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Oxford University Exploration Club

Bulletin No. 22
Section 2

Report of the expedition to
Sierra Nevada de Santa Marta,
Colombia 1973
1974

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Oxford University Exploration Club

Bulletin 22 No. 2

Editor: Andrew Goudie (School of Geography)
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CONTENTS

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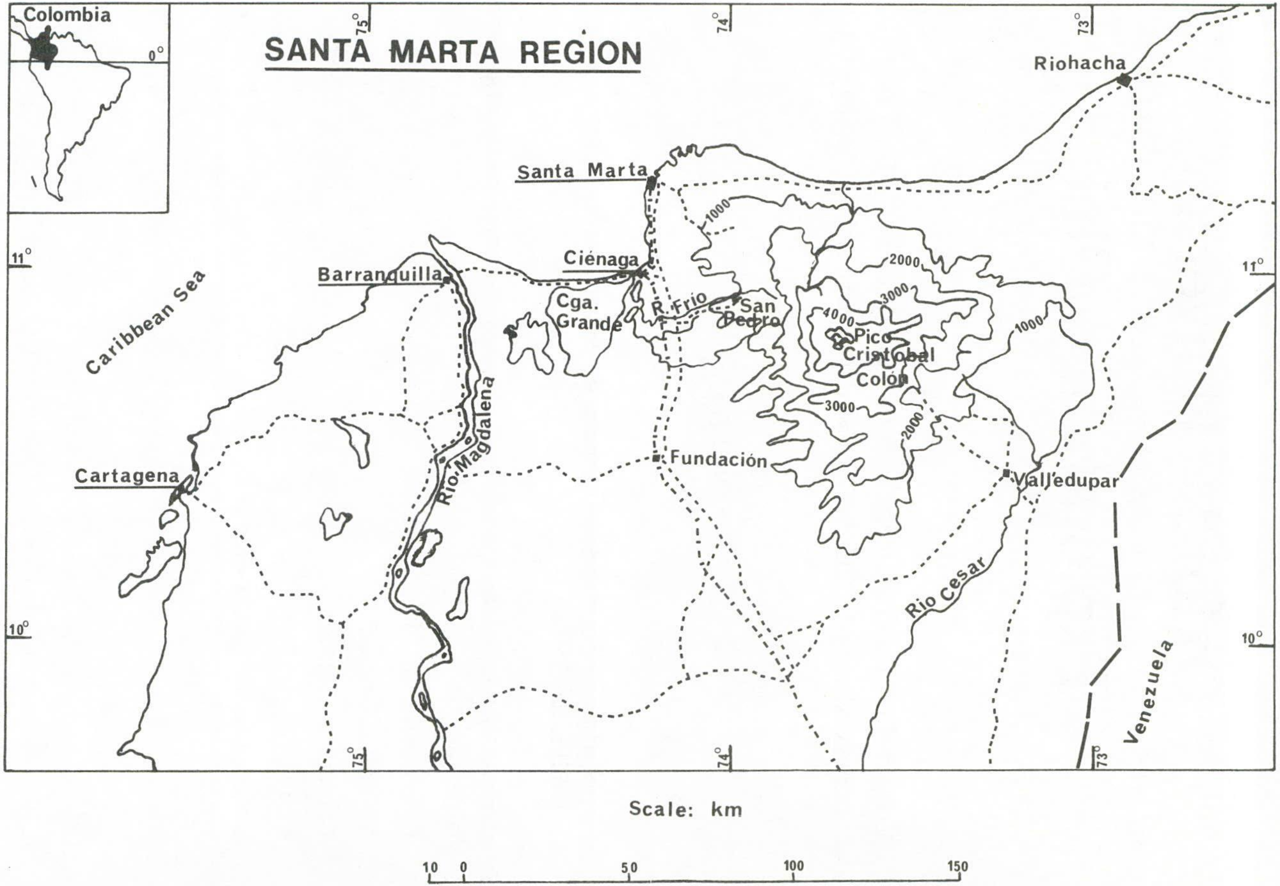
SANTA MARTA REGION
Colombia
0°
75°
74°
73°
11°
10°
Riohacha
Santa Marta
Ciénaga
Barranquilla
Caribbean Sea
Cga. Grande
R. Frio
San Pedro
1000
2000
3000
4000
Pico Cristobal Colón
Rio Magdalena
Fundación
Cartagena
Valledupar
Rio Cesar
Venezuela
Scale: km
10
0
50
100
150

MAP I: SANTA MARTA REGION

KEY

————————	International Boundaries
----------	Principal Roads
-I-I-I-I-I-	Railway
Santa Marta	Major Towns
San Pedro	Minor Towns and Villages
Venezuela	Bordering Countries and Seas
—— 1000 ——	Contours, in Metres

Oxford Expedition to the Sierra Nevada de Santa Marta, Colombia, S.A.

July - September 1973

AIM

The expedition proposed to perform investigations into the following:

1. The epiphyte cover on trees of the montane forest zone at different altitudes by quantitative estimates of the cover on various parts of the trees, backed by herbarium specimens of the plants found.
2. The Lepidoptera of the Sierra Nevada, paying special attention to the moths but also supplementing the butterfly collections of previous expeditions.[1,2] It was hoped to gain information on altitude zonation and flight times from this material.
3. The macrofauna associated with epiphytic members of the family Bromeliaceae, at different altitudes in the cloud forest. This became a preliminary survey, as we soon appreciated that this matter alone needed a complete expedition.
4. The paramo vegetation (i.e. high-mountain grassland above the tree line) by cover quadrat analysis.
5. To collect certain other orders of insects as requested by some members of the Zoology department, Oxford University.

Specimens were deposited as follows:

Plant material with the Herbaria of the Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá and INDERENA*, Bogotá. Live plant material was flown back to the Royal Botanic Gardens, Kew, for growth and identification.

Insect material at the Instituto de Ciencias Naturales, INDERENA; the British Museum (Nat. Hist.) and the Zoology Department, Oxford.

Identification of material:

Dr. Enrique Forero at the Instituto de Ciencias Naturales is having the plant material identified, and subsequently will add it to their collection. The British Museum (Nat. Hist.) are

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*INDERENA stands for "Instituto de Desarrollo de los Recursos Naturales Renovables".

identifying the Lepidoptera and will return a set to Bogotá in due course.

We are deeply indebted to those who are performing this service for us.

PERSONNEL

R.J. Robins	Leader (21)	Biochemist. Pembroke College, Oxford.
C.W.D.Gibson, B.A.	Treasurer (21)	Zoologist. St. Catherine's College, Oxford.
S.M. Bunt	Secretary (20)	Zoologist. St. Catherine's College, Oxford.
K.J. Kirby, B.A.	Equipment (21)	Forester. Brasenose College, Oxford.
P. Rodriguez-G.	Ornithology.	Zoologist. Instituto de Cien-Cias Naturales, Universidad Nacional de Colombia, Bogota.

