average head of this sort being 1¼ inches in diameter, again some 5 inches above the corky base. Other sparsely hairy stems were 2½ inches above the soil, in a tight clump. Some clumps with more hairy heads were similar to this last one in size and compactness and between 2 inches and 4 inches high from the soil or corky base.

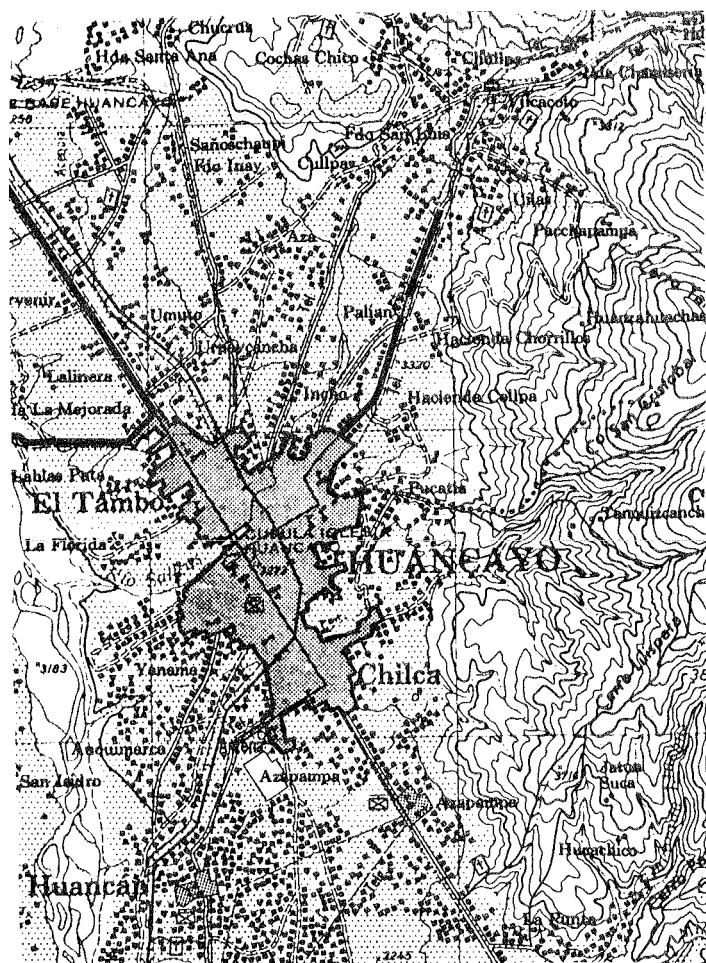
It had been a fine sunny day so far at this site but as I climbed further up the slope, some darker clouds rolled over and for a while I was pelted by a hail shower. Just after it cleared up I came across another patch of *Opuntia* similar to those just described, but the site was more extensive and there was no cultivated slopes nearby. In among the damp tussocks of ichu grass I found 35 clumps or groups of *Tephrocacti*, ranging from one foot in diameter up to one large clump which was three feet across. These were mainly white haired stems with yellow spines. But two groups each some two feet across had definite yellow hair and yellow spines. Other clumps there had hair not pure white in colour but at various stages between



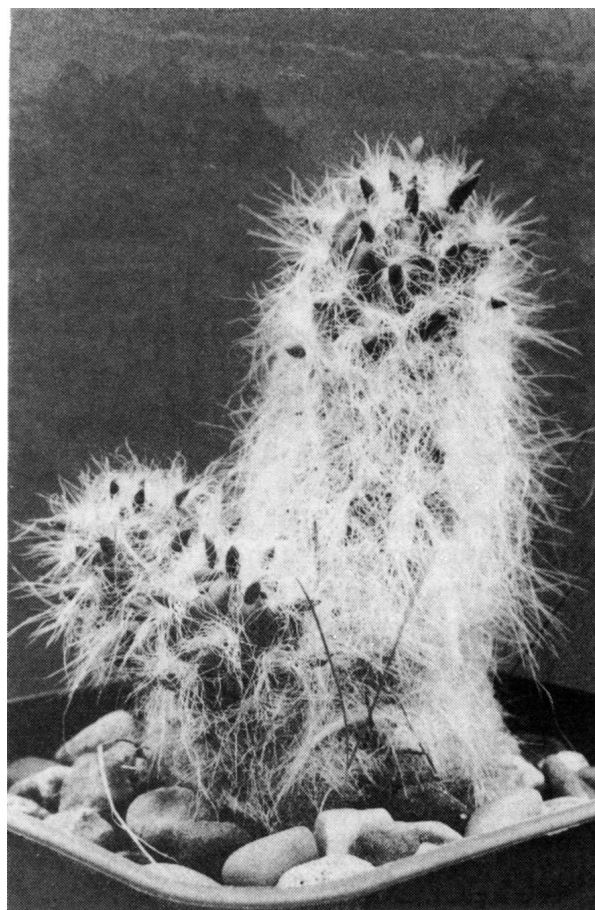
**TEPHROCACTUS
FLOCCOSUS**

Photos - R K Hughes

RKH 67 Huancayo - Co. San Cristobal 1981



Habitat location



Offset from RKH 67 - in
cultivation, November 1982

white and yellow. One large white haired group with a few small clumps close by, was obviously the remains of a larger group whose centre had died. There were also a great many plants with only a few heads, scattered among the colony.

Yellow flowers, which were hardly open at all, were found among the large colony, as well as on groups as small as nine inches across. In addition to the dead flowers and unripe seed pods, ripe seed pods of the previous year were found, but just a few that were tight between stems of plants and had not been robbed of their seeds, presumably by insects. These fruits varied in size from small, to the largest of 1¾ inches in diameter. Among the yellow haired groups, stems were two inches to three inches in diameter (excluding wool and spines) and eight to nine inches tall. In the white haired clumps stems were of similar size and some five to six inches in height. When I was searching this site the cloud cleared for a few minutes to let the sun shine through, but more storm clouds were coming along, so I set off back down the mountain slope as it started to rain here. In town, normal spring weather (I am told) is for the sunny day to turn to cloud from the mountains by 4.00 p.m. and then about 6.30 p.m. it sheets down with rain for one or two hours. (This was seen to be pretty accurate on my second visit to Peru but less so the following year.) When leaving the base of this mountain I reached the outskirts of the town to find the dirt road covered in a couple of inches of sludge due to a cloudburst.

Later on during the same trip I paid a visit to the site of the old Inca fortress at Sacsahuaman, overlooking the town of Cuzco. Walking up the hillside after passing this fortress, I came across a rocky hillock among cultivated fields, carrying short tussock grass up to a height of three feet or so and lodged between the rocks. Unexpectedly I found a colony of numerous *Tephrocactus floccosus/lagopus?* type here; the first plants which I noticed were small clumps in the low grass. These must surely have been only a portion of the many small clumps and single headed plants revealed by looking round the site. Searching the area revealed a number of clumps from eight inches in diameter up to 20 inches in diameter, all of rather lax growth, some half-covered by the grass, herbs and bushes, all of which were obviously growing in competition with each other. The spines were yellow but the hair colour varied from white to yellow. One of the larger stems had a diameter varying from 1½ inches to 2¼ inches (excluding wool and spines) and grew six inches above the soil. There were many groups with smaller heads and the quantity of hair on the stems varied from a lot, to very sparse, almost bald. Climbing higher still I found little natural vegetation on the top of the hill where Eucalyptus trees had been planted. Here was found one yellow haired clump and then some single headed plants, before I came upon a large clump of compact heads some 28 inches across.

On reading in *The Chileans* about Wagenknecht's *Arequipa hempeliana* having white silky down, brings to my mind *Tephrocactus rauhii*, the *T. floccosus* type described as being like a small *Oreocereus*. It is recorded in Backeberg's *Lexikon* both near Huancayo and also around Ausangate, south of Cuzco. I seem to have read somewhere that *T. floccosus* has yellow flowers and white hair whilst *T. lagopus* has red flowers and yellow hair. Having seen *T. floccosus* at Huancayo with hair varying from plant to plant from white to yellow, thick to sparse, joints from three inches to nine inches tall and with yellow flowers, it does make one wonder what the difference really is between the two species. The stem length of nine inches is that quoted for *T. rauhii* but those which I saw at nine inches tall did not have the larger stem thickness of *T. rauhii*. Perhaps the belts of similarity in vegetation and habitat conditions which run from north to south in the Patagonian Andes are also similarly disposed in Peru, so that a species has an elongated belt of distribution here, too. Perhaps the high altitude mountain weather in Peru, changing from sunshine to rain, hail, or snow and then back again to sunshine with little warning may be constant in its unpredictable nature. In contrast to this, is it the depths of the valleys that separates and isolates each patch of ground from the next, resulting in different species on each patch? And is it the tremendous length of the distribution area that produces such variation of each species over these distances?

... . . from A. W. Hill

Some years ago a speaker came to our local branch and brought with him a cutting of *Tephrocactus floccosus*, which I acquired. It had originated as a cutting from Sargent about 1969/70 and was reported to have come there from Rauh, presumably acquired on one of his Peruvian trips. It is still possible to see the very small original piece at the base of the present plant; the original piece is completely obscured by its coat of hair, but the three newer stems do carry a pretty good amount of hair, although certainly not as dense as the original. Two years ago I cut off one of the new stems to set it down on its own roots. This was placed on the top shelf, as near as possible to the glass, so it was rather a disappointment when it put on over an inch of virtually hairless green stem during the summer of 1982. But to my surprise it had acquired a fairly respectable amount of hair by the end of the winter. This hair must have appeared very gradually over the winter as it was certainly not noticeable until towards the end of that season. More new green growth is appearing in the latter part of 1983 summer.

In addition to *Tephrocactus floccosus* I also have a small plant of *T. crispicrinatus*, on a graft. It is interesting to see that the rather crinkly looking hair continues to appear on the new growth.

... . . from R. Mottram

A clump of hairy *Tephrocactus* came to me as *T. rauhii*, with stems up to barely three inches tall, about finger thick, in a clump about six inches across. This plant stands out of doors during the summer, on a convenient roof, being brought inside the greenhouse in October and put outside again in Spring. It has put out quite a number of new offsets from within the clump and at the edge and whilst one can see the green of the fresh epidermis I am pleased to say that this new growth also seems to be carrying a coat of long hairy wool which is nearly as good as that grown in the wild.

. from R. K. Hughes

My own *Tephrocactus* cuttings are also kept out of doors during the summer. They are put outside in about February or March when the worst of the wet and cold weather seemed to be over. After the snow, hail and rain storms which these plants receive in habitat I suspect that the Andean winds may have a drying effect. At Huancayo these plants were at the lower boundary of the ichu grass; on gently sloping ground. From the Ticlio to Oroya railway, small clumps could be seen among the green grass on pretty level ground. About two hours out from Huancayo there were clumps to be seen on slopes almost 45 degrees steep in places, where associated vegetation was some grass and low-growing herbs. Above Mayoc, the plants seemed to be in rather longer grass. It suggests to me that the plants from these high altitude grasslands may not like the hot and dry conditions in my greenhouse.

A VISIT TO CHILE By R.M. Ferryman

During the latter part of 1982, I had the opportunity to visit Chile and see for myself the cacti growing in their natural environment, those same plants that I had grown and studied for many years. Having declared an intention to go, the next problem was, where? Geographically Chile is unique, very narrow but over 4200 km long. The cacti occur over about half this length, from south of Santiago to the northern border with Peru. Many of the plants are coastal or follow the numerous valleys that run from the Andes down to the sea. Despite the narrow band of country that these plants grow in, it would not be possible to tackle more than a small area within my time scale.

Of the options open to me I decided to join Fred Katterman on a trip to the Tarapaca region. Fred had been to Chile five times previously but never before further north than Antofagasta. Neither of us knew too much of the region as it is only met within the cactus literature very occasionally. There appeared to be around a dozen species there according to Ritter and most of these he considered rare. The terrain we knew would be harsh; we could expect few places where we could replenish food, water, or petrol. We would therefore have to carry plenty of reserves; this, we decided, meant taking two vehicles, a decision which was later to be our salvation.

I left England with as light a pack as I could, bearing in mind I would be in the field some eight weeks. Travelling light has problems; my camping equipment weighed 10 kilos, camera equipment 5 kilos and that left very little for clothing! Clothes were a problem; they had to be suitable for the extremes we were to encounter in temperature and be strong enough to withstand the rigours of this type of travelling without requiring too much attention like washing!

I arrived a week ahead of the Kattermans in an attempt to become accustomed to the climate and people of Chile. I also hoped to do some field work close to Santiago. The flight had been long but comfortable; the highlight coming as we crossed the magnificent Andes still capped in snow. I was soon to learn that it had been a particularly wet winter in this region, one of the wettest on record. That evening, I had dinner with Adriana Hoffman, a botanist who was now involved in producing a field guide of the Chilean Flora. The task in hand was to produce a field guide on Chilean Cactaceae and with this in mind she had decided to join us on our trip north. She had arranged a couple of field trips for me and got under way the required permits to enable me to collect and export certain specimens. During both the early and latter part of my stay in Chile much of my time was taken up in pursuing this very essential documentation and carrying out our import requirements, sanitary inspection, etc.

My first field trip was to an area around Valparaiso. Adriana had arranged to meet some friends and we would journey to Quintay on the coast, studying the Flora en route. As we left Santiago the cacti were soon evident; the low hills were covered with *Trichocereus chilensis* — they had even re-introduced themselves amongst the fruit trees on the fertile plateau. Having met up with Adriana's friends we left the main Pan American Highway along a narrow dirt road leading to Quintay. The early vegetation consisted of introduced pines, occasionally giving way to the true nature of the area by the appearance of *Puya chilensis* amongst the pines. After several stops to photograph the numerous wild flowers, more evident than usual because of the high winter rainfall, we stopped at a sight known to Otto Zolner as the habitat of a rare orchid species. Otto, like Adriana, had an interest in all forms of plant life which made for a particularly refreshing trip. The other member of our small party was Mario Pino, an entomologist who seemed happy anywhere as long as there was something he could bash with his stick and collect the falling insects in his enormous net! Mario had a good knowledge of cacti as he had spent some time in the field with Lembcke.

The area we were in reminded me of England, very green, rolling hills with cattle grazing against a backdrop of the pine forest. Imagine my surprise, therefore, when, whilst searching for the elusive orchid I came across *Pyrrhocactus horridus* (RMF 1) — a small colony of about six plants growing on a slightly raised area amongst various shrubs and the invariable *Puya chilensis*. The population was too sparse to stand collecting, but I did find a couple of small seedlings that had become dislodged due to soil erosion.

From there we made our way towards Quintay but we were brought to an abrupt halt a few kilometres from the coast. The now very narrow road had been made impassable as a result of the winter rains washing great channels in it. The walk to the sea would not be far and it took us over almost typical English moors, fairly flat with occasional shrubs. As we descended from the cliff tops, *Neoporteria subgibbosa* (RMF 2) came into view. It never grew over the cliff line but was abundant on the slopes and the craggy rocks that rose out of the sandy beach. Most examples were in flower to the delight of

a visiting hummingbird which never stayed in one place long enough to be photographed. The vegetation of this area would seem to support hummingbirds but this was not always the case at other Neopterteria sites I visited later. From here we travelled further north along the coast where we found *Trichocereus litoralis*. the *Neopterteria subgibbosa* was again here among rocks and the brickwork of an old whaling station. Our return journey took us via Casablanca where we had hoped to find *Pyrrhocactus* on the surrounding hills. Once more the area was untypically lush and our searches were in vain.

During the next few days I made visits to the hills and mountains around Santiago, spending a fair amount of time along the Rio Mapocho valley and the Rio Colorado valley. I collected plants in the Mapocho valley (RMF 3) that I believed to be the original *Echinocactus curvispinus* Bertero. There remains some doubt, however, as others believe this plant to be Ritter's *Pyrrhocactus andicolus*. I found this plant throughout both valleys up to 1800 metres and later near the end of my stay I also found it at El Volcan (RMF 80) at an altitude of 1800 metres. At this last site I also found *Erdisia spiniflora* (RMF 81) growing some 200 m higher on the summit of a hill. The vegetation between the last *Pyrrhocactus* and the *Erdisia* consisted of low shrubs and fairly abundant bulbs like *Phicella ignea* (Amaryllidaceae) but no further cactus. Upon reaching the flat crown of the mountain I found the *Erdisia* growing under low shrubs. It was only visible by the new reddish growth but it was not until I was on top of it that it gave itself away. Much of the old growth had been frost damaged and a quick scan round showed that this area must receive snow during the winter. The terrain throughout this area and that of the Colorado valley appeared much drier than the Mapocho valley where I experienced mist that not only restricted ones view but was dense enough to soak me to the skin. The very abundant *Trichocereus chilensis* had water dripping from its spines. *Trichocereus chilensis* is common throughout both valleys where it is often covered by *Phrygilanthus aphyllus*, a quite attractive parasite.

The time had now approached for the main trip to commence; Adriana had had the Land Rover serviced, new tyres fitted and a trailer purchased to enable us to carry more supplies. We made our way to Valparaiso where we were to meet Fred Katterman, passing yet more *Trichocereus chilensis* en route. Unfortunately Chilean servicing appears to be little better than ours and we started to experience fuel problems on our way. A day's delay resulted whilst the Land Rover received a further check up. We spent a day visiting the collection of a Mr. Soni who had, besides a marvellous cactus collection, outdoor gardens representing many parts of the world including a huge patch of English roses. The following day we left Valparaiso for the north, stopping en route to visit Rudolph Wagenknecht at his home in La Serena. His collecting days are long over and his cactus collection has gone but he still retains his great knowledge and many photographs. We made camp that night a few kilometres north of La Serena among the clumps of *Copiapoa coquimbana*. I was soon to learn of the frailty of tent pegs supplied with lightweight camping equipment.

As dawn broke I made my way into the hills where the night before Adriana had found *Neopterteria wagenknechtii*. I found several small specimens (RMF 6) on a hill facing north in sight of the ocean, the altitude being no more than 100 m. We made a further stop some 20 km onward at the Cuesta Buenos Aires and here I found *Pyrrhocactus chorosensis* (RMF 7). Its very large tap root made it difficult to extract the plants from the crevices they were growing in without causing the head to break from the narrow neck. I settled in fact for removing two plants intact and simply removing the heads from another couple. This improvisation was necessary on account of the very close attention that a swarm of hover flies were paying me! The heads I removed should root down without much problem; it is standard practice to do this, and hopefully there will be sufficient neck left on the remaining roots to offset. We were soon to come across *Austrocylindropuntia miquelii* and *Eulychnia breviflora* both in flower, so too was *Cumulopuntia berteri* at El Dolpho and *Copiapoa coquimbana* at Los Choros. However, the area was becoming much drier with the barren red hills the dominant feature of the landscape. Little else grew between here and Copiapo apart from the cactus. I collected *Copiapoa coquimbana* (RMF 8) fourteen km south of Vallenar and also photographed *Austrocylindropuntia miquelii* in flower.

Upon passing Copiapo the road once more headed towards the coast; we had last seen the Pacific Ocean some 300 km back at La Serena. After a slight delay at the efficient S.A.G. Control at Caldera we made our way up the coast to look for a campsite. From the road we spotted a large area of Copiapoas and despite the lateness of the afternoon, we decided to stop and take a look. *Copiapoa calderana* (RMF 9) was the dominant species here along with examples of *Copiapoa marginata* (RMF 10). Almost the entire population of both species had been badly damaged, particularly the older clumps. The cause of this damage was not obvious, there was no sign of rock falls as most of the plants were on the flat coastal belt and a fair way from the cliffs, and no sign that the damage was inflicted by animals. Before our eyes lay hundreds of mutilated plants many of which were well over a hundred years old, all with stems broken off. Further along the road, no more than a few hundred metres, is a fast developing holiday centre — could this be the cause, directly or indirectly? It is certainly my belief that the damage was wilful and destructive.

As the night drew in we made camp at Pta. Flamenco; I pitched my tent alongside *Eulychnia Saint-pieana* which in habitat is not the white woolly plant we grow in our greenhouses. It is in fact very similar to *E. breviflora* and I suspect similar also to *E. barquitenis*; I say "suspect" because the plants I found at Barquito did not appear to be any different to all the other *Eulychnias* which I had previously seen. In the now fast fading light, preliminary searches were made for *Thelocephala malleolata* v. *solitaria* which Ritter reports from this site. It was difficult to imagine that something as delicate as *T. malleolata* could be found amongst the large gravel in what is obviously an extremely arid area, yet grow it does and I was lucky enough to find some specimens. Collecting however, would have to wait until morning when we would have more time

to ascertain the strength and variation of the population.

On the following morning photography proved as difficult as the night before; the sky was extremely dull and overcast. Mist had rolled in from the ocean at a height well above us but it was dense enough to cause light problems for the camera. The plants where we were, at sea level, did not seem to derive any benefit from this fog, possibly accounting for the very poor condition of the plants at sea level here. The two globular cacti of this area both have very distinctive tap roots and were always found level with the soil. A number of *Theloccephala malleolata* were found, both singular and clustering and for this reason I find the variatal name of *solitaria* unacceptable; furthermore I could see no difference between these plants and the type specimens. The other globular plant here was much scarcer, *Copiapoa longispina*, and very few live specimens were found. The plants have an extremely narrow neck joining the head to the tap root and it proved impossible to keep the complete plant intact throughout our journey.

The journey from here to our overnight stop of Calama took us through some of the driest areas of Chile. The landscape became quite monotonous, dull brown hills and plains with no sign of life whatsoever, punctuated by only the few remarkable oasis that exist wherever the rivers have sufficient water that can be used to irrigate the otherwise barren land. There are not too many rivers that manage to carry water from the high Andes to their coastal destination but where they do, little villages appear in the valleys and decorate the landscape with narrow bands of greenery. Calama is quite a large town but owes its very existence to the river Loa that runs along its outskirts. The river here is quite vigorous and, in keeping with the increased altitude, very cold. As we made camp that night we were reminded that the nights in the higher altitudes bring with them a particularly fresh cold.

The following morning we set off to perhaps the most remarkable of all the oases in this part of the world, San Pedro de Atacama. The terrain between Calama and San Pedro is practically lifeless with some very strange lunar-like scenery. Near to San Pedro we saw *Cumulopuntia tortispina* for the first time. It has however a wide distribution at altitudes of between 2850 m and around 4000 m and forms quite sizeable mounds as Ritter's new generic name suggests. Several examples were in flower and quite a few still had fruits enmeshed in the very tight spination. Generally it grew with little other vegetation except the coarse tuft grasses.

The sight of the green San Pedro de Atacama as one approaches from the dry desert is truly quite remarkable. Introduced trees and palms give quite a false impression of its surroundings. The village itself has a first class museum which, together with its church, brings what few visitors the area sees. Our attraction however was to see *Trichocereus atacamensis* which grows to the north of the village along the Quebrada del Diablo. Having done the tourist bit in San Pedro, including identifying the various cacti that the museum had collected locally, we set off for the Quebrada. *Trichocereus atacamensis* (RMF 95) grew on the steep sides of the numerous valleys at around 3400 m along with *Oreocereus leucotrichus* and a couple of species of *Cumulopuntia*, *tortispina* and (?)*hystrix*. The *Oreocereus* were generally in very poor condition and gave the impression that the climate was becoming too dry for their survival. Moreover it had to contend, along with the *Trichocereus*, with the ravaging of its fruits by larvae, which results in very few seeds reaching maturity. The lava egg is laid within the fleshy fruit whilst it is still developing and the grub which hatches out eats the entire contents of the fruit. Although I found several fruit in this area very few contained viable seeds; in fact the only seed I did collect was from the *Trichocereus* and that was after removing the grub! An interesting *Tephrocactus* was found high on the flat ground near to the road at 3250 m. The species is unknown to me, although I suspect that it could be *Maihueniopsis conoidea* (RMF 13). It has very little growth above ground, small cylindrical heads of ca. 2 cm in length, but has an enormous tuber underground. Very few specimens were found.

I had not seen my colleagues for quite some time and returned to the Land Rover to make contact. Whilst awaiting their return or arrival I noticed the trailer we had been towing was leaning heavily to one side. Upon inspection I realised that the suspension had gone and the offside tyre had worn itself bald and damaged the trailer body to such an extent that I had no alternative but to dump the complete trailer. Having completed the transfer of the equipment from the trailer to the Land Rover, I decided to backtrack in the Land Rover to look for the absent friends. They were found some 5 km back, as a result of the camper breaking down. The coil had gone and fortunately we had a replacement, but already we had cause to verify the wisdom of travelling with two vehicles. We camped that night on the Quebrada del Diablo at 4200 m amongst the *Cumulopuntias*. Next morning we set off for the Geiser del Tatio and it took practically all day to complete the seventy km. The going was tough on both vehicles and fuel starvation became a real problem; the Land Rover with its four wheel drive fared better than the camper and was often needed to push the camper back into life as it strived to climb the increasing heights. No one single hill proved a problem — it was more a case of the gradual but regular climb. We reached El Tatio that night and were allowed to camp in the now disused mining quarters. The next morning, we were to be up around five o'clock in order to see the Geysers at their best. That night, however, was to prove the worst of the trip. All four of us had headaches as a result of the rarified air at this altitude (4400 m); the evening meal we prepared was very light but even so I was extremely sick. Throughout the night I endured a splitting headache and heart pounding. It was not therefore a question of waking up the next morning since I never slept, but I must admit that I needed a gentle push to start me on my way to the highest geyser field in the world. I had seen these geysers on the T.V. film "The flight of the Condor" and the events of the previous night were very much the same as outlined in the book on the film series by Michael Andrews. Pillars of steam rose from the ground and

on the edge of the resulting water pools heat resistant algae formed in marvellous colour. On the edge of this basin grew *Cumulopuntia* and at this time of the morning they had a covering of ice.

The return journey to Calama was downhill and therefore would not be such a strain on our vehicles. Nevertheless both had developed faults which needed attention and our petrol situation was near desperate. This meant that we could not make too many stops on the return journey for fear of reaching Calama too late in the day. We did stop east of Caspana where Fred noticed a group of "different cactus". They were infact *Soehrensia uebelmannianus*; I regret that I never saw them, perhaps because my attentions had turned to the numerous Alpacas and Llamas that feed on the high puna. I was also fortunate enough to see Darwin's rhea, a single bird who did not hang about long enough to be photographed. I stopped further along the road nearer to Caspana and collected seed from *Oreocereus leucotrichus* (RMF 96). Here the population was much healthier and there were a number of seedlings evident. *Trichocereus atacamensis* was again evident but I regret that we were unable to find further populations of the *Soehrensia*. We made Calama virtually on fumes and made arrangements to have the repairs carried out to the vehicles. The fuel pump had gone on the Land Rover and although we could not obtain a replacement we were able to find an alternative electric pump that the garage could use. Here in Chile life is a little different to England; it is up to the customer to obtain the parts he wants fitted, the garage merely fits them!

After a further two nights at Calama, we made our way north to Pisagua. The road from the main Pan American Highway towards Pisagua was typically Chilean. The numerous potholes dotted about the road made driving very difficult, the more so as this particular road had a habit of disappearing. This was still the dry, lifeless Atacama desert where nothing grew; it is a long flat plain devoid of anything. The ocean came within sight and Pisagua lay down below us, a small caleta which typified many of the tiny villages along the coast. Before making our descent we decided to take a couple of exploratory walks to see if we could spot the *Eulychnias* that typified the area. We met with no success, all we could see was barren cliffs. Upon reaching the village we made enquiries about the location of cacti in the area. Despite showing several of the villagers Ritter's illustration and our own plants that we had collected elsewhere, nobody knew of a single cactus. We had to register with the police here and again we asked the same question. This time the reply was more emphatic, in the seven years this policeman had been stationed here he had never see a cactus, not even as he travelled up and down the coast line by boat. How then could we get to other possible locations along the coast? This we were told was no longer possible as the only road out of Pisagua was the one we had used in getting here. There was once a narrow road that travelled south for about twenty km but this was no longer open. I was particularly anxious to search this area as Lau reportedly found *Neochilena iquiquensis* (L 804) here. We made several attempts to travel south via the desert but each time we reached the coast we were greeted by the same barren cliffs that existed back at Pisagua. But it was on one of these sorties that we spotted through our field glasses what we thought might be *Eulychnia*. At first they looked like a few upright poles but as we travelled further it became evident that they were indeed *Eulychnia*.

Returning to the Land Rover we headed in their direction across the vast sandy plains weaving our way round, up and down the many ravines that crossed this area. We could not get any closer to the coast than about two km but here we left the Land Rover to make our way on foot. Fred and Adriana went in one direction and I made a separate journey in a more southerly direction. Upon reaching the coast I found nothing; I scanned the horizon in both directions for signs of *Eulychnia*, but again nothing. I had seen far away to the south a high bank of cloud hovering over the cliffs and decided to aim for what appeared to be a small caleta. Distance is deceptive in these parts and I walked for several hours before I could be sure that there were plants there. They were still a long way off but I decided having come so far that I would continue my walk. The problem here was that I had to walk three km to get one km nearer, for the ravines were deep and winding. The last few km were travelled at a record pace as I realised that the hitherto dots were indeed *Eulychnia*. They were actually within the mist limit on very steep cliff slopes and my descent had to be slow and cautious in order to retain a footing on the loose rocks. Furthermore the slope was so shear that it was almost straight.

The *Eulychnias* here were not like the earlier plants I had seen at La Serena; here they were taller and much stronger in the trunk. They were also, for the best part, dead! Very few of the specimens I saw were alive and those that were, were holding on by a narrow line. All the plants had a type of moss or algae clinging to the stems which at times completely enveloped the whole plant. This competition for the extremely scarce water supply was obviously one reason for the *Eulychnia*'s lack of health. Despite very lengthy searching I was unable to find any sign of globular cacti throughout this area. As I made my way laboriously back to the cliff tops my clumsy efforts came to the attention of two condors who not only came closer for a look but presumably did not rate highly my chances of survival. The walk back to base seemed eternal as it often does when you return empty handed. The others had been back for some time and had started to become concerned about my welfare, concerned enough to sink a bottle of wine over discussions of what to do! They had found the *Eulychnia* stand we had spotted earlier but all the plants were dead. Fred had found a *Tephrocactus* and a single *Neochilena iquiquensis* but despite a lot of searching he could not add to that tally. We returned to Pisagua tired and defeated.

A further search was made at Caleta Junin but produced nothing. The area itself was extremely strange. It was the site where mining had been carried out and the remains of much of the equipment laid strewn over a small area. The vicinity of the cliff top there had been planted out with several species of shrub and palm but all were now dead. When we arrived, the fog was extremely dense, hanging from the remnants like huge spiders's webs. Having decided that we had spent

enough time in searching for our elusive *N. iquiquensis* it was now time to make for Arica where we would reprovision for the trip east to Putre. We had also hoped to receive permission to visit Cabo Lobos to search for *Neochilenia aricensis* but despite concerted efforts only Adriana was allowed to make the trip. The whole area is now a strong military base and they do not take kindly to foreigners tramping round their closely guarded quarters. Adriana was allowed to visit on the basis of being a Chilean native, she was however escorted throughout by two military personnel. She succeeded only in finding several small specimens of *Eulychnia aricensis*. Having failed to convince the Army to let us loose around the cliff tops, Adriana then set about the Navy! They kindly agreed to take us by boat from Arica to just south of Cabo Lobos if we came back on Sunday! We arrived at the Arica docks early Sunday morning to be met by the Captain and his two crew members who were to take us out for the day. The boat turned out to be a military gun boat complete with guns that were unwrapped and loaded as we left the quay. Never before have I been so well behaved. The journey was extremely interesting and we spotted several small stands of *Eulychnia* high up at the top of the cliffs. These were clearly not accessible from the beach anymore than the area where we disembarked at Caleta Vitor. There was nothing else for it but to sunbathe under the watchful eye of the military. Clearly then if *Neochilenia aricensis* still exists it has developed a unique conservation tactic, the Chilean military!

Monday morning we left Arica for the east having enjoyed three nights in the comfort of a local hotel; it was good to sleep well and be able to bath twice a day. Following the valley basin along which the Rio Lluta runs we made for Poconchile to search for *Islaya krainziana*. The hills on both sides of the valley were completely bare of vegetation and consisted of very fine sand making climbing exceedingly difficult. We knew that somewhere here *I. krainziana* existed for Ritter's description and photographs indicated just such a terrain even though we found it difficult to believe that any plant could exist in such a harsh environment. After several fruitless sorties, I found the plant growing, or perhaps merely existing, in two very localised patches tucked neatly into spots where whatever mist that managed to make its way along the valley would be sure to reach. The condition of the plants indicated that such incidents were very infrequent but each plant was uniquely adapted to take advantage of whatever moisture there was available. All the plants grew facing towards the crown of the hills and were almost prostrated, thus maximising the area on which the dew could settle. The roots were long but very shallow, the sand in which they grew was so loose that by merely grasping the head and gently pulling, it was possible to remove them complete with roots. The memory of sitting amongst these plants and scanning the barren hills set against the green sward of the valley floor will long remain in my memory. I now fully understand the notes I received from Karel Knize when I imported some of these plants — "No Wasser" for clearly these plants come from the driest of all cacti habitats; to me their mere survival was among the most incredible sights I witnessed on this trip.