Home Agents

Dr. J. Phillipson	Reader in Animal Biology, Zoölogy Department, Oxford.
M.J. Ford, B.A.	Research Zoologist, Animal Ecology Research Group, Oxford.

The preparation of this Report was undertaken by all members of the expedition.

INTRODUCTION (R.J.R. and C.W.D.G.)

Late in 1971 Mr. Robins, who had for some while been contemplating a scientific journey to South America contacted Dr. E. Forero of the Herbarium, Bogotá enquiring about the possibility of performing a project in Colombia. It was intended that the expedition would work with their own project, but in an area that would benefit the overall study of the Flora of Colombia.

Dr. Forero was most encouraging saying that the Sierra Nevada de Santa Marta would be 'a very interesting place' for a project that followed one of Mr. Robins' suggestions. This was that of a study of the epiphytic Flora of a mountain region.

Throughout the summer of 1972 correspondence and planning progressed, partially from Zanzibar where Mr. Robins was expeditioning that year, and in the autumn plans were drawn up for an expedition from Oxford University. By this stage it had been suggested by Dr. B. Juniper that the expedition should extend its range of interest, and thus the final plans included the entomological work cited here.

We greatly wanted at least one Colombian worker on the expedition, but these plans were not finalised until after we left England.

ITINERARY AND ORGANISATION (R.J.R. & C.W.D.G.)

Due to the length of time required to send sea-mail to Colombia it was not possible to convey our equipment to Santa Marta by this method and thus for the last few days before departure hours were spent cutting down what we thought would be required from England and weighing our baggage on a set of kitchen scales, of five pounds maximum load. Only some thirty pounds overweight, we left Heathrow at 11.15 on the morning of July 3rd. Before departure a hectic two hours passed as we bought tickets *out* of the United States, before we were allowed to fly to Miami. This recent regulation enabled us to go at all, since until three days before visas were required even for transit at Miami. We had not been aware of this. The only consolation of the considerable added expenditure was that because of the hurry to get us aboard the aircraft in time our baggage was not weighed.

Nearly two hours were spent under security guard at Miami before we flew to Barranquilla at 15.30. It was dusk when we landed and thus our first real views of Colombia came the next morning when we surveyed the Plaza Simon Bolívar from the window of our hotel, the Roxy. This abode had been recommended as 'a bit grotty but cheap'; it is the worst hotel in Barranquilla.

The day was spent purchasing a variety of goods in Barranquilla, travelling at break-neck speeds to Santa Marta in a typical Colombian bus, and trying to buy maps at the Augustin Codazzi Institute in Santa Marta. Finally we took another bus to San Pablo, the village owned by Sñr. Cortez at the end of the dirt road to San Pedro, at the foot of the Sierra.

The bus to San Pedro starts at some time in the early morning in Ciénega and usually reaches San Pablo by eight-thirty. We had been told that it can be caught here but later the missionaries said that to do so was an exceptional stroke of luck, as it always fills in the market place, in

Ciénega. Thus it came and went without us, and only by bribing a lorry driver to take us part of the way and borrowing the Toyota land cruiser from the Mission did we arrive that day. Green to the country, we tasted our first Colombian politeness. On enquiring the distance from the point at which the lorry left us to San Pedro we were told 'two kilometers': it took two hours to walk there and driving back it proved to be nine. Distance it seemed is of little importance and we had been given this outrageous underestimate as Colombians like one to be pleased and they were clearly convinced that we did not wish to walk too far!

The missionaries at Colonia Carmelo received us most warmly, and always did so at whatever time of day we arrived from the mountain, and whatever state we were in at the time. Frequently we would be caked in mud from the path, but they never batted an eyelid. It is solely due to the extreme kindness and hospitality shown to us during our stay by those at Carmelo that we ever existed for two months on the mountain. They gave us the use of a school-room with benches and a sink for a laboratory and a fully equipped house in which we were able to live and sleep when in San Pedro. These solid structures are essential in an area such as the Sierra Nevada where high rainfall occurs and if we had existed in tents all the time it would not have been possible to stay long. They assisted us in hundreds of ways and thanks to them life in San Pedro was quite comfortable. We are all most deeply indebted to them.

A week was spent in preparing the equipment for use and surveying the lower parts of the path. Mr. M. Adams had supplied us with a detailed guide to the San Pedro trail and this was most helpful.[3] As a result of this guide we were quickly able to plan our work and saved much valuable time. Messrs. Gibson and Bunt went to Santa Marta to make further purchases and in the meantime Messrs. Robins and Kirby made plant presses and a portable drying oven. Further details of the work and equipment will be given later.

On the 11th July we made final preparations and set off up the mountain in the morning of the 12th, accompanied by two mules and Orlando, our muleteer. It took four hours to reach our first base, an abandoned hut at 2300 m. This had been affectionately nick-named 'Hotel Solito', and must have as fine a view as any in the world.

Here we learned to put up with one another and studied the methods we proposed to employ. The entomologists had already started to collect in San Pedro and here continued their seemingly aimless net sweeping: the botanical contingent cut their way into the cloud forest to stare skywards at the luxuriant epiphyte growth. The former party soon found where to look for their prey and the best time to catch; the botanists radically altered the methods they previously intended to use. Notably it soon became clear that any method involving tree climbing or cutting was not possible. The methods finally employed are given later.

After Messrs. Robins and Bunt spent the 17th and 18th July walking to San Pedro and back with new supplies the expedition split in two. The entomologists spent three days at the Finca Cebolleta, 2700 m, and befriended the two families that lived there: the Martinez and Rodriguez (Rodriguez is a common name in Colombia and this family were not related to Pedro Rodriguez-G who later joined us). This was the pleasantest of our camps as the two families were extremely kind and sold us eggs, cheese, milk, and potatoes, all of which they produce on the fincas. This considerably supplemented the supplies that we brought from San Pedro. In all we spent two weeks here, with the botanists doing a three day stint after the entomologists returned to Hotel Solito.

After this week, the only time the expedition 'split camp', we all made a brief visit to San Pedro leaving specimens in the laboratory and getting supplies for an eighteen day stay on the mountain. The first part of this was at Finca Cebolleta, the second week of our stay there and then we moved camp, using a horse and a donkey, from the Finca to the Paramo, camping at 4000 m. At times the path was in a deep gulley and at one point the poor donkey got suspended on either side by its packs and hung kicking in the air. It was only freed by breaking down the sides of the gulley.

From the paramo camp the entomologists wandered far and wide collecting across the open grassland. We all felt a great sense of freedom in this open country after being hemmed-in by the forest for several weeks. Here we were able to choose our own paths, and this was a great advantage. Messrs. Robins and Kirby worked the quadrats in the valley of the Río Sevilla from here and also performed the cover analysis of the grassland.

We all felt the cold, although Stuart Bunt, used to such conditions suffered the least, and Keith Kirby, as usual, took it all in his stride.