Having washed the sand from ourselves and bathed in the cool Rio Lluta we headed for Cuesta Cameros where we made camp for the night. As the road climbed to around 2250 m we saw for the first time the only cactus known to most of the locals, *Browningia candelaris* (RMF 17). The terrain was now very rocky but with little vegetation other than the cactus. The distribution range of *Browningia* appears to lie between 2000 — 2800 m, always in very barren areas. Our guide informed us that this area never receives rain; the rain bearing clouds carry the moisture over until it reaches the border where rainfall can be quite severe. The name *candelaris* typifies the mode of growth of these plants; the characteristic candelabras are held above a single stem which appears to become almost spineless on the top growth prior to offsetting. Similarly the offsets/branches are very often almost spineless; a single stem could quite easily be mistaken for a cylindrical *Opuntia*. Solitary non-branching specimens were observed but very few small young plants were encountered. I did find several dead *Haageocereus* which one again indicated that the area was becoming much drier.

Climbing the Cuesta still further we came across a superb *Tephrocactus* (RMF 18) at 2900 m. A single specimen, which I could not identify, grew on a hill with no other vegetation in sight. Despite extensive searching, I could not locate a second specimen, yet clearly there should have been as this plant had set seed. It was a mound forming plant, probably *Cumulopuntia*, with fierce long red spines some 12 cm long. Each pad was about 5 cm in diameter and this particular clump was about 80 cm across. Continuing on, we came across the first *Corryocactus brevistylus*, which was later to typify much of this region. Whilst I found both fruit and flowers, I confess that I never saw a "good" specimen of *Corryocactus* throughout the trip, hence I took very few slides of this particular plant. Its altitude range appears to be from about 2500 m to 3500 m. *Oreocereus leucotrichus* was now becoming quite significant in terms of vegetation; several forms were observed throughout this region but only really differed in regard to strength and colour of spination and by the density of the wool. One such variant was observed near Tignamar and had the strongest yellow spination I have ever seen. Unlike other habitats where the various forms grow together, this particular area had only the one form. In appearance it was much like the *Oreocereus* which I first encountered further south around San Pedro, although the spination was much stronger, probably on account of the terrain. A good number of the *Oreocereus* were in flower and fruit and their general condition was much better than their more southern relations. The range of this species was from 3300 m to 3800 m but very widely distributed.

Sharing much the same distribution zone as the two preceding species is *Arequipa hempelina*. Equally as common, it is always found in association with both *Oreocereus* and *Corryocactus* in fairly open areas i.e. without the cover of other vegetation. Both single plants and sizeable clumps were encountered throughout its distribution, the largest clump I recall was about half a metre across, with the main head perhaps 250 mm long. I collected *Arequipas* at various localities —

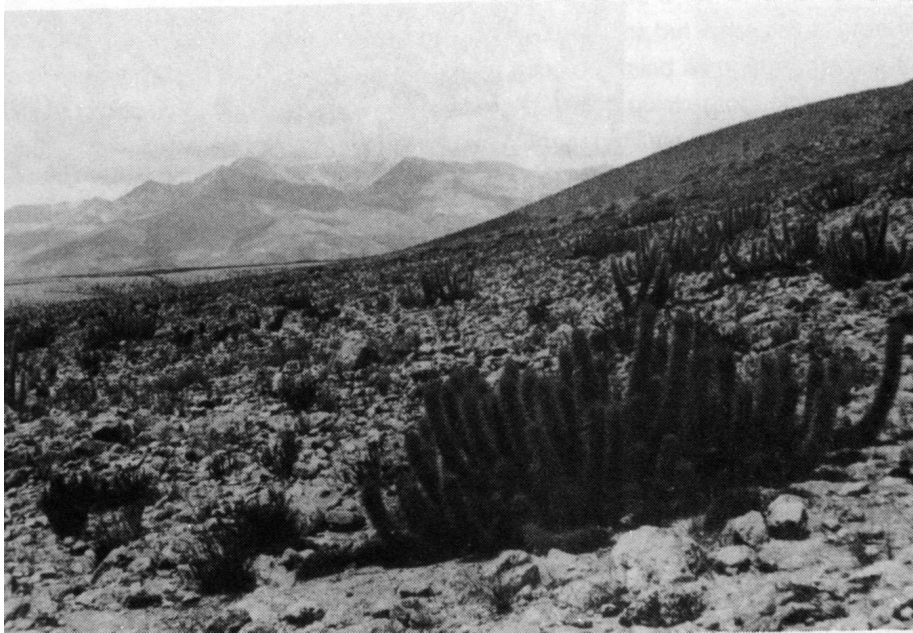
Parianacota, Putre, Zapahuira, Belen, Tignamar and finally from the very margin of its distribution 76 km from Arica in an area known only as The Atacama. Here it grew with a surprising mimicry with *Haageocereus fascicularis* (RMF 34). My visit coincided with the flowering season of *Oreocereus* but I never found any evidence of flowering amongst the Arequipa — no sign of buds, flower remains, or fruit — perhaps nature's way of ensuring that these two similar floral characteristics do not get a chance to cross or hybridise in the wild. You will note from the specific names I use for *Oreocereus* and Arequipa that I side with Ritter's conclusion in regards to Philippi's *Echinocactus leucotrichus* being an *Oreocereus* and not, as many have proposed, an Arequipa. The original Philippi description is very brief but there are certain points that seem to rule out the plant being an Arequipa. Nowhere did I find an Arequipa with wool some 50 cm long or covered in white wool, as Philippi describes. Furthermore he also described *Cereus* (*Trichocereus*) *atacamensis* from the same region and in my experience this plant only grew in association with *Oreocereus* and *Tephrocactus*. Had Philippi found the plant we call Arequipa then quite clearly he would also have found *Oreocereus*.

Neowerdermannia has a narrower distribution in this area and generally grows beneath other shrub-like vegetation. It is however very frequent as far as the plant Karel Knize calls *N. chilensis* v. *putrensis* is concerned. This variety is justified as far as I am concerned for it differs substantially from the plant Backeberg described as *Neowerdermannia chilensis*. Taking the latter first, I found this plant only near Tignamar (RMF 13). It is a small plant, no more than 6 cm in diameter, with an obvious tap root. Backeberg describes the flower as white, but at the time of my visit the plants had finished flowering and were in fruit. The other form, which I found at Putre, Zapahuira, Belen and to the north of Tignamar around 3300-3500 m was a much larger plant, up to 25 cm diameter without a tap root and with a clear yellow flower. The *Neowerdermannias* appear to be more particular in regard to habitat sites, most areas where I found them were fertile with a wealth of other vegetation. These sites obviously suited them well as nearly every specimen I observed was plump, fresh and in flower and/or fruit. They often occurred with Arequipa but this was generally at the end of their range of distribution and here the plants would be drawn deeper into the soil. Arequipa are less selective in their choice of sites, provided they were somewhat open. Rarely did I find them among the *Neowerdermannia* strongholds even though the distance would be no more than a couple of hundred metres between what was typical Arequipa growing areas and the typical *Neowerdermannia* habitat. It was not uncommon to find Arequipa amongst strong limestone areas; the plants I collected north of Belen (RMF 27) came from a very marked limestone area. *Neowerdermannia chilensis* (RMF 31) grew in a very open terrain not far from the site of the strongly spined *Oreocereus* mentioned above. In this terrain there was precious little other vegetation to afford these plants the protection they seem to enjoy.

On most maps you will not find a road linking Belen with Tignamar but we were assured that the hitherto track was in good enough condition at this time of year to allow us to make such a journey. Needless to say the journey proved quite eventful. The road had not been constructed for vehicles and some of the climbs together with hairpin bends proved too much for the camper. Without four wheel drive I doubt if my Land Rover would have made it either. On a couple of occasions the Land Rover had to push the camper very slowly up the incline before it could one more use its own power. On one particular steep incline even this proved to be insufficient; furthermore there was no room to turn round and to descend backwards would be very dangerous. We had no choice therefore but to strip the camper of all its contents and remove the large gas cylinder attached to the underside in order to lighten it as much as possible. The spare wheel was fastened to the Land Rover front end to use as a buffer for pushing the camper uphill. Very slowly we gained momentum until the top was reached and the camper was once again under way on its own power. This was to prove our last reminder of just how essential two or more vehicles were in this region, for help does not exist close to hand. Villages are a good distance apart and natives are rarely encountered outside their villages. Supplies in these villages are very basic; we were unable to get bread or food of any description in the "towns" of Belen and Tignamar.

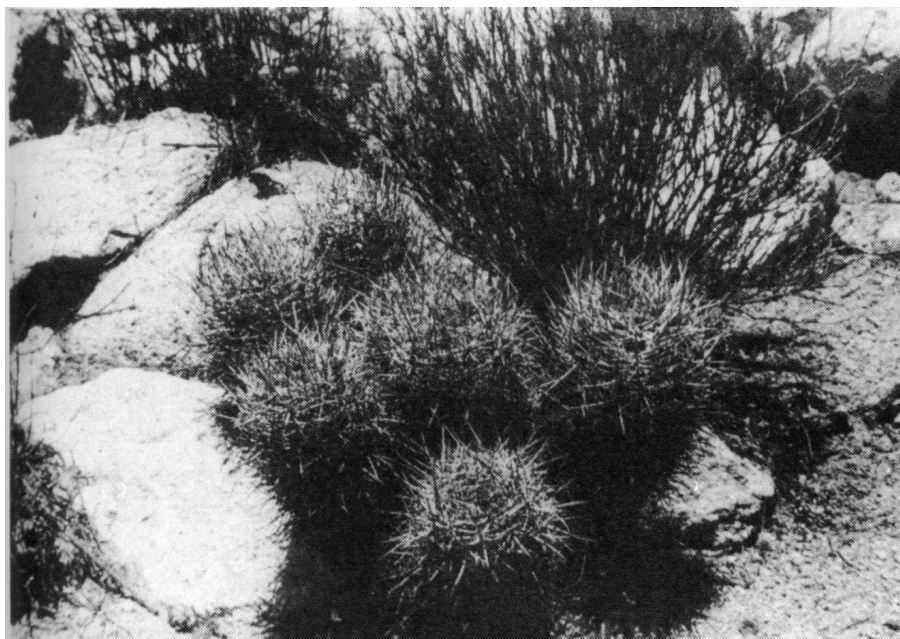
Having resolved our problems we headed for Arica where we would spend a further couple of days in the luxury of a hotel and replenish our depleted stores to enable us to make the return journey to Santiago. The road, as it twisted through the Quebrada Camina, Quebrada Tignamar, and Quebrada de Vizcacha, gave us our last sight of the magnificent *Oreocereus*. The hills facing north were particularly densely populated to the extent that one could truthfully say that they were clothed in *Oreocereus*. Arequipa were also presented here, as was *Corryocactus*, but no *Neowerdermannia* were found. It was along the Quebrada de Vizcacha that we made our last stops as we searched for good specimens of *Haageocereus* and to discover how far west the Arequipas reached. Both plants were collected by me some 76 km from Arica, that is 55 km to the Pan American Highway. Cacti continued in the form of *Browningia* for a further 15 km (altitude 3500 m) before the sterile Atacama desert took hold, making the last part of the journey both monotonous and boring.

We left Arica and headed for Iquique where we spent another fruitless day searching for the elusive northern *Pyrrhocactus*. This time however we were granted military approval to search along the coast line; *Eulychnias* were found but nothing else. Again we learnt of the continuing drought that affects this area. A heavy rainfall forty years ago had caused extensive flood damage as the rain rolled down the hills and cliffs that stand behind the town of Iquique. Fears that this could happen again were voiced several times but little had been done to protect the town; little appears to be possible indeed as the ground which has not seen rain since that time has become almost like concrete.

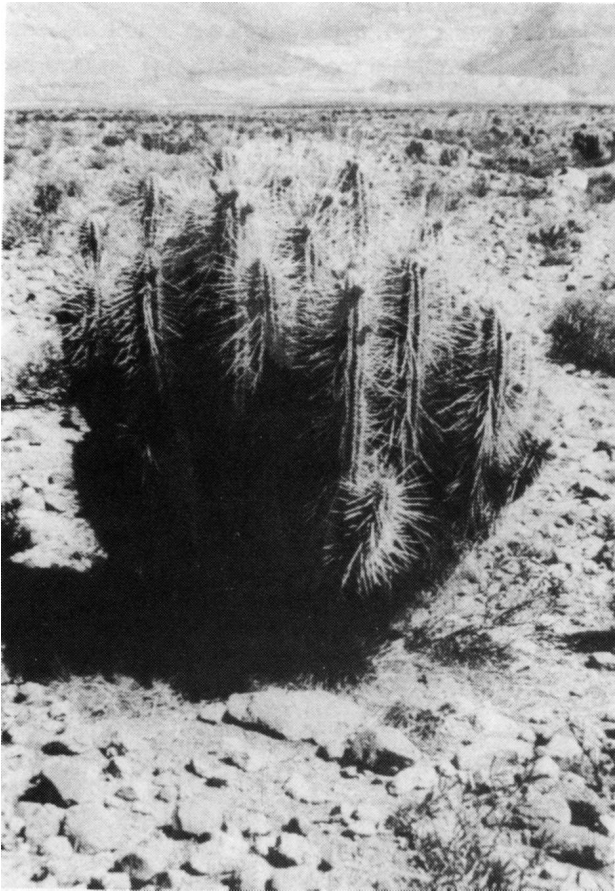


OREOCEREUS
near Tignamar
at 3350 m

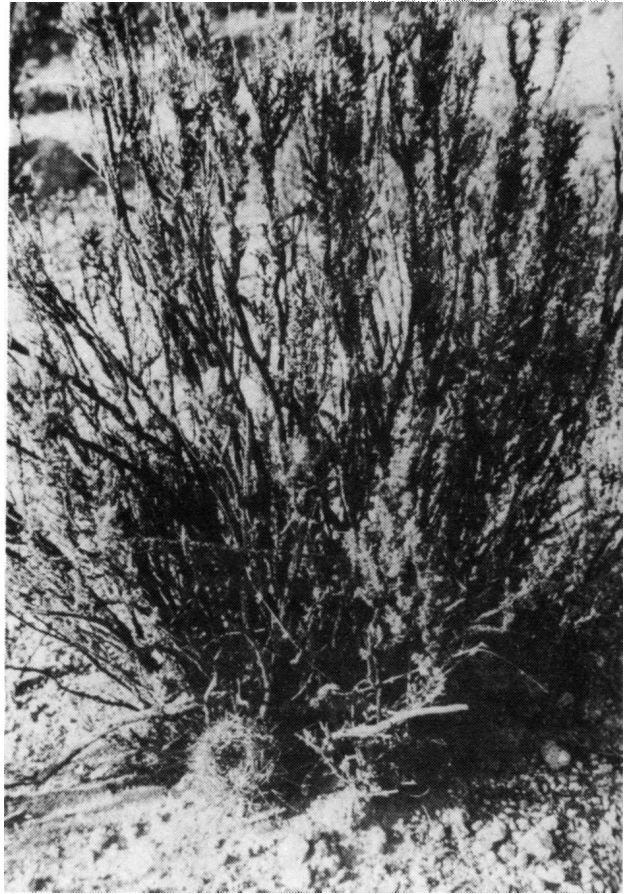
COPIAPOA SOLARIS
(right)
COPIAPOA ATACAMENSIS
(left)
at Blanco Encalada
600 m



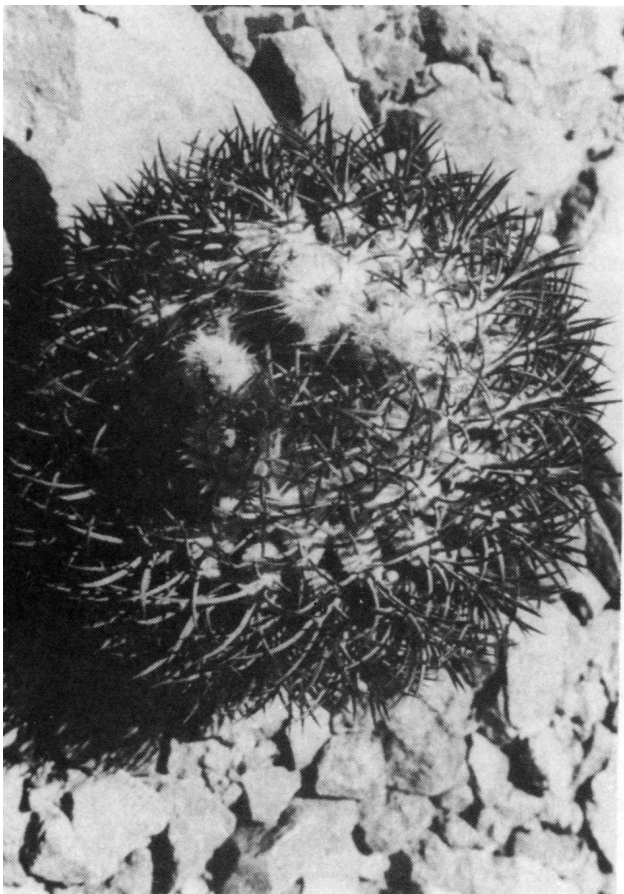
AREQUIPA
HEMPELIANA
near Zapahuira
at 3350 m



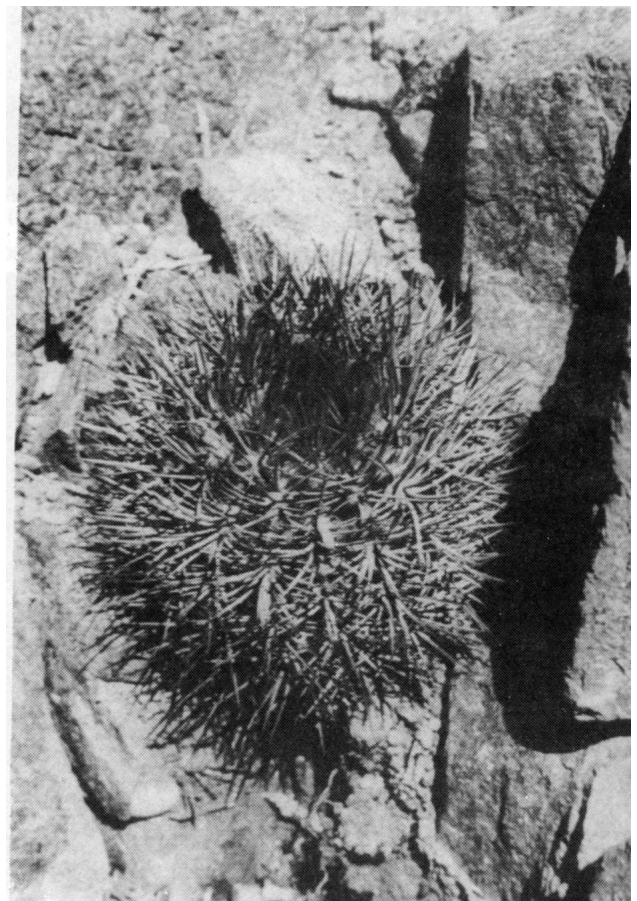
EULYCHNIA BREVIFLORA
30km north of La Serena



NEOWERDERMANNIA CHILENSIS
v. *putrensis* at Chapiquina



ERIOSYCE MEGACARPA
near Barquito



PYRRHOCACTUS FLOCCOSUS
at Blanco Encalada 600m

Leaving Iquique by the coast road we made a few further searches for the elusive *Pyrrhocactus* without success. Wherever we found *Eulychnia* it seemed worth a look but these plants grow in terrain where a look can mean several hours of climbing. One such climb north of Pta. Lobos occupied an hour and a half to ascend a gradual incline of little more than three or four hundred metres. The descent was much quicker for I simply slid down. *Eulychnias* were for the best part growing in pure sand although they attained much firmer footings higher up the slope. The terrain reminded me of the habitat of *Islaya krainziana*.

At Cta. Guanillos del Norte we came across *Eulychnia* after several hours of climbing and walking. Here for the first time were encountered signs of *Pyrrhocactus* but were unable to find any living specimens. It is the type locality for *P. saxifraga* and from what we saw it was fairly obvious that quite a large population had once inhabited the otherwise barren land; now all that appears to exist is the *Eulychnia*. Although not terribly vigorous the *Eulychnia* seem able to survive where the mist reaches; the slopes facing the coast are a particularly favourite location provided it is steep with little other vegetation, and so are the flat, narrow valleys behind the cliffs.

The most northern *Pyrrhocactus* that I encountered in good health was south of Tocopilla almost at sea level. The plants (RMF 36, 37) I identified as *P. residuus* and grew in clefts on the rocks facing the sea. *Eulychnia* also grew here in some abundance. The plants I collected came from a small inlet that formed a break in the cliffs and grew on both sides, benefitting from the moisture that the mist would deposit on the rocks. The next site we made for was Cerro Moreno and I confess that if I had not been told that plants grew there I would never have spent a moment searching. We had to cross miles of desert waste land as we made our way from the road towards the coast. Nowhere did this seem to be cactus country, no sign of the now familiar landmarks such as the steep coastal slopes. We were by now at sea level and the land between us and the sea was flat and lifeless. After several hours of driving across the wasteland we came to the coast but it was now time to make camp. The 'Cerro' lay before us and although of no significant height would be best tackled with a full day in front of us. The following morning was extremely cold as the clouds completely hid the sun from us all day; even at midday I was surprised just how cold it could be without the benefit of the sun.

As we made our way up the gentle slopes, *Copiapoa boliviana* became extremely common, large multi-headed clumps with tuberous roots. Few were in flower but the *Eulychnia* had several fat healthy buds apparently only a few days off flowering. The area was covered with various lichens illustrating that this was a particular damp locality. Damp, but rarely wet, as the moisture here does not appear to extend to supporting flora other than cacti. Apart from some dormant twig-like vegetation amongst the cacti, all the other vegetation was restricted to the few gulleys between the hills at the lowest altitude. In this area the goal was to find Ritter's *Pyrrhocactus vexatus*, described only recently in his *Kakteen in Sudamerika* Vol. 3 but cultivated since its discovery in 1960. It was to prove an extremely difficult plant to find, but find it we did on a few flat areas where there was a fair depth of soil. The plant grows flush with the ground, heads mostly solitary up to 2 cm in diameter, with a large tuberous root. Extraction was very difficult on account of the narrow neck and it was interesting to note that most specimens were in bud. This plant appears to be as much a *Thelocephala* as a *Pyrrhocactus*. It has all the characteristics of *Thelocephala* although I have yet to see flowers or fruit. Nevertheless it shows just how fine are the generic divisions of Ritter.

Our next stop was to be El Cobre, which like many other place names, exists only as a map reference, for there is no town or village. Despite the names we have been accustomed to reading in the cactus literature, our route from Antofagasta to Taltal via the coastal road only passed one very tiny settlement at Paposo; for instance Blanco Encalada is known to most cactophiles, as is El Cobre, but there is no settlement or road signs to advise the traveller where he is. We only realised we were approaching El Cobre when the large mounds visible high in the hill were recognised as *Copiapoa solaris*. As the road winds towards the coast the hills either side must enjoy the benefits of the coastal mists as they roll inland through these gulleys. The *Copiapoa*, scarce at first, becoming more frequent nearer the sea, are the only vegetation to be seen. My first encounter was to be a sad one for the large clumps visible from the road in great numbers were all found to be dead upon close inspection. Still perfectly formed but apparently attacked by some virus, their decay would presumably have been a slow process. After making such a journey to this spot, followed by a tiring climb, only to find each clump you looked at was dead, the hollow feeling one senses cannot really be put into words. Fortunately this was to be the only site we visited where the plants were like this; at all the other sites there were healthy populations of surprising size both in terms of quantity and of individual clump size. Clumps of one hundred heads was not uncommon which is really quite remarkable considering the slow rate of growth of these plants. It was difficult to find single heads or small clumps but this was almost certainly due to collecting activity rather than a quirk of nature. It was to be the only area I visited where heavy collecting must have occurred; there were several indications that professional traders had been active here. The plant population will probably stand this as there are still many thousands of plants still left; however it is still a problem especially as flowering is rare even in habitat and hence rejuvenation is all that much slower.

Having made camp here that night we left the vehicles on the following morning to search for *Pyrrhocactus glaucescens*, as well as spending more time with the remarkable *Copiapoa solaris*. I was fortunate enough to find the *Pyrrhocactus* growing amongst rocks and on ledges on the side of one narrow valley — fortunate, since the other members did not find it despite extensive searching. I found several specimens, the largest of which was no more than 7 cm diameter; all were typically squat with the epidermis a strange muddy colour. Possibly on account of better localised growing conditions

some were more greyish, yet still with the muddy brown tinge. I found no evidence of flower or fruit here. In addition to these two cacti and the odd *Eulychnia* there was no other vegetation in that area.

In order to continue down the coast we had first to drive inland along the road which brought us to the coast, in the hope of picking up the track that led to the map reference Blanco Encalada. As we left behind the last Copiapoas the land became truly barren and it was not until we had made a turn towards the coast and started to descend that we came across more stands of *Pilocopiapoa*. The altitude here, 600 m, was much the same as at El Cobre, but the plants displayed minor difference. Firstly the clumps were nowhere as big as those at El Cobre and many of them had longer, lighter spines, yet they were in fact the plants that Knize calls var. *luteispina*. There was also a large number of smaller plants and evidence of flowering. The condition of the plants throughout this area made it obvious that they were enjoying a damper environment. Some very beautiful *Copiapoa boliviana* (RMF 46) were also found growing side by side with the *C. solaris*. Their beauty owed much to the fact that they were in better condition than their counterparts from Antofagasta; in fact such was the difference that they could easily be mistaken for another species. It is also interesting to note that whilst they were fairly abundant here I never encountered a single specimen at El Cobre.

A few hundred metres along the road we came across the superb *Pyrrhocactus floccosus* growing amongst the rocks. Those we encountered first were not so floccose as I had been accustomed to with cultivated plants but later I was to find several plants with a dense covering of wool. Again all were in exceptional condition with several plants over 25 cm high. As we descended towards the coast there were a few dormant woody shrubs amongst the cacti and even the odd *Bromeliad*.

We reached the coast and turned south to follow the coastline back to Taltal. At first the terrain was completely barren but as we scanned the ground on either side of the road — a fairly easy task as travel over these roads is very slow — we noticed a very different *Copiapoa* (RMF 53). Individual heads were 2.5 to 5 cm diameter and formed clumps of up to 30 heads. Single plants were uncommon but I found several with no more than three heads. The body was typical *Copiapoa* grey with reddish-brown hair felt in the crown, spines reddish to black, root tuberous; most specimens were in flower. This particular plant grew up to a few metres from the edge of the sea and covered a fairly narrow bend on the flat coastal plain. Ritter describes *Copiapoa variispina* as coming from this area and I have provisionally called by plants by that name; however, I confess that I do not understand the term “*variispina*” in relation to this species as it was probably the most consistent form that I found throughout the region.

As we made our way along the coast, further larger *Copiapoa* became increasingly common, growing mostly at the base of the rocks, in the sand. Some 60 km north of Paposo we encountered the first of the *Pyrrhocactus* from this region. Ritter suggests that *P. paucicostata* is the most northerly of the group that includes *P. paucicostata* and its variety *viridis*, *P. neohankeanus* and its var. *densispinus*, var. *elongatus*, and var. *flaviflorus* and finally *P. taltalensis*. Of all these names I could find only two distinct forms, firstly *P. paucicostata* which included individual plants that were more densely spined, more elongated, etc., etc., but no populations of dominant forms and all forms appeared to have interbred with each other, and secondly *P. taltalensis* which I found somewhat later.

Much has already been written about the Copiapoas of this region and there is very little that I can add except to assure you of the remarkable sight one is greeted with. Isolated specimens in the north give way to larger clumps as one heads south; the size and quantity of these clumps around Paposo has to be seen to be believed. Again several names have been attached to various forms and there is certainly a huge variety of form; *C. hasltoniana* and *C. gigantea* are quite distinct as forms but what of the plants in between? Taxonomy had to take a back seat as I marvelled at the amazing quantity of plants growing from the shore-line up the hills. The *Copiapoa* appeared to grow everywhere, whilst *Pyrrhocactus* were more demanding in their requirements. *Eulychnia*, *Trichocereus* and *Euphorbia lactiflua* were all dominant in various areas. My search for *Copiapoa humilis* was in vain, caused as much by diversion of interest as by the scarcity of the plant.

The coastal mists were once again very evident during our stay here, clearing around 11.00 a.m. but once again even at this time of day there was rarely any moisture on the plants and certainly not enough to penetrate the soil. Yet clearly the plants do derive considerable benefit from these fogs as many of the Copiapoas, *Pyrrhocactus*, *Trichocereus fulvilantatus*, *Eulychnia breviflora* and *Euphorbia lactiflua* were in flower as were the Bromeliads, a daisy-like plant, as well as newly germinated herb-like plants.

Having lunched at Taltal we moved a couple of miles inland via the “Quebrada La Canchina”, to a range of hills that run inland from Taltal towards the interior. Along the Quebrada was the area known as Breas where Soehrens claimed there grew the plant which Philippi described as *Echinocactus occultus*. (Note Philippi says that the plant grows from Copiapo to El Cobre along with the sea shore, a point that has often been refuted since the original description in 1860.) We made our way to where we thought Breas lay, according to our map reference but later found out that Breas lay a further 10 km to the east. We were given this information and also our exact location by the local land owner, who told us about an American botanist who had visited this site on several occasions some 20 years or so before; we speculated that this was probably Paul Hutchinson. The first plants we came across were *Copiapoa cinerea*, seemingly thousands of them in all shapes and sizes. A number of small plants were observed as well as sizeable clumps almost a metre across; many were in flower and some had set fruit. I did manage to collect some seed but it was an awkward fight to beat the ants to it! The

Copiapoa throughout the region appear to stagger their flowering times and thus it was not uncommon to find buds, flowers, fruit and seeds all within a limited population. Again the Copiapoa did not seem to be too selective in its habitat for it grew both on the flat plain and on the gentle slopes of the hills. On the other hand the Eulychnia preferred the gentle slopes as did the not quite so common Trichocereus fulvilanatus. Also on the slopes were numerous Puya and Bromeliads whilst the very rare Pyrrhocactus taltalensis grew only at the base of large rocks.

The soil here was a sandy loam covered with a layer of walnut sized granite-like stones. On the flat plains we did find Pyrrhocactus occultus, but only after extensive searching. The name truly epitomises this plant for it really is hidden, not just concealed as are many of the Thelocephala that I found, but genuinely growing completely below the surface. To find it we were forced to drop on to all fours and gently rub away the surface stone and soil before finding the plant; I lost count of the number of times that this operation was carried out without success. Perhaps it can best be summed up by recounting one of the trip's many teasers; I was stood on a spot and told that the plant was within a metre of me — it still took a slightly over ten minutes to find it! From our searches it would appear that this plant is very rare, at least in this location and can only really be detected when in flower or fruit.

We left this area and made camp on the beach at Barquito. The following morning we climbed the steep coastal cliffs, passing the odd Copiapoa growing amongst the massive lumps of rock. On the way up I found Eriosyce megacarpa (RMF 66) in full flower and collected a couple of specimens that would otherwise be destroyed by the extending construction work here. On the very top of the 300 m high cliffs we found Eriosyce atacamensis and Copiapoa humilis var. barquitensis, but there was no sign of the Pyrrhocactus that we had hoped to find here.

We left this area, travelling south to Copiapo, a town nowhere near as attractive as the cacti named after it! Some 30 km south of Copiapo we stopped to photograph one of Chile's tourist attractions a (quote) one thousand year old Eulychnia. Whether the plant is really that old is pure speculation but it really is a monster of a plant some six metres high with well over a hundred branches. In the rocky terrain behind that plant I searched for, and found, a few scruffy plants of the species which Ritter calls Pyrrhocactus kunzei (RMF 68). Ritter has argued for some time now that the plant most of us know in cultivation as P. kunzei is in fact his P. eriosyzoides — which explains why the two are so similar — and that the kunzei described by Forster in Forster and Rumlper, Handbook Cacti. 293:1886 represent a totally different plant. Certainly the plants I found are very distinct from the golden spined species we cultivate as kunzei/eriosyzoides, but whether Ritter is correct in his belief is in my opinion very debatable. In keeping with many descriptions of that era, the Forster description is not very clear, however there are one or two points that would seem to refute Ritter's claim, notably that the habitat of the plant is "Chile, off the extreme mountain range, occasionally under a light snow covering." This area we were in now is never likely to see snow as the altitude is only 650 m and can hardly be considered as a mountain range. The habitat of Ritter's eriosyzoides on the other hand fits the habitat description perfectly.

Making our way towards Vallenar we stopped to collect Pyrrhocactus atroviridis (RMF 69). Despite being so numerous, the damage caused by insects burrowing within these plants made it impossible to collect undamaged specimens. The plants appear to be tolerant of very severe damage in some cases, as most plants were in flower or fruit. Eulychnia breviflora and Austrocylindropuntia miquelii were both very common here; nearly all the Eulychnias were either in flower or about to flower whilst the size of the Opuntia put the glasshouse efforts of most of us Europeans to shame! Further on we came to an unusually level area and pulled off the road; the view south was uninterrupted for probably 10 km. There were numerous tyre tracks around; whether it was a stopping off place from the monotonous road or whether numerous plant hunters had been here prior to ourselves. I do not know, but we hoped to find an unusual plant somewhere in this area. Find it we did, at first very scarce but later becoming easier to spot although really there were not too many specimens around. It is the habitat of Thelocephala duripulpa (RMF 73). A large number of the plants which we found had offsetted and whilst it was not possible to determine whether this was a result of damage to the main head, I did find a couple of plants with offsets but without any sign of damage to the main head. The soil was very similar to that in which we had found P. occultus growing and significantly both plants had large tubers. A four headed plant of about 7 cm overall breadth had a root of more than 20 cm in length. Unlike P. occultus but like many other of the Thelocephala, I found that these plants had the typical narrow neck about 6 mm in diameter and often with a surprising length of up to 7 cm. South of Vallenar, Copiapoa vallenarensis became increasingly common, the green body forms were now replacing the grey bodied plants.