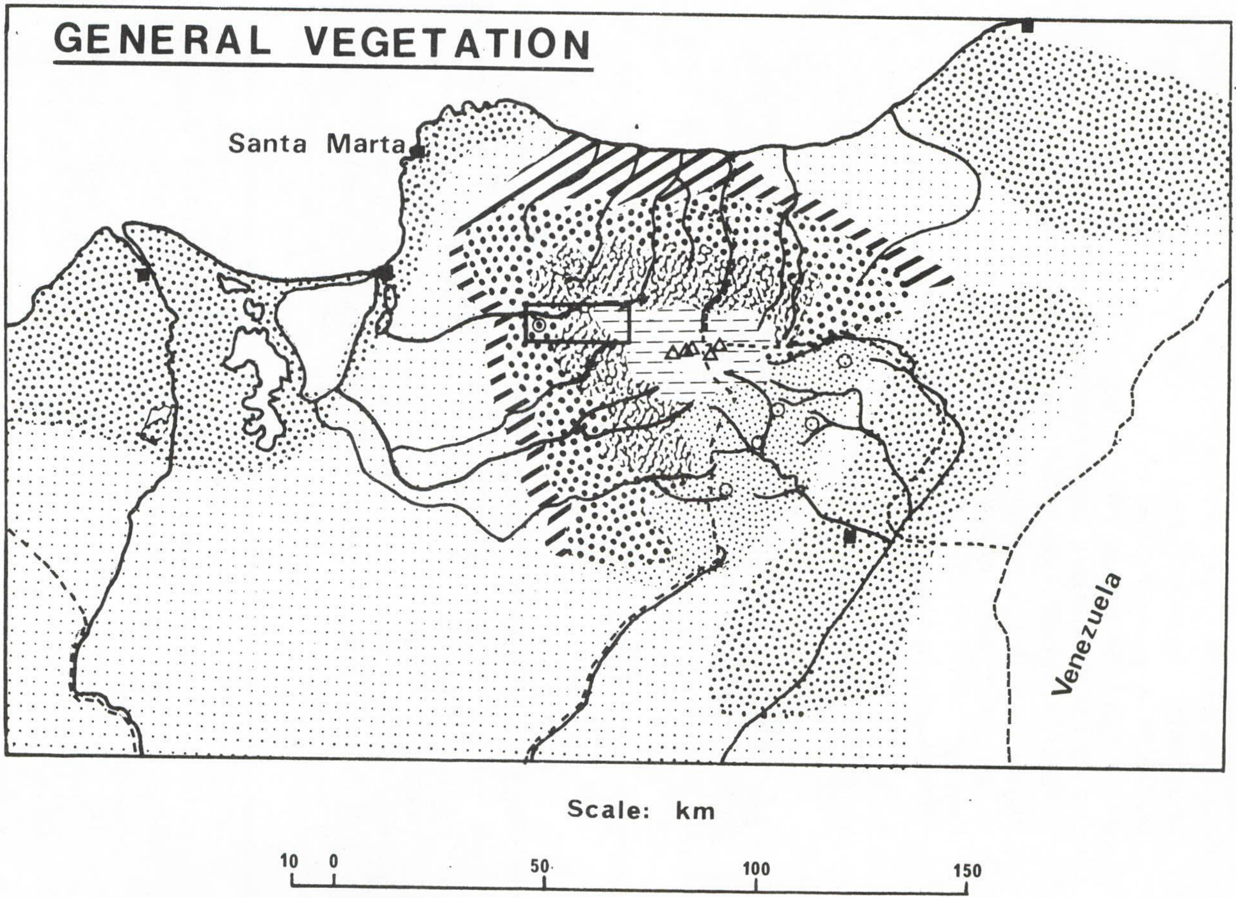
We felt that it would be foolish not to do a little exploration of this seldom visited area, and so two days were devoted to this. One we walked as far as time permitted along the path. This crossed a saddle at 4200 m, about half an hour from camp, before dropping away and crossing a series of rivers as it wound over the top of the paramos to the Don Diego valley. Our other day involved a climb up and along the ridge to the south of the camp in an effort to see the snow peaks. We had already had tantalising glimpses of each end of them, but to see Pico Cristobal Colón and Pico Simon Bolívar we had to get to the top of the ridge. The view was well worth the climb, and we were all sorry to have to leave as the cloud chased us back to camp.

On the last evening it rained continuously and this was the only time that we had serious trouble with water getting into the tents. Thus a very wet expedition left the paramo station on the morning of the 12th August carrying heavy packs, a lot of which was water. Kirby and Gibson made a direct descent to San Pedro with the specimens while Robins and Bunt spent a night at the finca. Bunt had swollen ankles (the worst medical trouble on the whole expedition) and Robins was to collect some specimens. Both came down the next day.

A few days were spent in and around San Pedro before a trip to Santa Marta, partially on business and partially for a day or two of rest. Here we received disquieting news about permits to work and so it was decided that Robins and Gibson would travel down to Bogotá to sort these out and if possible obtain a Colombian to join us. They spent three days in the capital and were successful in both their aims. Thus we returned with permits and Pedro Rodriguez, who stayed with us until the end. All those whom we met in Bogotá were most helpful and pleased that we were working in their country. It was a great pleasure to have Pedro with us. He taught us much about the country and the people, including the language!

In the meantime the others had returned to San Pedro, although Stuart Bunt had made another visit to Santa Marta to see Professor Schemmer, at the Colombo-Aleman Institute, where he was studying social insects in the Sierra Nevada region. Messrs. Robins, Gibson and Rodriguez returned to San Pedro with Dr. John Braden, a botanist with INDERENA, Santa Marta. He stayed for a short while and kindly identified some grasses for us.

From then, the 24th August, to the 1st September was employed working the forests at and around San Pedro. This was at times a problem as this region is populated and thus it


GENERAL VEGETATION
Santa Marta
Venezuela
Scale: km
10 0 50 100 150

MAP II: GENERAL VEGETATION
KEY

Vegetation Zones:

Tropical Dry Forest

Tropical very dry Forest

Tropical Humid Forest

Montane Rain Forest

Cloud Forest

Riverine Forest

Paramos

Features:

International Boundary

Department Boundaries

Rivers

Major Towns

Minor Towns

Peaks

Boxed area represents approximate extent of *Field Area* shown in *MAP III.*

was difficult to find suitable areas of forest. A final trip up the trail by the botanists in search of more plants, and Snr. Rodriguez after birds, brought the interesting part of the expedition to a close. Two days passed clearing up and on the 3rd the expedition made its way to Santa Marta in the traditional way — on the back of a lorry.

A few days were spent sorting out and sending off specimens and equipment: one interesting day excavating a pre-Tairona burial with an American archeologist: and the expedition broke up. Mr. Kirby had to fly back to England and went on the 6th. Mr. Gibson left for Cartagena, and a few days in the sun, before flying on the 11th. The remainder took a train to Bogotá.