It was late afternoon as we passed the Cuesta de Pajonales but for some unknown reason I decided to stop and take a look into the hills by the side of the road. Such was my excitement at what I saw that I clean forgot to warn the other vehicle of my intentions. The result was that not only did they pass me but returned more than an hour later, certain that I had met with some kind of accident. The temperature of the other driver — Fred Katterman, cooled distinctly as I offered my apologies and a peace offering of one of the most impressive Eriosyce species that we have seen to date. We decided to camp here for the night and make a further study of the area on the following morning, for not only were there Eriosyce to see (RMF 70) but also Pyrrhocactus eriosyzoides var. domeskeyoensis (RMF 72). The following morning the Eriosyce positively glowed in the sun, their reddish brown spination making them extremely attractive. Nearly all the plants I found had fruit on them, complete rings of fruit — I counted as many as 55 fruit on one plant; considering that each fruit usually contained about 200 seeds they would have been expected to have been more plentiful than I saw. Just what species this plant is, I am not

certain; Ritter records *Eriosyce algarrobensis* as coming from near this locality but that particular species is unknown to me, other than the description and illustration in Ritter's book. Of a surprising likeness was the *Pyrrhocactus*, the body perhaps a little more open but the same bronze colour. However, the fruit is distinct enough to identify itself as a *Pyrrhocactus* as it had the typical elongated berry of the *Neoporteria* and not the woolly globular fruit of *Eriosyce*. I also found a single specimen of another *Eriosyce* with a green body and black spines, *E. ceratistes* or *E. sandillon* as Ritter calls it now.

Our last stop was now in sight, Trapiche. Here we were to look for a *Thelocephala* newly described by Ritter — *T. fankhauseri*. It was found after extensive searching and was visible only by the fruit projecting above the surface of the ground. One of the smaller species, most specimens were no more than 2 cm in diameter. It had the characteristic tap root. Very abundant in the same locality was another tap rooted plant, *Pyrrhocactus deherdtianus* (= *trapichensis* Ritter). A number of forms were found along with several flower colour variations. It was quite a fitting climax to the trip to find so many plants in flower within such a small compass. They seemed to have adapted well to this environment, growing both in the shade at the base of the numerous *Eulychnia* and in the open without any plant cover. In addition to the dominant *Eulychnia*, there were also numerous *Copiapoa pseudocoquimbana* in full flower. More difficult to detect was *Pyrrhocactus simulans* (RMF 76) which has evolved a striking similarity to the *Copiapoa*. It is an art of detection to separate the two and more than once I stood pondering which was which. Obviously flowers set them apart but I was too early for the *Pyrrhocactus* flowers but after careful scrutiny I was able to collect two specimens — I think! As we left the area we were able to see the lifeline of many of these plants making its way through the hills around the district called El Tofo; the coastal mist had started to roll inland.

As we made our way south from Coquimbo, we stopped for a quick bite to eat. Not wanting to wait for sandwiches to be prepared, I hurried off to the nearest hill. Crossing the wire fences I came to a typical citrus grove but in amongst the trees I found the odd specimen of *Eriosyce* of considerable size, 75 cm, such is their tolerance of growing conditions.

Having returned to Santiago, it was now time to have the plants that I had collected inspected and the correct documentation raised to export the plants back to the U.K. In Latin America things like this cannot be hurried and it took the best part of four days before the plants were boxed and ready for despatch. I am quite certain however that without the help of Adriane it may have been nearer four weeks!

There was still time to make one or two more trips before returning home, so having been a possible burden to my hosts for long enough I slipped off and hired a rental car. The first few days I spent around the Santiago basin that I had been to earlier in my stay. My next aim was to visit Pichidangi which lay some 150 km north of Santiago. But first I visited an area of Montenegro, about 50 km north of Santiago. Here I found the familiar *Pyrrhocactus* of the region, *P. curvispinus* (or *andicolus* Ritt). It was a sheep grazing district with numerous forms of plant life; trees dominated much of the south facing slopes and the cacti were restricted to isolated north facing areas. The exception to this is *Trichocereus chilensis* which, like its relatives in the Santiago basin, is quite happy competing with almost all other vegetation. Whilst most of my searches have proved fruitless despite the obvious presence of large stands of *Trichocereus*, I did find a broad mix of flora at one particular location. Here the rocks were a very unusual reddish colour and in amongst them I found *Pyrrhocactus curvispinus* (RMF 84), *P. horridus* (RMF 83) with deep red flowers, a further *Pyrrhocactus* of whose identity I am uncertain, and the plant which I had come here to find — *Neoporteria coimasensis* var. *robustior* (RMF 82). The latter were particularly fine plants with either black spines, or yellow spined, really robust and up to 50 cm high. Interestingly enough, despite growing within a hundred metres of the *Pyrrhocactus*, the two genera did not mix. The *Neoporteria* preferred the steep slopes or sheer rock faces whilst the *Pyrrhocactus* grew on more level ground often amongst the Puyas.

The *Neoporteria* had impressed me tremendously, so much that I decided to find the type species *N. coimasensis*. Ritter gives Las Coimas as the type locality but I could not find the place name on any of the large scale maps I had with me. I decided to take a chance and head for where I thought it should be! I was later to learn that I actually asked for directions from the very place that was once called Las Coimas. As the road wound its way beneath the hills I suggested cacti must exist there. Exist they did, in large numbers, including the *Neoporteria* I had come to search for. The problem was getting to them. Getting across the farmer's field complete with cows, that lay between the road and the hills was no problem to a lad from Suffolk, but how was I to cross the man-made dike that had been cut into the hill? Although brim full of water, the width would not have put me off, but I could not see a suitable landing place on the other side where there was a thick growth of bramble and other plants. I travelled some 15 km with the same result — there plants no more than ten metres away but there was no way across. I travelled on towards Llay Llay and at last I found a clearing, but by now the plants were few and far between. However, I managed to collect *Neoporteria coimasensis* (RMF 87) as well as the *Pyrrhocactus* of this area, *P. aconcaguensis*, but by now it was nearly 8 o'clock in the evening and photography was not possible. I returned to the car and after a quick bevy of Chilean wine and a cuppa, decided to travel by night to Pichidangi. I arrived shortly before midnight, having avoided all but the worst of the potholes en route. The night was cool and I had intended to sleep under the stars on the patch of grass between the rough road and the sea, but after laying down my sleeping bag I decided against it — the place was full of cacti!

Early the following morning I surveyed the scene; *Pyrrhocactus horridus* (RMF 89) grew on almost every piece of flat ground, and where the rocks had formed low piles grew *Pyrrhocactus chilensis*. Most of the *P. horridus* were in

flower and these were fairly consistent in colouration. Body morphology varied slightly, some green some brown, some offsetting but mostly single. As I wandered throughout this locality, I came across literally thousands of plants and I questioned how justified Ritter's varieties of *P. horridus* really are — var. *minor*, var. *mutabilis*, and *P. odoriflorus*. Of the many plants I found here and further north at Los Vilos, there were individuals that fell within the descriptions but I did not find consistent groups. Similarly with *Pyrrhocactus chilensis*, there is no geographical separation from the variety *albidiflora* and I found them in flower side by side. *Pyrrhocactus chilensis* bears an uncanny resemblance to *Neoporteria subgibbosa* both in terms of body morphology and mode of growth. Both plants grow at the base of extensive rocky escarpments, but both seem happiest wedged in crevices of the high cliffs. Pichidangi has quite a varied flora; in addition to the cacti mentioned above there are abundant *Eulychnia castanea* (in flower), *Trichocereus*, *Puya*, *Nolana petiolata*, *Alstroemeria augustifolia* and numerous other species that I could not identify.

From Los Molles I travelled to Illapel. My aim was to find *Pyrrhocactus choapensis*, which I did find amongst citrus trees at Choapa. It would seem that many plants have been removed since this type of farming commenced, but they still hang on, on the edge of such areas. The plants I collected came from just above the main orchard. *Eulychnia* grew on the other side of the valley but I could find no trace there of the *Pyrrhocactus*. At Pte. Confluencia (near Illapel) I was surprised to find a plant which I believe to be *P. chilensis* (RMF 93); its true identity will have to wait until it flowers for it grew in a most unlikely habitat for this species. There were, however, a large number of seedling plants in this area, which was once again dominated by *Eulychnia*.

This was the last opportunity I was to have of studying the plants on this trip as I had to make my way back to Santiago to spend my last night with Dieter Forstmann, to make provisional plans for my return in 1983. Dieter has built up a fine collection of Chilean plants and we hope to make a trip together to Huasco, Elqui and onwards to Paposo around the end of the year.

Footnote: The plants I collected have by and large settled down well in our European climate and whilst it is still early days, it is interesting to note that several of those I collected in flower or fruit have already reverted to our seasons. October is early spring in Chile much the same as May (except warmer) but it is perhaps surprising that the plants did not need to condition themselves or in some cases even produce roots, before embarking on another flowering season. Already *P. deherdtiana*, *simulans*, *floccosus*, *horridus*, *paucicostata*, and *taltalensis* have all flowered, whilst *P. neohankeanus*, *kunzei*, *atroviridis*, *curvispinus*, *Copiapoa haseltoniana*, *cinerea*, *coquimbana*, *Thelecephala fankhauseri*, *Eriosyce megacarpa* and RMF 70 are all in bud.

. from I. M. Johnston "Flora of Northern Chile" 1929.

The coast of northern Chile, with the possible exception of that of northern Peru, is the driest in America. On this section of the coast are situated the principal nitrate ports — Antofagasta, Tocopilla and Iquique. Viewed from the passing steamer the region consists of a wall of greyish-brown hill rising abruptly from the narrow coastal plain to about 1000, or here and there 1500m altitude, and extending in a line almost north and south. Only near Antofagasta is the regularity of the coastline broken by a prominent headland. Almost at the crest of the coastal hills begins the great desert tract or flat or rolling country that stretches eastwards for nearly 100 km. It is on this elevated, quite barren desert that the nitrates are obtained. The slopes of the hills facing the sea appear to be also quite barren of vegetation, an impression indeed which is not at once dispelled even when one lands and in port gazes at them from a much closer range. In ordinary years the slopes nearby are quite bare and utterly devoid even of lichens. The vegetation of the region is confined to certain higher slopes where the moisture from the fog-clouds, which frequently drift against them, is sufficient for the development of a meagre flora in this otherwise completely desert region.

Drifting in from the ocean, particularly during the winter, these wet fog mantle certain slopes and by their condensation there as mists supplement the scanty rainfall sufficiently to develop a vegetation along most of the coast of Peru and northern Chile. Along the nitrate coast, however, the formation is not luxuriant, though it is of particular interest because of the simplicity of the factors permitting its development. The relation of fog to the presence of vegetation is here most obvious. In north Chile there is no continuous band of fertile slopes. These vary in size and in the moisture they receive and are scattered in occurrence. Only here and there along the coast are meteorological and topographical conditions right for the formation and banking of fog and so consequently for the development of some vegetation.

Because of the meagreness of the flora, its disrupted occurrence and the difficulties and danger (from lack of water) of travelling along the coast, no one has ever attempted to make a thorough and general collection or study the detailed distribution of the plants in the area. Consequently we know the flora only as it is represented on the slopes about the ports of Antofagasta, Cobija (now deserted), Tocopilla and Iquique. Fortunately, however, there is a means of estimating the general extent and development of the vegetation along the coast. Growing on and confined to the fog-moistened slopes of the nitrate coast is the large columnar cactus, *Cereus iquiquensis*. This plant grows 2-3 m tall and is sometimes used as a source of fuel. Its size and economic importance to not permit it to be overlooked even in the dry months when the herbs, associated it in the more favourable seasons, are absent. It becomes evident, therefore, that this conspicuous cactus serves as a ready index to the extent and distribution of the fog-bathed fertile slopes. From the mention of the occurrence of the plant by travellers and from observations of it made with field-glasses from the steamer, one may say with fair confidence that the fertile areas are

most abundant and best developed on the stretch of coast from the vicinity of Tocopilla south, near Antofagasta.

. from H. Middleditch.

Maps of Chile which carry a number of the place names that are mentioned by Roger Ferryman will be found in Chileans No. 11, No. 37 and No. 40. There are sketches of tuberous rooted plants in No. 15 p. 54, an account by Karel Knize of a visit to Antofagasta in No. 16 p. 10, a description and illustration of *C. ferox/solaris* in No. 17 p. 64, an account by Buining of collecting in central Chile with Ritter in No. 18 p. 168; articles on *C. cinerea* in No. 33 p. 109, on *Neowerdermannia* in No. 37 p. 15, on *Browningia* in No. 39 p. 53, on *Oreocereus leucotrichus* in No. 38 p. 53 with the original description by Philippi and in No. 40 p. 30.

In regard to the statement by Philippi that *Echinocactus occultus* occurred from Copiapo to Paposos, it may be as well to recollect the state of the art at the time that comment was made. At that time there were known perhaps half a dozen species each of *Gymnocalycium* and of *Notocactus*, a similar number of *Echinopsis* and *neoporteriae*, a few *Lobivia* and *Eriosyce*, and a sprinkling of *Copiapoa*, no *Parodia* and no *Rebutia*. If we bear in mind that Philippi would find cacti buried in the ground almost up to the top of their spines between Copiapo and Paposos, then in the context of the day they would all be *Echinocactus occultus*. That we now divide them up into various *Thelocephala* etc., is simply a matter of progress; whether that progress is forwards or backwards can be debated.

ICONES CACTEARUM No. 1 R. Mottram

Cleistocactus fossulatus (Backeberg) Mottram comb nov.

Basionym: *Oreocereus fossulatus* Backeberg, C., in *Blatter fur Kakteen-Forschung* 6.1934, and in *Der Kakteenfreund* 3:11, 122.1934; non *Pilocereus fossulatus* Labouret (in *Rev. Hort.* 4:4, 24.1855 – *Oreocereus celsianus*). Type: Bolivia, Chuquisaca; illus., no specimen preserved.

Synonyms:

Oreocereus celsianus v. *fossulatus* Krainz, in *Stadt. Sukk – Samml. Zurich* 98.1967.

Oreocereus fossulatus v. *fiavidus* Knize n.n., in *Index Field Numbers* 8, 31.1977 (Bolivia, Cuchu Ingenio, alt. 3000 m; Knize KK880).

Oreocereus fossulatus v. *flavispinus* Ritter n.n., in *Winter Cat.* 3.1954 (FR100).

Oreocereus fossulatus v. *gracilior* (Schumann) Backeberg, in *Die Cact.* 2.1032.1959.

Oreocereus fossulatus v. *lanuginosior* Backeberg (non *Pilocereus celsianus* v. *lanuginosior* Salm-Dyck), in *Kaktus-ABC* 186.1935.

Oreocereus fossulatus v. *magnificus* Knize n.n., in *Index Field Numbers* 8, 12 and 31.1977 (Bolivia, Otavi, alt. 3000 m; Knize KK881, 1335). This name is probably referable here, although young plants raised from Knize seed proved to be *O. celsianus*.

Oreocereus fossulatus v. *pilosior* n.n., in *Borg, Cacti* 114.1937 (155.1951 in edn. 2).

Oreocereus fossulatus v. *potosinus* Knize n.n., in *Index Field Numbers* 31, 1977 (Bolivia, Potosi, alt. 4000 m; Knize KK1455).

Oreocereus fossulatus v. *robustior* n.n., in *Borg, Cacti* 114.1937 (155.1951 edn. 2).

Oreocereus fossulatus v. *rubrihorridispinus* Knize n.n., in *Index Field Numbers* 8, 31.1977 (Bolivia, Cuchu, Ingenio, alt. 3000 m; Knize KK879).

Oreocereus fossulatus v. *spinis-aureis* n.n., in *Borg, Cacti* 114.1937 (155.1951 edn. 2).

Pilocereus celsianus v. *gracilior* Schumann, in *Gesamtb.* 180.1898. No type. According to Backeberg, it is from Bolivia, near La Paz.

Borzicactus fossulatus (Backeberg) Kimnach, in *Cact.Succ.J. (US)* 32:2, 59.1960.

There is repeated confusion in the literature with *Pilocereus fossulatus* Labouret, which is now generally regarded as a synonym of *Oreocereus celsianus*. In the sense which this species is now known, the earliest reference at the level of species is that of Backeberg, in *Kakteenfreunde* of November 1934, where the plant is illustrated but not described. The same illustration, and formal description appears in his *Bulletin of Cactus Research* in the same year. Another illustration, probably of the same plant appears in *Die Cactaceae* Vol. 2 page 1034. Original description, reproduced from *Blatter fur Kakt. – Forsch.* 6.1934:

“Finally tree-like, up to 2.5 m high, much branched, stems fresh green, greyish brown in age, up to 10 cm thick, becoming bare below, the crown covered with quivering, harsh, shining white hairs. Ca. 12 low round ribs, 1 cm across with areoles almost 1 cm wide, with thick yellowish white wool. Radial spines ca. 16, usually about 1.5 cm. long, several stiffer. Generally 1-2 central spines, up to 5 cm; all amber coloured. Flowers greenish pink, ca. 10 cm long, pistil and stamens lilac pink. Occurrence: Central Bolivia, 3500 m, in warm, rather damp regions.”

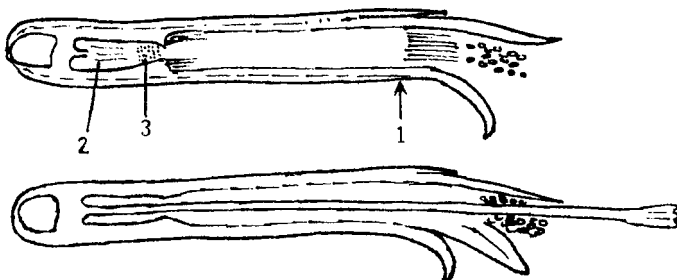
Many readers will be perplexed to see this plant moved from *Oreocereus* into *Cleistocactus*. Had Backeberg stressed seed differences as much as his contemporary Buxbaum, he too, might have segregated *fossulatus* from *Oreocereus*. Already, he had hinted at such in his statement “*Oreocereus fossulatus* has small, bright, black seeds, the other four (species) on the contrary are larger, duller, brownish black with a large hilum.” (*Blatt. fur Kakt. – Forsch.* 1934.)



CLEISTOCACTUS FOSSULATUS var. RUBRISPINUS

(Ritter) Mottram

Top of flowering plant 1.3m high, grown from Ritter seed collected under his field number FR100a. The flowers are 8.5cm. long (including style).



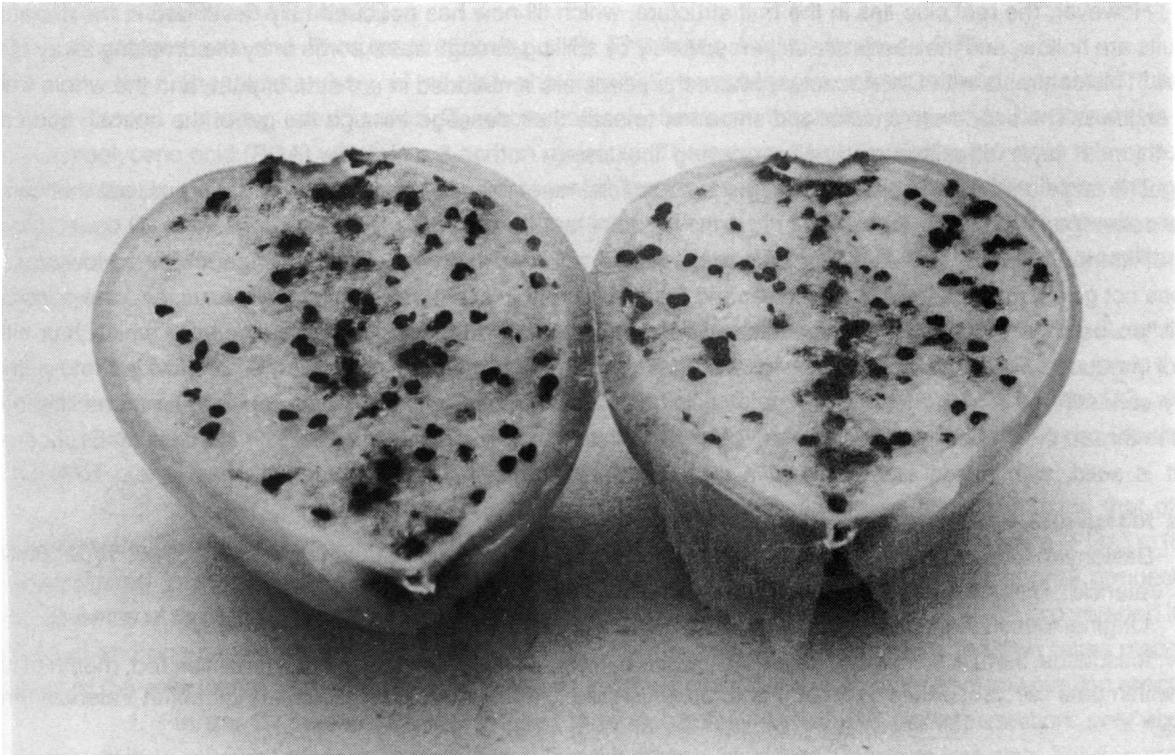
FR100a: Diagram of flower structure

The stamens are inserted mainly in the lower part of the tube, reducing in number towards the throat.

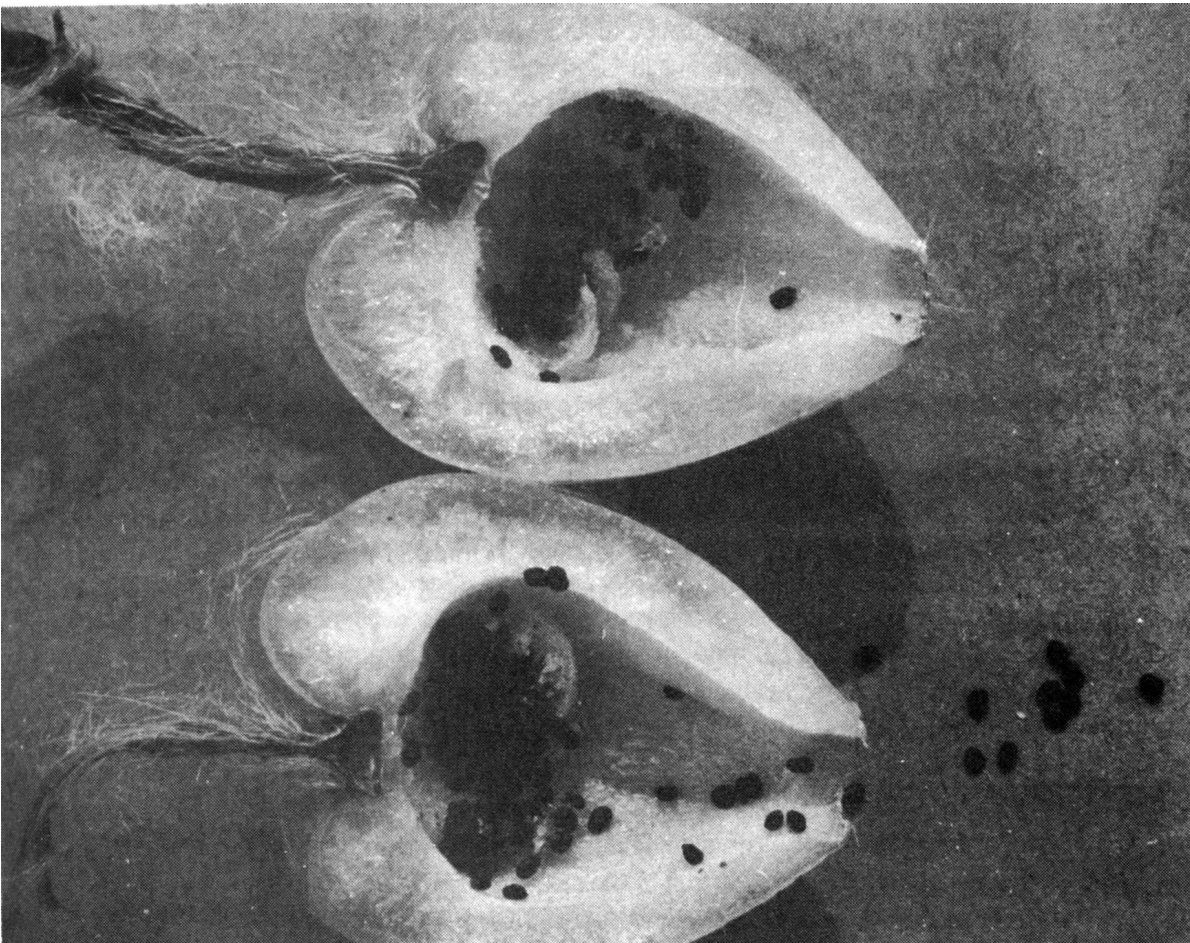
1. Throat circle
2. Nectar chamber. Glands are very elongated
3. Uppermost part of nectar chamber coloured deep pink



Pictotype illustration of *Oreocereus fossulatus*
Backbg., reproduced from Blätter f. Kakteenf. 1934



Cleistocactus fossulatus v *rubrispinus* FR 100a Fruit section
Fruit 5.2 cm long x 5 cm diameter



Morawetzia doelziana Fruit section Fruit about 5 cm diameter

However, the real clue lies in the fruit structure, which till now has not been fully described in the literature. *Oreocereus* fruits are hollow, and the seeds are dispersed freely by spilling through basal pores or by the breaking away of the fruit at the base. This contrasts with *Cleistocactus*, where the seeds are embedded in a matrix of pulp, and the whole fruit is consumed by animals. The seeds are smaller and smoother to ease their passage through the gut of the animal, and carry only the very thinnest layer of arillus material overlaying the testa.

The large areoles and areolar hair give a superficial resemblance to species of *Oreocereus*, but this can be interpreted as convergence.

Ritters' treatment of *Loxanthocereus piscoensis* is interesting, in his transfer to *Oreocereus*. However, his description does not give sufficient detail of the flower and fruit structure to place it definitely in that genus, and the possibility remains that it too belongs properly in *Cleistocactus*. If any member has a *Loxanthocereus piscoensis* which has either flowered and/or produced fruit, then the features to examine are (i) the arrangement of the stamens. If divided into primary and secondary series in the throat, then it belongs in *Cleistocactus* or *Oreocereus*, but if one series of stamens lies in the upper part of the throat, then it belongs in *Loxanthocereus*. (ii) If fruit is hollow and releasing seeds, then it is an *Oreocereus*, but if the fruit is solid, with seeds embedded in a pulp, then it belongs in *Cleistocactus*.

***Cleistocactus fossulatus* v. *rubrispinus* (Ritter) Mottram comb. nov.**

Basionym: *Oreocereus fossulatus* v. *rubrispinus* Ritter, in *Kakteen in Sudamerika* 2,697.1980. Type: Bolivia, Prov. Murillo, Valencia; Ritter FR100a; figs. 701, 702 Bot.Inst. Univ.Utrecht.

Original description, reproduced from *Kakteen in Sudamerika*:

"Resembling v. *fossulatus*, stem 4-9 cm thick, ribs 8-13, areolar hairs 20-100 2-5 cm long, spines brownish red, mouth of tube oblique, tube within pale reddish, petals 5-7 mm broad, brownish red to purplish, fruit ellipsoidal, dry; habitat Valencia, Prov. Murillo, Bolivia."

The plant of *Cleistocactus fossulatus* v. *rubrispinus* FR100a which flowered and fruited in the Whitestones Collection in 1982 reached maturity at a height of just over 130 cm., from seed sown in 1959. Two plants of *Cleistocactus fossulatus* FR100 of the same age and stature have not yet flowered. The flowers were 8.5 cm long, including the exerted style and stigma, and 1.7 cm diameter across the petals at fullest expansion. The colour was a dull pinkish mauve, of a similar hue to that found in some forms of *Cleistocactus strausii*. Fruit failed to set using its own pollen, but fruits were obtained by cross-pollination with *Oreocereus hendriksenianus* v. *densilanatus*, *Oreocereus doelzianus*, and *Matucana yanganucensis*.

Cross-pollinations with *Matucana oreodoxa* and *Oroya neoperuviana* failed, as did the reverse pollination with *Oreocereus hendriksenianus* v. *densilanatus*. Cross-pollinations with other *Cleistocacti* were not attempted, but progeny from crosses between *C. fossulatus* and *C. strausii* are widely cultivated, and examples in the Whitestones Collection flower with the dark mauve colour mentioned above, and intermediate in character between the two species.

Axillary hair is almost totally absent from flowers of FR100a. The fruit of FR100a measures 5 to 5.5 cm long and diameter. The pericarp is a pale apple green, partially translucent, and showing veins and some of the seeds within. Within, the seeds are embedded in a matrix of white, air-filled pulp, formed by the expanded funicular material. It is almost tasteless, but has just a trace of apple flavour. The seeds are about 1.5 mm long, irregular in shape, shiny black, with intercellular pits. The hilum is large, more or less basal, dark brown, pediform, with prominent micro-pyle and funicular orifice almost central.

... from R. Zahra

Some years ago I sowed seeds of FR100a which came from Ritter as *Oreocereus fossulatus* v. *rubrispinus*. One of these plants has now flowered and as I was keen to get it to set fruit, I crossed the flower with *Submatucana formosa*. At the same time I applied some pollen from the *Oreocereus* to the flower on the *Submatucana* but this did not set fruit. However, a fruit did set on the *Oreocereus*; the flower remains stayed on the fruit which was still green when it eventually fell off the plant. It cannot be an *Oreocereus* because it is not hollow inside; the fruit is filled with a white pulp, just like *Cleistocactus*, but the fruit did not split open like a *Cleistocactus*. I tried the pulp and it was edible — it tasted rather like melon. Perhaps it is a *Borzicactus*?

... from H. Middleditch

The fruit on *Oreocereus* and *Morawetzia* is thick-walled and hollow. When the fruit finally falls off the plant it has an opening at the base and the seed trickles out of this opening rather in the manner that it escapes from the fruit of *Neoporteria* and *Islaya*. In the accompanying photographs from R. Mottram may be seen the fruit from a *Morawetzia* sliced in half to show the seeds escaping from the thin-walled container under the crown of the fruit (again similar to *Neoporteria*) and then escaping through the basal pore in the fruit; the fruit of *Cleistocactus* FR100a is filled with pulp. My recollection of fruit on *Cleistocactus* is that as a rule they do split to expose the pulp and the seeds embedded in the pulp, before the fruit drops off the plant. In Rauh's "Beitrag zur Kenntnis der Peruanischen Kakteenvegetation" the fruit of *Haageocereus* is described as "filled with pulp" and Dave Angus tells me that the fruit on his decumbent *Haageocereus* eventually fell off the plant without splitting. Do all *Cleistocactus* fruits split before falling off the plant?

PHOTOSYNTHETIC PATHWAYS

From Photosynthesis and Photorespiration by J. R. Ehleringer, Hort Science 14.3.79

The biochemistry of all the photosynthetic processes revolves around a central theme. This is the Calvin-Benson pathway, or so-called C_3 photosynthesis because the initial product to be formed in this pathway is phosphoglyceric acid (PGA) which is a 3-carbon molecule. The energy which is required to drive this cycle comes from the photosynthesis reactions for which light is an essential requirement. Up until the mid 1960's it was thought that all plants possessed C_3 photosynthesis. It was discovered that in sugar cane the initial product of photosynthesis was not a 3-carbon molecule of PGA but rather a 4-carbon molecule of oxaloacetic acid (OAA). Thus a new photosynthetic pathway, C_4 photosynthesis, was discovered.

The Crassulacean acid metabolism or CAM photosynthesis is a modified form of the C_4 system. The process of converting CO_2 into OAA and then converting the OAA into PGA is carried out not in different cells (as in the C_4 system) but at different times of day at the same site. During the night the stomata are open to take in CO_2 and the CO_2 which is converted into C_4 acids (e.g. Malate) is stored within the vacuoles (storage regions within the cell-H.M.). To provide this storage facility the CAM plants need large succulent mesophyll cells.

In the C_3 process a secondary reaction of photorespiration takes place alongside that of photosynthesis. Photorespiration involves oxygen being taken in at the stomata, combining with phosphoglycerine (PGA) to form CO_2 which is then respired to atmosphere. This process takes carbon out of the plant body. Under normal atmospheric conditions, six-sevenths of the carbon which is taken in by the C_3 plant in the form of carbon dioxide (CO_2) is converted into plant building material and one-seventh is respired again. In the C_4 process, the C_3 photosynthesis reaction takes place within the inner layers of the cells where there is no intake of oxygen and in consequence there is no photorespiration reaction taking place.

In the C_3 process, energy is used both for photosynthesis and photorespiration; only six-sevenths of the energy which is consumed is put to use in converting the carbon from the CO_2 intake into plant building materials. In the C_4 process energy is used both to drive the initial reaction forming OAA and again energy is used to drive the reaction reforming OAA into PGA. Thus the C_3 system would appear to require more energy per unit of carbon converted to plant building material. However, calculations and measurements have shown that at $30^\circ C$ there is a balance where the energy consumption of photorespiration in the C_3 process exactly equals the additional energy needed to perform a two stage process in the C_4 system. In the C_3 process there will be an increase in photorespiration as temperature increases, but there is no photorespiration in the C_4 process. Thus as temperature rises above $30^\circ C$, the C_4 system will become more efficient and conversely as the temperature falls below $30^\circ C$ the C_3 system becomes increasingly more efficient.