They stayed there for a week, term having started for Snr. Rodriguez, while Messrs. Bunt and Robins studied material in the Herbarium and Entomological collection of the Instituto de Ciencias Naturales.

Joining with Patrick Jaqueline, the leader of a Cambridge expedition to Colombia this year, they looked round the sights of Bogotá before setting off on a tour of the country.

DESCRIPTION OF FIELD AREA (R.J.R.)

The Sierra Nevada de Santa Marta is an isolated mountain massif in the north-east corner of Colombia. The range forms a triangular block with one edge running parallel to the Caribbean coastline, and the apex some 130 kilometres inland. To the south-east of the center of the range the mountains culminate in the magnificent peaks of Simon Bolívar and Christobal Colón. The latter of these at 5775 m is the highest in Colombia, although the difference in the height of the two peaks is very little. However, such is the proximity of the peaks to the sea that in the dry season it is possible to stand on the tropical beaches of the Caribbean at the foot of the mountain and see snow on the top of the Sierra. The distance is about thirty-five kilometres.

To the southwest and west the mountains rapidly drop into the Magdalena valley, a low flat plain only slowly rising above the level of the sea. In the southeast and east is the valley of the Cesar river, flowing south and into the Magdalena at the edge of the Sierra. This valley is again of low-lying country, never more than 200 m above sea level. On the north is the sea and in the northeast the mountains are boarded by the deserts of the Guajira peninsular.

Because of this rapid increase in altitude there is an equally rapid change in the climatic and ecological zones. For this reason, and others relating to the suitability of the terrain in relation to the work we proposed to perform, the area was chosen.

The prevailing winds come from the Caribbean to the north of the range, and clouds form early in the day on the upper parts of the mountains. During the latter period of the day these sweep down, notably towards the west, and drop their rain. Thus the region in which we chose to work was one of the wettest in the whole range. This causes a more luxuriant vegetative cover than in the south (see map II).

The part of the Sierra Nevada chosen as a field area lies to the west side for the reasons given above. It is also more accessible than other parts, and has a good trail all the way up the side of the mountain. This gave easy and fairly rapid access to the different zones. The area worked lies between latitudes 10°53′ and 10°56′ north, and longitudes 73°52′ and 74°04′ west of Greenwich (see Map III). This covers a complete cross-section of the different zones on this side of the mountain.

The vegetation can be roughly divided into the following zones:

1. *40-700 m.* From the eastern edge of the Magdalena plains up into the foothills the range is covered in a humid tropical forest. This has been extensively cleared for agricultural use and only small isolated patches of forest cover remain. The region was not worked extensively by the expedition, but a small collection of Lepidoptera was made at San Pablo (40 m) on July 5th. Two epiphyte quadrats were done at 700 m but these are not particularly satisfactory, due to the low level of epiphyte cover to be found, and the low forest density.

2. *700-1900 m.* This is the region of montane tropical rain-forest. The small village (pueblo) of San Pedro de la Sierra falls in the center of the zone, at 1400 m. This is the market town of the area and at the week-end is full of the local finceros selling their products. Coffee is the principal crop of the region, and most of the fincas grow all their other requirements. This makes it difficult to buy fruit and vegetables which, although plentiful, are not usually for sale. Regions of virgin forest remain in some areas that for one reason or another are not suitable for cultivation: notably on steep hillsides and in gullies. These proved sufficient to supply sites for botanical and entomological collecting.

3. *1900-3200 m.* This range is covered by a series of forest types all grouped under the general classification of 'cloud forest'. Cleared areas, from abandoned and still-occupied fincas become less common with altitude, and the highest finca is at 2700 m. Similarly the patches of secondary forest in the virgin mass become more sparse. The fincas here largely carry cattle and potatoes, with a few other crops grown for the use of the finceros and their families. The milk is made into a curd-cheese which is sold in San Pedro on market days. Potatoes are similarly sold, a lot of these going to supply the markets of Santa Marta and Barranquilla.

4. *3200-about 4500 m.* The paramo grassland zone. Defined at the lower limit by the treeline and at its upper by uncolonised or lightly colonised rock this is the open area higher than the forest and typical of tropical mountains. The limits of the zone vary somewhat. At the lower edge intrusions of scrub-forest occur up to 3500 m in gullies and on hillsides with a favourable aspect. The upper limit was above the highest level that was reached by the expedition but may well be partially controlled by the period since the rock was covered by glaciers, as well as by aspect.[4,5]

5. *Above 4500 m.* Colonisation zones and finally the nival zone covered by permanent snow and glaciers. These regions were not visited.

For a more detailed description of the vegetation to be found in these zones the works of Siefriz[6] and Espina[7] should be consulted. However neither of these relates to the actual area in which we studied.

The trail on which we worked (see Figure I) runs from San Pedro along a system of ridges, up to the Paramo and over the saddle. From here it drops into a series of valleys, finally entering the top of the Don Diego valley and following its course to the sea. Although none of us performed this walk the path does still appear to be in use since it was reported possible to cross the paramo to the Don Diego by some Indians we met from the Kogi tribe.[3,8,9,10]

On leaving San Pedro the trail follows an extension of the road which was to continue some way but has never been finished. Climbing steeply it ascends to about 2000 m in a series of three stages. After a level region it descends some 200 m and before turning a right-angle corner to the northeast the path to San Xavier drops steeply away to the right. Descending slightly the path joins onto another ridge which gradually rises to the camp site of Hotel Solito at 2300 m. This is on a flat-topped ridge running slightly south of east. Rising sharply and swinging to the north the path passes through a region of very fine cloud forest to emerge on the top of a north running ridge, at about 2500 m. Climbing slowly this goes to just over 2700 m at which point the path drops into the valley of the Quebrada Cebolleta, passing through a region largely covered by abandoned fincas. The climb up the other side to Finca Cebolleta is through secondary forest, cleared twelve years ago in the making of the finca, but subsequently regrown.

After this finca the path again turns to the north of east and rises extremely steeply onto the paramo. From here on there is a continual gentle uphill rise with the trail running along the edge of the ridges and no longer staying on the crest.

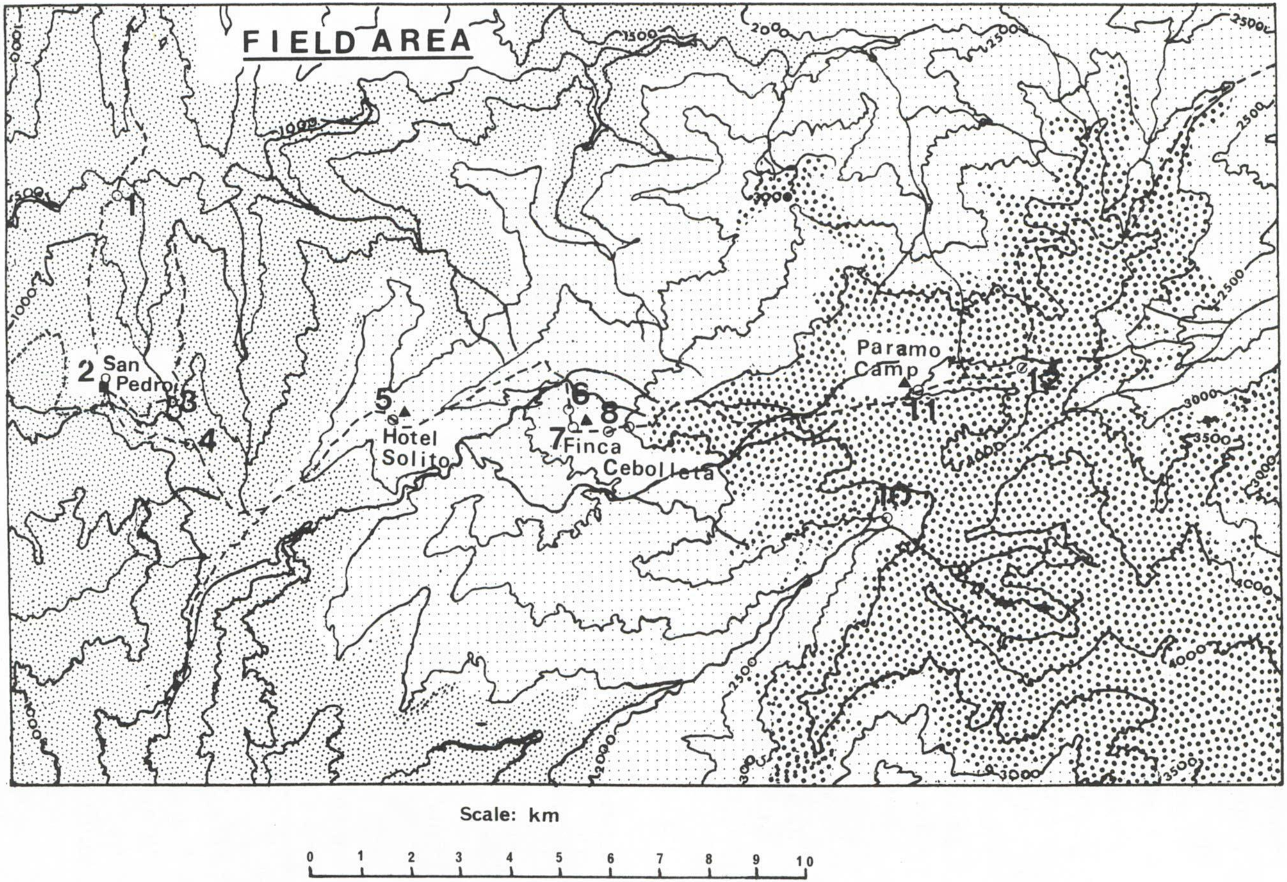
Below San Pedro a different path was used. This ran due north along the ridge where the pueblo of San Pedro is situated, and then climbed down into the valley of the Río Frío. Most of the way it passed through coffee plantation but in the bottom of the gully there were small patches of residual forest.

To obtain suitable working sites at the same altitude as San Pedro a path running round the top of the side-valley below the mission was used. This passed through a series of patches of residual forest located along water courses running down the sides of the valley. These were fairly extensive in places but tended to be used as sources of timber for the town and had been considerably cut. However satisfactory regions were found.

Specific Sample Sites

In theory it was desirable to establish sample sites every 500 m and on identical aspects. Because of the rugged nature of the terrain in which we were working this seldom proved possible, and therefore sites had to be established at points as near as possible to the desired levels. It was also not possible to work at any distance from the path, except above 3200 m and therefore the possibility of human interference with the habitat must be considered. Sites with no sign of such tampering were chosen but since the trail is well established it was difficult to be certain that the regions examined were entirely in their virgin state.

We have demonstrated that none of the areas covered have been totally cleared and reverted to forest by the placing of two botanical quadrats in a region of forest at 2600 m known to be secondary. The results, reported later show a


FIELD AREA
San Pedro
Hotel Solito
Finca Cebolleta
Paramo Camp
1
2
3
4
5
6
7
8
10
11
12
1000
1500
2000
2500
3000
3500
4000
Scale: km
0 1 2 3 4 5 6 7 8 9 10

MAP III: FIELD AREA

Vegetation Zones:

(fine stipple)	Rain Forest
(regular dots)	Cloud Forest
(coarse dots)	Paramo grassland

Features:

—— 1000 ——	Contour
-- -- -- -- --	Motorable Track
-------------	Mule trail
■	Town
▲	Camp site
6o	Quadrat site

considerable difference in the composition of this forest as compared to other regions studied.

The methods employed by the two contingents of the expedition differ principally in the area that could be covered. The botanical analysis is based on two quadrats each of area 100 m^2: the entomologists were able to wander over a much greater range than this. Details will appear under the separate subsections.

Base camps were established at 1400, 2300, 2700, and 4000 m, as discussed in the section on organisation. From these sample sites were worked at the following altitudes:

From **San Pedro** (1400 m): at 700 m in the Río Frío Valley; at 1400 m in the forest near San Pedro; at 1900 m in the forest two-thirds of the way up the first climb on the trail:

From **Hotel Solito** (2300 m): at 2300 m in the forest just above Hotel Solito:

From **Finca Cortez** (2700 m): at 2600 m in the secondary forest; at 3070 in a gulley above the finca; at 3180 m at the top of the same gully near the top of the forest:

From the **Paramo camp** (4000 m): 3200 m in the edge of the forest on the south side of the Río Sevilla valley.