One advantage of the C_4 system may lie in an increased water use efficiency in comparison with the C_3 system. This is because the ratio of transpiration to photosynthesis will be higher in C_3 plants. This is because the C_4 plant can attain the same photosynthetic rate as a C_4 plant but with a smaller stomatal opening and hence a reduced water loss. Under hot and/or arid conditions this could mean a much lower rate of water loss in a C_4 plant. The CAM system represents an even further increase in water use efficiency over the C_4 system. Because the stomata open only at night under conditions of much cooler temperature and thus lower transpiration rates, the ratio of transpiration to photosynthesis will be very low with a CAM plant. Because of this, CAM plants may be simply better able to survive extreme drought than C_3 or C_4 plants. However, as a consequence of only nocturnal stomatal opening, the maximum rates of photosynthesis in CAM plants are also much lower than of either C_3 or C_4 plants:

System	Maximum photosynthetic rate	Transpiration ratio
C_3	10 to 60	450 to 600
C_4	30 to 60	250 to 350
CAM	3 to 10	25 to 150

There are a large group of plants which change their photosynthetic pathways. It appears that many succulent perennials are able to change from the C_3 system to the CAM system depending on environmental conditions. Under mesic (moister) conditions the plants discontinue the CAM system and utilise the C_3 system to obtain a higher rate of carbon gain, which is equal to a more rapid rate of growth. Under arid conditions the plants use CAM photosynthesis and are better able to survive drought conditions than they could do with C_3 photosynthesis. Into this class comes *Mesembryanthemum crystallinum* and *Dudleya farinosa*. A variation on this theme is *Freria indica*, a plant with succulent CAM stems and drought deciduous C_3 leaves.

To summarise, C_3 photosynthesis is most common in cool and moist habitats, C_4 photosynthesis in hot or salty habitats, and CAM synthesis in extremely arid habitats. The CAM system requires succulent diurnal storage cells.

... from Kluge and Ting "Crassulacean Acid Metabolism" 1978

The CAM plants found in the 18 families studied are largely distributed along the tropics of Cancer and Capricorn and in the wet tropics in physiologically dry, epiphytic type habitats. Within the families the distribution ranges from all members with CAM potential in the case of the tropical and arid-distributed Cactaceae and the Crassulaceae, to two

genera out of about 20 in the Vitaceae and Geraniaceae. In these latter two genera i.e. Cissus and Geranium (Pelargonium) both are xerophytic.

Of the large families with both CAM and non-CAM species e.g. the Asclepiadaceae, Euphorbiaceae and Liliaceae, the fleshy xerophytic forms have CAM. In the important CAM families of Bromeliaceae and Orchidaceae, most of the CAM species are epiphytes living in physiologically dry niches.

The concept has emerged that CAM is a mechanism which facilitates a specialised group of plants to survive in habitats where water is temporarily deficient and there are now compelling arguments to interpret CAM as an ecological adaptation. All the CAM species occupy arid or locally dry niches. These include arid desert-type habitats such as encountered by epiphytes and plants existing in very rocky or shallow soils. Most of these species which show CAM are either stem or leaf succulents, or fleshy or coriaceous leaved plants.

CAM is usually regarded as a typical feature of succulents because of its occurrence in many succulent species. However, two questions must be asked: first, is the occurrence of CAM restricted to succulents? Secondly, do all succulents exhibit CAM? The classification of a plant as succulent is based exclusively on morphological criteria, and does not indicate a special taxonomic status. The single morphological criterion which classifies a plant as succulent is the possession of voluminous water-strong tissues resulting in an increase in volume relative to surface area. Hence succulents are generally characterised by their ability to store relatively large amounts of water.

There is no doubt that the storage of water by succulents represents an ecological adaptation, because succulents are xerophytes which occupy habitats where either precipitation occurs only periodically or soil water is generally not available (e.g. epiphytes) and periods of water deficiency are overcome with endogenous water reserves. In succulents, all basic organs of the plant can function as water reservoirs. Thus, leaf succulents, stem succulents, and very rarely root succulents can be distinguished. CAM plants are only known as members of the leaf and stem succulents.

The key reaction in CAM is the fixation of the CO₂ taken in during the dark. The first intermediate product of dark CO₂ fixation is oxalacetate (OAA) but of the first stable products detectable by chromatography, the predominant component is C₄H₆O₅ (malic acid). An essential feature of CAM is the accumulation of substantial amounts of malic acid during the night, requiring a compartment where the acid can be temporarily stored without endangering structures and biochemical processes. Such a compartment is provided by big vacuoles where malic acid is stored as an aqueous solution. It is obvious that a high degree of succulence should correlate with CAM since it offers a large storage capacity for malic acid.

There is overwhelming evidence that high night temperatures inhibit malic acid accumulation in CAM plants whereas low night temperatures have the opposite effect. Dark fixation of CO₂ may also be inhibited by very low night temperatures. In Kalanchoe tubiflora and Tillandsia usneoides, net CO₂ uptake is zero at 5°C, but in Echinocereus net dark fixation of CO₂ at 5°C was only slightly inhibited. For Tillandsia usneoides, optimal CO₂ uptake is observed at nightly temperatures from 15-22°C.

Investigations have clearly shown that nocturnal malic acid accumulation by succulents occurs only with sufficient pre-illumination during the period preceding the night. The influence of the intensity of pre-illumination on subsequent dark CO₂ fixation was investigated for Tillandsia usneoides and Kalanchoe tubiflora. The fixation of CO₂ during the subsequent dark night was relatively high after application of high light intensities and decreased if the pre-illumination light intensity was diminished. It is most likely that other species of CAM plants behave similarly. As for example, Kalanchoe daigremontiana:-

Light intensity during preceding light period (mW/cm ²)	1409	1230	1013	564
Nett dark CO ₂ fixation (micro-gm/gm dry weight)	1149	990	725	319

There are several possible explanations of the mechanism by which the degree of pre-illumination can influence subsequent dark CO₂ fixation. A substance (PEP) acts as a CO₂ acceptor to form OAA during the dark; this acceptor is synthesised during the day and it is supposed that the quantity synthesised is dependent upon the degree of illumination. In turn this will determine the amount of CO₂ acceptor which is available for dark CO₂ fixation during the course of the following night. A further possibility by which pre-illumination might affect dark CO₂ fixation is the extent by which photosynthesis consumes the malic acid during the day and so "empties" the vacuoles to provide the storage capacity which is required during the subsequent night.

There is strong evidence that photoperiod is of great significance in the regulation of nocturnal CO₂ exchange in certain CAM species. This has been demonstrated in the short-day plant Kalanchoe blossfeldiana var. Tom Thumb, where dark CO₂ fixation only occurs after a critical number of short days i.e. long nights. The magnitude of carbon gain during the night increases with the number of short days. Plants cultivated under long-day (i.e. short night) conditions show little or no CO₂ uptake during the night. This effect was not observed with a different variety of Kalanchoe. More investigations with a larger sample of species are needed prior to generalisation.

In certain deserts where precipitation is low and irregular, CAM plants are considerably less abundant than in the deserts of the New World and are restricted to specific habitats. Such an example is Caralluma negevensis from the Negev desert in Israel. In April and May the plant has high rates of temperature-dependant dark CO₂ fixation. Beginning with May and lasting throughout the dry season, high night temperatures inhibit dark CO₂ fixation. In the middle of August, any

nocturnal CO₂ uptake was prevented. The growth of *C. negevensis* is apparently limited by the generally high temperature level of the Negev. This could explain why *C. negevensis* is found only in shady habitats — gaps and crevices between rocks — where full sun radiation is avoided. In this sense it is somewhat comparable to *Dudleya saxosa* in the S.W. United States deserts. These CAM plants also occur in shady sites and grow best during the cooler season.

It is now generally accepted that CAM plants are distributed in many of the deserts of the world. The epiphytic CAM plants — predominantly Bromeliads and Orchids — exist in locally dry environments. Others still, although perhaps existing in seemingly mesic habitats, actually occur within rocks or on shallow soils with prolonged water deficiencies. Hence it can be indicated that water economy is an important ecological aspect of CAM. In this sense, the ecological significance of CAM is the adaption to arid or otherwise dry environments.

. from H. Middleditch

The author observes that CAM plants are found in moist (mesic) locations but on local water-deficient places; would this comment apply to the *Eriocactus magnificus* found by Ritter and Buining which were surrounded by rampant forest, but growing on a patch of stony ground? And also to the *Malacocarpus* and *Notocactus* found by Dr. Moyna in Uruguay on the crowns of low hills where the local stony ground was obscured by the height of the grass, and to the *Notocacti* and *Frailea* found by Prestléé in similar locations.

The author states categorically that CAM plants are only known as stem and leaf succulents but not as root succulents. Does this mean that *Thelocephala* (*Chileobutia*), *Pterocactus*, *Pygmaeocereus* and *Wilcoxia* are not CAM plants, or does it just mean that no-one has determined yet whether or not they are CAM plants?

In general terms, we are told that Cactaceae are CAM plants and from this we may assume that those factors which are stated to have an effect on growth of CAM plants, should equally apply to cacti. For example, the author tells us that a high night temperature reduces rate of growth or, if the night temperature is high enough, it may prevent growth altogether. The example of a *Caralluma* growing in the Negev desert is cited where growth is negligible in the period when the night temperature is high. In a previous issue of *The Chileans*, a number of members recorded observations even in this country upon cacti in cultivation which appeared to slow down in growth rate during the height of summer i.e. when the night temperature is high. Does this mean that we should leave doors and ventilators open throughout the summer nights in order to evacuate the hot air of the day, to cool down the pots and the staging and get the ambient temperature down to a level at which the plants will grow better (bearing in mind that they grow at night)? And what sort of lowered temperature should we aim at for night time? The author tells us that *Kalanchoe* and *Tillandsia* required a night temperature of 15°-22°C for optimum growth, but growth rate for *Ferocactus* was barely affected down to 5°C. Could this be due to the *Ferocactus* being acclimatised to this level of night temperature as a regular regime in the wild, whereas the leaf succulents would not expect such a low night time temperature as a regular regime? Would information regarding normal night-time temperatures at cactus habitats in the wild provide some guidance towards an answer to the questions of optimal night time temperature in the greenhouse?

The author also observes that rate of growth during the night can be affected by the intensity of illumination during the previous day and also by the duration of the illumination: the less intense the light, the less the growth over the subsequent night: the longer the day (and the shorter the night) the less the growth over the subsequent night. Now when we get some fine sunny days in spring or autumn one can almost see the plants growing as you walk round the greenhouse. Is the problem in these latitudes that it is light in summer until after ten o'clock at night, with dawn light (not sun-up) before five in the morning, so that there is insufficient length of real darkness in which the plants can grow, despite the adequate daylight intensity? Travellers and residents in the tropics appear to concur in the sharpness with which dusk and dawn passes and also how even summer days differ little in length of daylight from winter. Does this mean that in habitat the cacti receive an adequate length of darkness, whereas here, where we are but some ten degrees of latitude away from the Arctic Circle, that there are insufficient hours of darkness for them to grow in mid-summer? Does this mean that they would grow better if the greenhouse was equipped with a set of black-out blinds which came into action at 6 p.m. and rolled back at 6 a.m.?

. from G. J. Swales

It has been my usual practise in summer to open the greenhouse ventilators on warm sunny days and close them again in the evening. However, events conspired to prevent me watering my plants for practically the whole of August and at the same time the ventilators happened to be left wide open. When I did get around to watering the plants again about the end of the month it was quite striking to see the amount of growth which had been put on by a great many plants during that period. It is possible that this good growth could be related to the fairly good light intensity during the intervening days, which Kluge and Ting tell us improves the growth rate of CAM plants. Or it may have been due to the fairly low night temperature arising from the ventilators being always open, which is also said to benefit CAM plants. Or to a combination of both factors.

. from D. Angus

For quite some time I have been rather unhappy with the way quite a few plants have failed to flourish when put into the propagator. Cuttings just seem to languish and neither put down roots nor shrivel up. One or two tender plants put there for safety have certainly survived but do not seem to want to grow. I had come round to thinking that the atmosphere in

the propagator was constantly warm and moist and pretty close all the time and that it might be this close atmosphere that did not suit the plants. So I have built myself a hot bed, putting in a soil warming cable, covered by two or three inches of fine builders' sand and topped off by a layer of gravel. The temperature of the bed is set at 70°F. There is no bottom drainage so the sand holds a fair amount of water. Drainage through the pots which stand on the bed seems to keep it pretty moist — just poking a finger into the bed usually finds it fairly slushy and it is only necessary to water the bed itself infrequently. By comparison with the propagator, the results have been not so much astonishing as out of this world. Roots just seem to jump out of cuttings in no time at all.

I have heard of timing controls which allow heating cables like these to be turned on and off automatically but I wanted to find out whether the idea was any good rather than go to a lot of trouble and expense with fancy gadgets to save heating costs. Although the heating cable is on all the time, it certainly will not keep the air around the plants at 70°F at all times like it was in the propagator. If cacti do grow at night, does it mean that my plants on the hot bed are just cool enough to grow at night whereas in the propagator they were too hot to grow at night?

. from Weier, Stocking and Barbour "Botany" 1970

Of the total radiant energy that falls upon green leaves, about 80% is absorbed (the remainder being transmitted or reflected). Part of the radiant energy absorbed is changed to heat and raises the temperature of the leaf. A large part of what is absorbed is used up in transpiration; less than 4% is used for photosynthesis.

. from H. Middleditch

It would appear from this statement that over 95% of the radiant energy absorbed by a plant is used for transpiration and also to heat up the plant. Now a C₃ plant has to transpire between three hundred and nine hundred units of water for every unit of dry weight added as growth. On this account it would seem to be most probable that most of the energy actually absorbed by a C₃ leaf or plant is used for the purpose of transpiration i.e. to balance the latent heat of vaporisation. But a CAM plant has a greatly reduced rate of transpiration in comparison with a C₃ plant so that it does not require the same amount of radiant energy intake; so for equal exposures to the sun, a CAM plant will receive a far more radiant energy that it can put to use. Hence a CAM plant must either reflect this energy or alternatively accept the incident energy at the expense of an appreciable increase in internal temperature.

But if a CAM plant grows in the shade of a C₄ plant, it will probably obtain quite sufficient light to drive the photosynthetic process — it needs less than 10% of the radiant energy requirement of the C₄ plant. Even if its roots are far less extensive than its C₄ companion it may still be able to acquire enough water to match the much lower transpiration rate. In his article about collecting cacti to the north of Los Colorados Knoll tells us that the cacti were "always hidden under bushes" and Jorg Piltz agrees that this matches his own observations. Bort also tells us that cacti "always grow under bushes or trees or in the shade of rocks" in the Sierras Ancasti, Graciana, and Ambato. In Chileans No. 15 p. 59, Van Vliet wonders in the dry belt between the Pampas and Patagonia, "why the plants grow, here too, so often under bushes." Although this particular patch of ground lies much further to the south than these locations which gave rise to similar comments from Knoll, Piltz and Bort, they all fall within the same major climate and vegetation region of the Monte. If the *Gymnocalycium* and *Parodias* are CAM plants then presumably the shading bushes are C₄ plants. Several of the slides shown by Jorg Piltz of *Parodia* growing in habitat were of *Parodia* growing in the shade of bushes — is this a typical situation? The *Austrocactus patagonicus* shown on a slide from van Vliet was growing in the middle of a clump of bushes on the Patagonian Monte, so presumably the *Austrocactus* is a CAM plant and the bushes are C₄ plants. When Van Vliet said that he nearly missed an *Austrocactus* because it was surrounded by a clump of *Xanthium spinosum*, was this again a CAM *Austrocactus* being shaded from excessive heat input by the C₄ *Xanthium*?

In Chileans No. 39 p. 47, Prof. Hauman-Merck observes that in the Monte vegetation in the north of Patagonia, *Cereus coerulescens* grow upright until they reach the height of the surrounding thicket and then they start to grow bent over "almost at right angles", always facing a north-south direction. If the *Cereus* is a CAM plant, the internal heat-load will be limited by the shading of the surrounding bushes until it becomes exposed to full sun by further growth. When the plant bends towards the north, it will expose far less of its external surface to the direct rays of the sun; by facing the high sun, the spination will surely be more effective in obstructing sun rays from reaching the body. Does this form of bent growth represent a method of controlling internal heat load in a CAM plant?

Alternatively, can a CAM plant growing out in full sunlight provide its own "shade" by means of a coating of chalky rime or even an epidermal layer of dark pigment? Is this the function of the dark-bodied *Neochilenia*, *Thelocephala*, *Gymnocalycium* (*stellatum*, *kozelskianum*), and *Copiapoa* (*barquitensis*, *hypogea*); and of the coating of rime on many *Copiapoa*? When *Copiapoa* grow in cultivation without this coat of rime and then become exposed to full sun, does the water in the surface layer of cells become heated up and evaporate so rapidly that the surface cells dry up completely and so we call it a "scorched" plant? Does a *Muscosemineae* *Gymnocalycium*, used to growing in the shade of bushes in the wild as Buining tells us, go flaccid when placed in full sun in cultivation because its root system and internal plumbing is unable to convey the quantity of water required for C₃ transpiration rates.? Do the *Muscosemineae* *Gymnocalycium* operate as CAM plants which do not revert to the C₃ system because they are unable to do so?