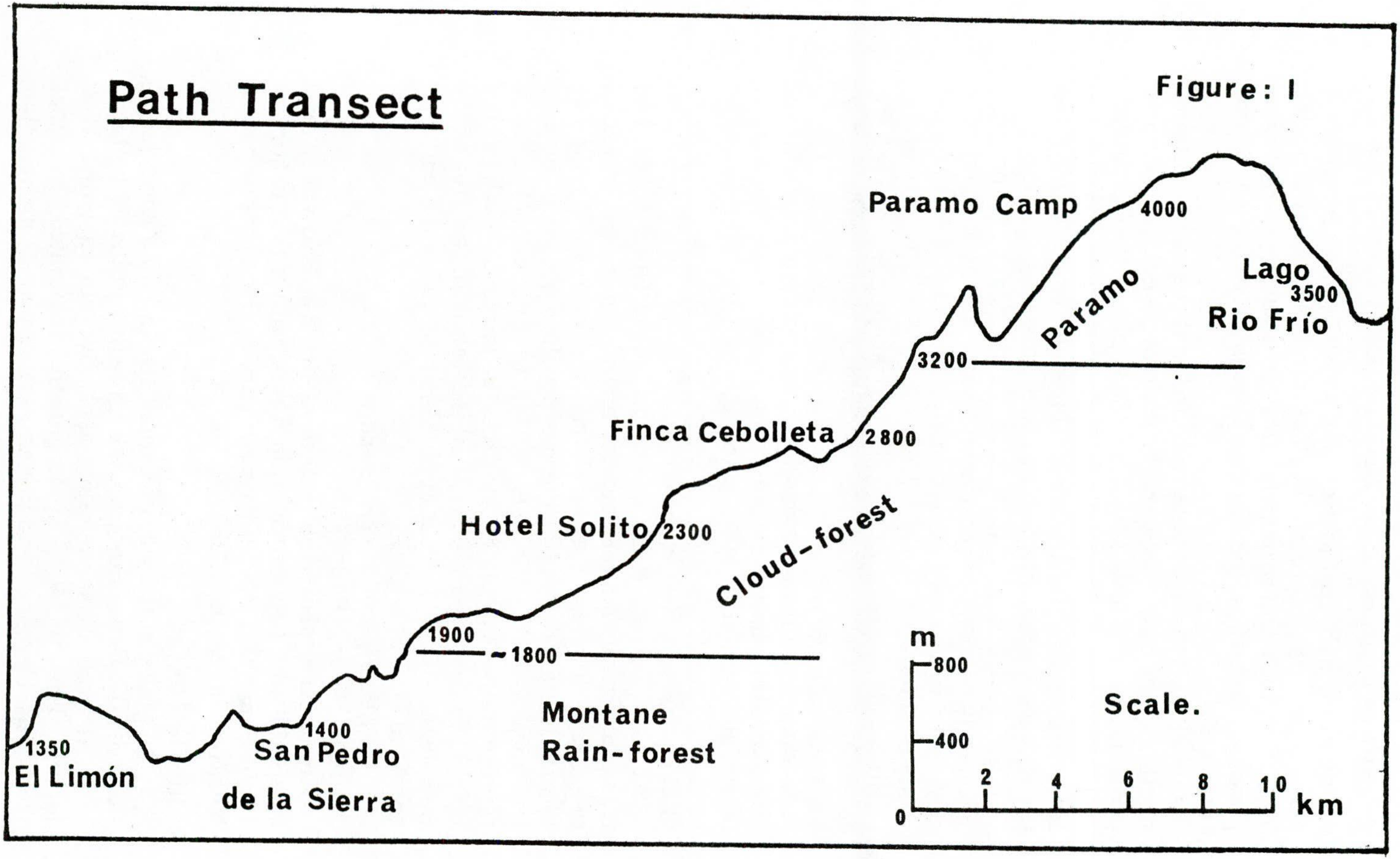
BOTANICAL SECTION (R.J.R. & K.J.K.)

A) FOREST QUADRATS

(i) *Methods*

As far as was possible the sites at which these quadrats were placed were selected in a random manner. In terms of the composition of the area by the tree species represented and the epiphytic vegetation present the siting involved no specific selection. However, in terms of the position of the quadrat within the forest it was found necessary to be selective, for a number of reasons. It was desired to place the quadrats close to the 500 m levels chosen for the survey, and this confined the choice to a maximum of some half a kilometre along the path. Further it was only possible to select a site close to the trail, as the forest was too thick to allow much movement through the undergrowth.

Once an area was chosen a ten metre square was marked out on the ground. This was a ground measurement and therefore the same area of forest was analysed in each case. The number of trees present, the girth breast height, the height of the tree and where possible the species were all recorded. The girth was measured with a thirty metre tape,



Path Transect
Figure: I
Paramo Camp
4000
Lago
3500
Rio Frío
Paramo
3200
Finca Cebolleta
2800
Hotel Solito
2300
Cloud-forest
1900
~1800
1400
1350
El Limón
San Pedro
de la Sierra
Montane
Rain-forest
m
800
400
0
Scale.
2
4
6
8
10
km

divided into half centimetres: the height of the tree with a clinometer: the species by collecting a specimen for identification. Unfortunately this frequently proved impossible, and thus the species composition record is not complete.

For analysis the trees were recorded in three metre sections, starting at the base. Moss and lichen cover was estimated as a percentage of the total area. Individual plants were recorded, and specimens for identification collected. With the Bromeliaceae, by far the most abundant single family, the plants were further divided into size categories.

Where there was a difference in the sides of the tree, frequently observed when the specimen was at a slant, then each side was recorded separately, with the direction and angle of slant.

Binoculars were used to observe the upper parts of the forest trees. Two quadrats of this nature were performed at each altitude worked.

A major problem encountered was the impossibility of siting quadrats on identical aspects. In most cases the aspects differ, and this factor must be considered during the following analysis. Therefore a brief summary of the general appearance of each quadrat is given below.

At 2300 metres, in the forest just above Hotel Solito, two transects fifty by ten metres were made. These were intended to indicate the degree of local variation in a small region of forest. The differences in the mean values obtained indicate ten metre-square quadrats are large enough to cover a representative sample of the trees in terms of girth-breast-height. Since this parameter is an indication of the area of the tree surface we consider it applicable to indicate the potential epiphyte load of a tree.

(ii) *Description of each quadrat*

Altitude *700 m.* (Both).

About 50 m above the bottom of the Río Frío valley on a steep hill-side. Low density rain forest, with a thin canopy at 15 to 20 metres. Little undergrowth and no treeferns or palms. North facing slope of 35°.

Altitude *1400 m.*

1. In gulley at the side of a small stream, on a north facing slope of 30°. Dense canopy. Undergrowth dominated by ferns.

2. At head of same valley as 1, but not in gully. West facing slope of 40°. Undergrowth dominated by small tree-ferns. Hanging liana present. Canopy at 20 metres, thin.

Altitude *1900 m.*

1. North facing slope of 40° near top of ridge. Tree-ferns to six metres. Undergrowth dominated by ferns, to two metres. Thin canopy at 15 metres. Terrestrial Bromeliads present.

2. North facing slope of 40° near top of ridge. Ground vegetation largely ferns with a few small palms.

Altitude *2300 m.*

1. North facing slope of 25° beside path at top of ridge. Canopy light. Undergrowth very dense, largely ferns, young tree-ferns and saplings.

2. South facing slope of 20°. At side of path on top of ridge about 50 metres from 1. Relatively flat area before rapid increase in inclination of slope dropping away to the south. Thin undergrowth, with large numbers of terrestrial Bromeliads, some on rotten stumps.

Altitude *2600 m.*

1. In secondary forest of twelve years of age. At top of ridge with slope less than 10°, and to the north-west. Thin undergrowth, mostly ferns and terrestrial Bromeliads of a different species to those on the trees (no. *519*).

Considerable number of liana often with Bromeliads growing on them. Canopy thin, with trees mostly little branched.

2. Situation similar to 1, but on west facing side of ridge with slope of 30°. A dense undergrowth of bamboo, young palms and climbing grass. Large numbers of small saplings. Bromeliads of type *517* present growing on ground.

Quadrats contain specimens of *Clusia sp* (Clusiaceae).

Altitude *3070 m.*

1. Across bottom of gully with slope varying from 5° to 20°. Dense canopy. Thin undergrowth, with young palms and tree-ferns. Some bare ground with protruding rock. Much bamboo, often causing low-level 'canopy' by intertwining, considerably hindering observation of the higher levels.

2. In same gully as 1, but higher up on the side, facing south-west with a slope of 35°. Moderate bamboo growth in clumps. Ground vegetation thin but more even than 1, and about one metre high, with a few young palms. No tree-ferns.

Altitude *3180 m.*

1. Near top of cloud forest on ridge above fincas. Just below a burnt area that had been cleared in the last few years. Quadrat area appeared little disturbed. On 40° slope increasing rapidly just below quadrat. Situation is top of

TABLE B1

SHOWING THE TOTAL NUMBER OF PLANTS RECORDED

PLANT	SP.NO.	ALTITUDE (m) 3200	3180	3070	2600	2300	1900	1400	700	TOTAL	
MOSSES[a]		230	248	385	781	111	5	1	1	1862	
LICHENS[a]		65	82	19	319	26	14		525		
FERNS	'H'	22								22	
Polypodium aff. leucorhizon (Kl.)	399	16	11	2	6					35	*
	321	12	4	1	7					24	
Grammitis meridensis (KL.) Morton	224 **	18			42					60	*
	230	7	8	20	11	14				60	*
Elaphoglossum lingua (Raddi) Brack	205	8	9	32	44	77	9		4	183	*
	242	14	40	63	64	25	3	7	3	219	*
Polypodium fraxinifolium Jacq.	208		1		3	18	25		4	51	*
	201		5	8	3	6				24	
Asplenium cuspidatum Lam.	418			2	77					79	*
	415				6		1			7	
	425				1					1	
	254					2				2	
	243					1				1	
	506						10			10	
	485						9			9	
	505						3			3	
	472						1	25		26	
	479							14		14	
	475							7		7	
ORCHID-ACEAE	343	9								9	
	344	5								5	
	209		1	1		25				27	
	271		2		13					15	
Stelis sp.	240		16	4	74	10	1			105	*
	414				4					4	
	277				2					2	
	423				8					8	
	424				3					3	
	440				2					2	
	223					15				15	
	210					1				1	

	510						1			1	
	478							5		5	
	494								14	14	
HERBS	328	1								1	
	401	2	8	8	1					19	
	219		1	1	5					7	
	400		4	4	4					12	
	403			5	2					7	
	207			2	1	5	3			11	
	276				2					2	
	202					4				4	
BROMELI ACEAE ***			169	29	929	1378	679	114	214	3712	*
CLIMBERS	323	1								1	
	203	1			4	14	1	3		24	
	204	1			21	1	1	1		25	
	268		1	3						4	
URTICACEAE *Pilea sp.*	228		24	19	32	19				94	*
	239			1		6				7	
	235					4				4	
	252						3	8		11	
	481						1	7		8	
LILIES	492								3	3	
ARACEAE *Anthurium sp.*	404		1	14	1	1	14			31	*
MARANTACEAE *Maranta sp.*	474							77		77	*
	498								10	10	
GRAMINAE	251					2				2	
	476							3	4	7	
CACTACEAE	495								1	1	
PARASITES	324	10								10	

* Indicates plant species analysed below on a quantitative basis.

** This specimen number is considered to probably refer to a series of closely related species which are indistinguishable in the field. Thus it was not possible to observe any zonation that occurred within this group, which is considered to only represent one genus.

This family cannot be sub-divided into species with any certainty in the field and thus has had to be treated as a whole.

[a]The mosses and Lichens are treated on a scale of density ranging from 0 to 5. The values of density cover in percentages is as follows:

Percentage	0–5	5–25	25–50	50–75	75–90	90 +
Numerical	0	1	2	3	4	5

These values refer to the sum of the numerical representations for each three metre section of a tree: thus the maximum possible for any one tree is 20.

TABLE B2

SHOWING THE DEGREE OF DEVIATION WITHIN THE MORE COMMON EPIPHYTE POPULATIONS WITH ALTITUDE.

Table obtained with Chi-squared test. Expected value is that postulated to occur at each altitude provided no deviation occurs. This is the total record for that species divided by the total number of altitude stations, eight.

SPECIES	**ALTITUDE (m)**							
	3200	**3180**	**3070**	**2600**	**2300**	**1900**	**1400**	**700**
FERNS								
[a] 399	+ + +	NS	NS	NS				
[a] 224	+			+ + +				
230	NS	NS	+ +	NS	NS			
[a] 205	NS	NS	NS	+	+ + +	NS		—
242	NS	NS	+ + +	+ + +	NS	— —	NS	— —
[a] 208		NS		NS	+ +	+ + +		NS
[a] 418			NS	+ + +				
ORCHIDS								
[a] 240		NS	NS	+ + +	NS	NS		
CLIMBER								
[a] 228		NS	NS	+ + +	NS			
[a] ARIACEAE								
404	NS	NS	+ + +	NS	NS	+ + +		
MARANTACEAE								
474							+ + +	
BROMELI ACEAE		— — —	— — —	+ + +	+ + +	+ + +	— — —	— — —

SYMBOLS

Representing the deviations as less or more than expected value:

p	Less	More
less than 0.001	— — —	+ + +
0.01—0.001	— —	+ +
0.05—0.01	—	+
greater than 0.05	NS	NS

[a] See Table B1 for identity

TABLE B3

DATA FROM QUADRATS

DATA	ALTITUDE (m)							
	3200	3180	3070	2600	2300	1900	1400	700
Number of trees	50	66	63	209	35	51	28	8
Average GBH of trees	0.46	0.32	0.42	0.24	0.60	0.40	0.76	2.23
No. of tree species	7	6	4	13	5	9	6	2
No. of unid. trees	0	24	31	12	20	5	7	2
No. of dominant trees	2	1	1	5	1	1	1	1
No. of epiphyte sp.	13	15	17	22	21	14	11	6
No. of dominant eps.	5	4	4	6	4	4	3	—
*Significance of variation in the number of trees	NS	NS	NS	+ + +	NS	NS	– –	

*The scale used is that given in the footnote to Table B2.

TABLE B4

TO SHOW THE DISTRIBUTION OF THE FAMILY BROMELIACEAE

(A) The numbers in each size class in relation to the quadrat altitude.