Does a heavy armour of spines contribute to an increased reflection of incident energy before it reaches the body of the plant itself? Is this why Knoll found that “. . . plants are always more strongly spined when not growing under bushes . . .” Could this also be why E. W. Bentley found his plants showed better spine growth when he moved from the built-up area of Thames Ditton to a Devon village “. . . where we seem to get more light. . .” — do the plants put out their own protection against an increased potential heat load? Where *Tephrocactus* are found growing at high altitude, sometimes a hairy *Tephrocactus* grows right alongside a hairless one; is the hairy *Tephrocactus* a CAM plant with built-in light-reflective protection and the hairless *Tephrocactus* a C₄ plant that can shed the heat load by transpiration or reflect it by means of a waxy body coating?

And if the *Austrocactus* normally grow in the shade of a C₄ plant, how did Britton and Rose find an *Austrocactus* growing out in the open to photograph for their book on “The Cactaceae”. Did they have to search for an abnormal one which made a better photograph than those growing amid the bushes; or did they not wish to penetrate the bushes and so never really knew they were there?

. from R. Kiesling

Austrocactus patagonicus normally grows in association with bushes which may be small or not so small. I think that the seedlings need some protection in the initial stages of growth. But there are many times when you can find an isolated example — perhaps it did grow that way, or perhaps the protecting plant has died.

. from D. W. Whiteley

There is some information about internal temperature of cacti published in *Flora*, Vol. 166 under the title of “Environmental adaptions of the Atacama Desert Cactus *Copiapoa haseltoniana*” by H. A. Mooney, P. J. Weisser and S. L. Gulmon. Dr. Weisser is an ecologist and Mooney and Gulman are from the Department of Biological Sciences at Stanford University U.S.A. In this paper the temperature of *C. haseltoniana* is recorded both internally and externally during the day with relation to orientation of different stems, farinose and non-farinose parts of stem and influence of mist upon inside and outside temperature — all this recorded by thermistors implanted in the tissue beneath the epidermis at positions 8 c.m. from the apex of the plant and 50 cm above the soil surface. An additional probe was placed in the central core of the cactus at the same height but at a depth of 8.5 cm. Air temperature was also measured at a height of 50 cm, along with measurements at soil surface and within the woolly “cephalium” at the top of the plant. It was found that the apical wool “cephalium” in fact kept the apical meristem considerably above the ambient temperature and in fact similar to the soil surface temperature which was well above that of the plant body. This, they reason, is to keep the meristem growing fast as “The orientation of the tip of the succulent stems of *C. haseltoniana* toward the noon sun results in a reduction of the total radiation absorption by the main body of the plant. However, the tip itself receives the full midday radiation load, and substantial overtemperatures result. Since the tip of the plant is somewhat thermally isolated from the plant body by a dense pad of bristles, these temperatures do not affect the water balance of the main plant body. the reproductive parts, as well as the stem meristem, are localised in this area, thus suggesting a positive value for such a positioning. The elevated temperatures would potentially result in increased rates of cell division and growth and hence of reproductive output in the dry but relatively cool coastal climate” . . . “Thus it appears that in *C. haseltoniana* there has been a selection of morphological features that result in a reduction of potential overtemperature of the photosynthetic, and hence water losing, parts of the plant simultaneously with an enhancement of potential overtemperatures in the meristematic and reproductive regions.”

. from G. J. Swales

Proteins in cacti appear to be able to withstand a higher than average internal plant temperature. Most plants have proteins which begin to break down at about 35/40°C and above that sort of temperature the denaturing of the protein means that the plant is beginning to die. Cacti apparently have proteins that denature at a much higher temperature than the protein in other plants.

. from A. Lau, C. & S. J. (U.S.) 50.6:1978

We headed for Huari over the Abra Cahuish. Everywhere white and yellowish-white patches caught our attention — pillows of *Tephrocactus floccosus*, *blancii*, *hirschii* and *udonis*. *Tephrocactus floccosus* maybe shows the whitest wool. Alas, in cultivation in Mexico it has lost all of this protective hair within a year. Is the hair protection there to maintain a certain warmth in the cold nights, or is it to avoid ultra-violet rays burning the plant?

. from H. Middleditch

It is not difficult to envisage the hair acting as an insulating layer to conserve heat overnight. But as a CAM plant the dense white wool will obscure a great deal of the powerful rays of the sun reaching the body of the plant where they would generate an excessive heat load. One can surmise that in cultivation in Mexico, the plant is no longer exposed to sunlight having the same energy (however that may have been brought about) and so there is no longer the need for the hairy coating to avoid an excessive internal heat load. Perhaps the apical wool in Mooney, Weiser and Gulman’s *Copiapoa haseltoniana* trapped the incident energy, so heating up the apical wool but at the same time protecting the apical meristem from excess heat load?

THE VARIED WAYS PLANTS TAP THE SUN By Peter Moore

From New Scientist February 1981

The process by which green plants use the energy of the sun to build inorganic carbon dioxide in the atmosphere into organic molecules is crucial for all living things, save for a few specialist bacteria; it is what allows plants to grow. But this process — photosynthesis — is beset with difficulty, for the plant loses water as it takes in carbon. If the carbon in carbon dioxide is to be trapped and used to build organic molecules, it must enter the plant through holes — the so-called stomata — situated mostly in the leaves. And if the gas is to enter the cells inside the plant, and hence reach the chloroplasts where photosynthesis takes place, the cells must be moist. Hence, as it takes in carbon dioxide gas, the plant tends to lose water by evaporation; and the more it loses, the more it must draw from its roots. Under dry conditions, unless it is specially adapted, the plant will dry out and die. One strategy that some plants adopt to overcome these stresses is to avoid opening the stomata during the day when stresses are at their greatest.

CAM — The Succulent Solution

Many plant species combat dry conditions by the fleshiness of their leaves, or as in cacti, by their fleshy stems; many of these so-called succulents reduce transpiration by keeping their stomata closed during the day and opening them only by night. In these plants carbon dioxide, entering the leaves by night, first combines with a three-carbon compound known as phosphoenol pyruvate or PEP to form the four-carbon oxaloacetic acid which is then converted into malate, also with four carbons per molecule. Malate can then be stored within the vacuoles of the leaf cells until daytime when it is moved into the cytoplasm. There the malate is degraded to produce CO₂ once more, and refixed by the conventional C₃ process. Here Carbon from CO₂ is first combined with a five-carbon compound, the phosphorylated sugar, ribulose biphosphate (formerly called ribulose diphosphate) to form a three-carbon compound phosphoglyceric acid or PGA. This three-carbon acid is then converted into a three-carbon sugar and in its turn the three-carbon sugar is converted into other sugars (including ribulose, which can be used to capture more carbon) and hence into all other compounds such as proteins and fats that the plant requires.

Such a mechanism clearly conserves water; the stomata are opened to receive carbon dioxide only when the conditions are least likely to cause evaporation. The system was first described in 1947 by Meirion Thomas, in the family Crassulaceae, which is represented in Britain by the stonecrop. Hence the system is known as Crassulacean acid mechanism or CAM. But CAM is now known to occur in 21 families. Many, perhaps most, of the succulents that practice CAM are also able to fix carbon by day by the normal C₃ route, when conditions are moist.

Photorespiration

The second problem in photosynthesis is photorespiration, a seemingly almost perverse process that was detected only about 20 years ago — the term photorespiration was first used and first described in detail by John P. Decker and Marco A. Tio in 1959. The term refers to oxygen competing with carbon dioxide and preventing its fixation. Photorespiration apparently takes place because oxygen interferes with the initial combination of CO₂ with ribulose biphosphate. This reaction is orchestrated by the enzyme ribulose biphosphate carboxylase. Oxygen apparently competes with CO₂ for sites on the enzyme so that instead of combining with the carbon in CO₂ and then dividing into three-carbon PGA molecules, the ribulose biphosphate splits to form a two-carbon compound which is then broken down to produce CO₂ again. The whole process of two-carbon compound formation and breakdown is stimulated by high temperatures. The net effect of photorespiration is that oxygen in the atmosphere depresses the rate of photosynthesis.

The mechanism of photosynthesis almost certainly evolved in a primitive atmosphere in which oxygen was scarce; atmospheric oxygen is almost certainly a by-product of photosynthesis. Current oxygen levels were probably achieved by Carboniferous times (about 350 million years ago) and from then on the photosynthetic green plant would have been embarrassed and rendered less efficient by the by-product of the very system that had made them so successful.

... from W. A. Ridley

The article about C₃C₄CAM in Chileans 41 was hardly light reading and I found it necessary to study it with some degree of concentration in order to be able to understand what it was all about, but I must say that I found it most interesting. There are, however, one or two things that are not altogether clear to me.

If the reactions depicted diagrammatically in Chileans 41 represent the process of photosynthesis, in which sunlight is involved, how can part of the CAM reactions take place during the hours of darkness? In addition, how does the CO₂ find its way into the plant during the hours of darkness, when I expect that the stomata will be closed? In Chileans 40 p. 16, Orians and Solbrig say that CAM plants have a strict requirement of high day temperatures and low night time temperatures. I do not understand what this has to do with the photosynthetic process; why do they make this observation? There have been one or two comments made previously in the Chileans about cacti growing well in cultivation in spring and in autumn when the days are warm and the nights are cool or cold, whereas they do not grow anything like as well in my experience in midsummer when days are hot and nights are mild or warm. So the comment made by Orians and Solbrig seems to fall in line with what happens with my own plants, but I still do not see how (or if) this is related to the CAM system.

... from H. Middleditch

Both Kluge and Ting and Ehleringer note that CO₂ is taken into CAM plants in the dark, the latter author

specifically noting that the stomata are open during the night in CAM plants. In "Biology, its principles and applications" Garrett Hardin states that "the coupling of CO₂ to RubP is a dark reaction — no light is required" — thus any CO₂ imbibed by the plant can be fixed during the night time.

Any plant can and does transpire water from its body out into the surrounding atmosphere through the stomatal openings. Although the total area of stomatal pores only amounts to some 1% to 2% of the total surface area of a plant (Strasburger — *Textbook of Botany*), the total internal surface area of stomatal cavities will be considerably more. Water from inside the plant will pass through the walls of the cells lining the stomatal cavity; within the stomata this transpired water will exist in the vapour phase. The interchange of air between this cavity and the immediate surrounding atmosphere will bring in fresh supplies of CO₂ into the stomata and remove the water-laden air. If the relative humidity of the air surrounding the plant is low, the air which then enters the stomata will be able to take up the transpired water; as the interchange of air continues, transpired water will thus be conveyed steadily from the plant into the surrounding atmosphere. However, if the incoming air is at a high relative humidity, there will be a negligible humidity gradient between the entering and departing air and so the stomata will not be able to transpire water out of the cells which line the stomatal cavity, into the already moisture-laden incoming air. Thus traffic through the walls of the stomata lining will be one-way only i.e. CO₂ entering the stomata lining but little or no water going out of the plant.

When the daytime air temperature is fairly high, it will induce the air to take up any available ground water, especially if the relative humidity is then pretty low. Then as the temperature falls during the course of the night the relative humidity of the same air will rise in like proportion. The lower the temperature falls at night time the higher becomes the relative humidity of the air entering the stomata and the more likely is stomatal traffic to be one-way only. In this respect, a wide divergence between daytime and night-time temperatures are conducive to water economy in a CAM plant and it seems to be probable that this is what is behind the statement made by Orians and Solbrig. Many CAM plants rely to an appreciable extent upon moisture provided by morning dew (*Browningia*, *Islaya*, *Discocactus*, *Brasiliparodia*, *Austrocactus*) which can only form when the temperature falls sufficiently at night time to raise the relative humidity of the air immediately adjacent to the ground to 100% and then the temperature must fall further still before dew will condense. In arid climates, this can only occur when there is a wide diurnal range of air temperature.

On the other hand, a high daytime temperature is commonly associated with a bright, sunny day. Insolation falling on a plant not only provides the driving force for photosynthesis, but also heats up the body of the plant. To quote Strasburger, "An adequate transpiration stream is of particular importance for the plant because of its cooling effect, which prevents a dangerous overheating of its organs by the sun's rays. Quantatively, the rate of transpiration is such that the heat taken up by the evaporating water is approximately equal to that provided by the insolation." But a CAM plant has all its stomata closed during daylight hours, so there is no transpiration, no means of disposing of heat received. So a CAM plant requires to be in receipt of sunlight to be able to drive the photosynthetic reaction but out of the heat of the sun in order to avoid becoming overheated.

Avoidance of the heat of the sun can be seen in the slides of *Islaya* taken near Ilo by R. K. Hughes and shown to the Chileans 1983 week-end: the crowns of the plants were covered by a layer of grit so that the crown was not exposed directly to the rays of the sun. Several *Pyrrhocactus* and *Thelecephala* photographed in Chile by R. Ferryman and seen on the ground so that the only heat and light to reach the body of the plant would be that filtered through the sand grains covering the plant. Slides were also shown by C. Rodgers of *Gymnocalycium mihanovichii*, *Echinopsis*, *Monvillea* and *Nopalea* growing within the confines of the Chaco woodland, where only dappled sunlight filtered through the leaves of the canopy overhead and fell on to the cacti. There did not appear to be any competition for the cacti here from other undergrowth, apart from sparse grasses or herbs, so presumably the amount of sunlight reaching the ground was inadequate, in combination with the rest of the environment, to permit the growth of C₃ or C₄ plants other than trees. The *Frailea* which Mr. and Mrs. Collins found in the north-east of Uruguay growing in a layer of moss and only discovered because the flower projected above the moss, would presumably be protected from the direct heat of the sun by its surrounding carpet of moss. When Dr. Moyna described the *Gymnocalycium* for which he searched amongst the long grass growing on a hillock in Uruguay, only when about to give up the quest did he discover that all along he had been walking over and on the plants he was looking for. These would be protected from direct sunlight by the long grass, even when it was brown and withered in the heat of summer.

Thus if we expose our plants to full sun in summer or to a warm night in the greenhouse, they may not be too suited and they may react by declining to grow under these conditions.

CHILEANS 1984 AUTUMN WEEK-END

It is proposed to hold this event on September 8th to 10th 1984 at Brookly College. As we go to press R. Ferryman is out in Chile and J. Lambert is in Argentina. We hope to hear from both members about their experiences.

STUDY GROUPS/REFERENCE COLLECTIONS

Cleistocacti	T. Lavender, Kalanchoe, Market Place, Tetney, DN36 5NN.
Echinopsis	M. Muse, 24a, Castle Road, Kirby, Muxloe, Leicester, LE9 9AB.
Frailea	J. Forrest, Spring Garden, 2, Darngaber Road, Quarter, Hamilton, Scotland.
Gymnocalycium	G. J. Swales, 5, Hillcrest, Middle Herrington, Sunderland, Tyne & Wear.
Lobivia	J. Hopkins, Primrose Cottage, Monks Lane, Audlem, CW3 0HP.
Matucana/Borzicactinae	P. Allcock, Windyridge, 77, Alvescot Road, Carterton, OX8 3JP.
Melocactus/Discocactus	J. Arnold, 4, Lonsdale Court, Churchill Park, Washingborough LN4 1HJ.
Neoporteriaea	R. Ferryman, Nichelia, The Street, Stonham Aspal, IP14 6AH.
Notocactinae	G. J. Charles, 138, Whitehouse Common Road, Sutton Coldfield, B75 6DT.
Opuntia/Tephrocacti	J. W. Bagnall, Wendy Cottage, 128, Huddersfield Road, Meltham.
Photographing Cacti	A. W. Craig, 32, Forest Lane, Kirklevington, Nr. Yarm, TS18 5LY.
Rebutia	P. Smart, 5, Tomlinson Avenue, Gotham, Nottingham, NG11 0JU.
Sulcorebutia & Weingartia	J. R. Gooch, 51, Bourn Avenue, Hillingdon, UB8 3AR.

THE CHILEANS

Organiser	H. Middleditch, 5, Lyons Avenue, Hetton-le-Hole, Co. Durham, England, DH5 0HS.
Treasurer	R. L. Purves, 19, Brocks Drive, Fairlands, Guildford, Surrey, GU3 3ND.
Membership Sec. & Back Numbers	Mrs. G. Craig, 32, Forest Lane, Kirklevington, Nr. Yarm, TS18 5LY.
Seed Exchange	J. Hopkins, Primrose Cottage, Monks Lane, Audlem, Cheshire, CW3 0HP.
Slide Librarian	A. W. Craig, 32, Forest Lane, Kirklevington, Nr. Yarm, TS18 5LY.
Weekend Events	Mrs. M. Collins, 11, Tudor Gardens, Upton, RM14 3DE.

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