*PLANT SIZE	CLASS	ALTITUDE (m)						*** Data type
		** (3180 + 3070)	2600	2300	1900	1400	700	
0.0-0.3	I	160	677	902	549	43	153	o
		153	685	901	501	84	157	4
		0.27	0.11	0.1	4.5	20.1	0.15	Chi^{2}-cont.
0.3-0.6	II	41	288	224	85	26	60	o
		41	183	240	133	22	42	e
		0.0	10.9	1.1	17.9	0.5	7.4	Chi^{2}-cont.
0.6-0.9	III	4	19	66	27	36	1	o
		9.4	42	55	30	5	9	e
		3.1	12.7	1.9	0.4	183	7.8	Chi^{2}-cont.
0.9 +	IV	3	5	29	18	9	0	o
		4	17	23	12	2.1	4.1	e
		0.23	9.0	1.4	2.0	2.1	4.07	Chi^{2}-cont.

Notes:

* Plant sizes given in metres. This figure represents the longitudinal length of the largest leaves of the plant.

** The altitudes 3180 and 3070 are both of low data yield, and are close together. Therefore they are grouped as one for these purposes. The altitude 3200 metres scored no Bromeliads at all. However isolated representatives of the family were seen, but uncommonly, at that height.

*** Data type: 'e' is 'Expected'; 'o' is 'Observed'; 'Chi^{2}-cont.' is 'Chi-squared contribution'.

TABLE B4 (continued)

(B) The numbers in each tree section in relation to altitude.
Numbers are for *all* Bromeliads, irrespective of size.

*TREE SECTOR	T-CLASS	ALTITUDE (m)						*** Data type
		** (3180 + 3070)	**2600**	**2300**	**1900**	**1400**	**700**	
0-3	A	31	196	326	234	9	25	o
		48	216	321	158	26	49	e
		6.3	1.9	0.07	36	1.6	12	Chi -cont.
3.6	B	72	296	400	163	3	38	o
		57	256	380	187	31	59	4
		3.7	6.1	1.0	3.1	25	7.5	Chi -cont.
6-9	C	61	297	301	198	35	41	o
		55	246	365	179	30	56	e
		0.6	10.5	11.1	1.8	0.7	4.3	Chi -cont.
****9 +	D	34	140	351	84	67	110	o
		46	207	307	154	25	47	e
		3.3	21.8	6.1	30.0	67.8	81.0	Chi -cont.

* Tree sector, in metres. Trees were visually subdivided into these three metre sections to enable more rapid and efficient scoring. This sized sector was convenient both in terms of the number of plants present and the tree size.
** See (A) above.
*** See (A) above.
****9+. This includes the canopy level. In most cases trees branched at about this height. Alternatively the trees, in the higher quadrats were not significantly higher than nine metres.

gully in which the quadrats at 3070 m were placed. Facing south-west. Dense undergrowth with much bamboo, ferns, and small palms. Canopy light.

2. Hillside facing south-west with slope varying from 45° to 60°. Old water course down one side. Thick undergrowth with much bamboo. Some signs of burning above here on previously cleared area. Light canopy.

Altitude *3200 m.*

1. At extreme top of cloud forest at forest/bamboo boundary, in Río Sevilla valley. Valley runs East/West, with stream in bottom, and *Sphagnum* bog. At edge of forest in bottom of valley, on north slope. Bamboo dominated. Shallow soil with much rock protruding at surface. Thick ground growth of moss and ferns. Much vegetable debris. Terrestrial Bromeliads present; arborial absent. Trees stunted, to about ten metres. Slope about 30°.

2. Similar to 1, but rougher terrain with less undergrowth. About 100 metres down valley from 1 and on a slope orientated South-west. Angle about 30°.

Quadrats contained representatives of the following trees: Fam. Mysinaceae — *(322) Geissanthus sp.*; *(329) Rapanea dependens* R. & P. Mez.; Melastomataceae — *(322) Miconia sp.*

NOTE: During the discussion that follows some of the plants have been identified from Herbarium Material. In a few other cases, particularly with the ferns, a tentative identification has been attempted by the authors, using the descriptions given in "Catalogo Ilustrado de las Plantas de Cundinamarca", Volume III, by Maria-Teresa Murillo. But this identification is only tentative, and awaits confirmation from the identification of the Herbarium Material. All plants thus identified are marked with an asterisk "*".

(iii) *Discussion of General epiphyte data*

Table B1 indicates the range of species and plant type found as epiphytes in the Sierra Nevada de Santa Marta. The indication for most species is that of being confined to a set range of altitude for one of a number of possible reasons. In those cases where a quantitiative interpretation is possible Table B2 indicates that there is a significance in the presence or absence of a particular species at a particular altitude. Most of those examined have one, or in a few cases, two adjacent altitudes which are distinctly preferred.

In the ferns seven species are frequently found and each of these is related to a particular level. *No. 399, Polypodium aff leucorhizon* is only common at 3580 m with a slight recurrence in the secondary forest at 2600 m. However at 2600 m different ferns are common, notably *Grammitis meridensis (224)*, and *Asplenium cuspidatum (418)*. The genus *Plagiogria spp.** (collectively 242) is very common here but also at the higher altitude of 3070 m. However *number 230 (unidentified)* although found over quite a wide range is most common at this altitude. Specimens of *Elaphoglosum lingua (205)* were taken over a very wide range, covering all the section of the mountain worked. But only at 2300 m and to a lesser extent at 2600 m is the number greater than expected. At the other levels numbers tended to be those expected or, at the lower edge of the field, must less than expected. Therefore this plant, although capable of growth over a wide range greatly prefers the region at 2300 m. The fern *Polypodium fraxinifolium (208)* has a wider range over which it is common and also a wide range which it can grow.

Of the Orchids collected only one is common, *Stelis sp (240)* and this species is abundant in the secondary forest, at 2600 m. Although present above and below this the figures show little other variation with altitude.

The climber *Pilea sp (228)* is also abundant in the secondary forest, with an extension of the range to each side.

The Lily, *Anthurium sp (404)* shows a highly unusual distribution, with two peaks of abundance. We consider that this material requires further analysis since the most likely explanation is that the observations cover two similar species, which are indistinguishable in the field. The other *Maranta sp. (474)*, only found at 1400 m, has very narrow limits but within these is plentiful. Some factor in the conditions to be found there must suit this plant, and such conditions are not reproduced elsewhere.

The Bromeliaceae show a distinct preference for the region of forest covering the lower part of the cloud forest zone. This is probably a reflection of moist nature of the atmosphere coupled with the regular rainfall. Table B1 shows a peak in the numbers at 2300 m. Here there is a forest density lower than either 1900 m or 2600 m (see table B3). Despite this the Bromeliad density is greater.

One reason that can be put forward for such variation is clearly the change in altitude. This has corresponding changes in the amount of rain, cloud, and sun to which the plants are subjected. Depending on the conditions to which a particular plant has become adapted then so it will have a preferred position of growth on the mountain.

However there are other reasons that cannot be ignored.

1. Aspect. The areas studied have little in common as far as aspect is concerned. Basically they fall into quadrats in a gully situation and those on or near to the top of a ridge. Although there is little indication of this affecting the results in other groups it is worth noting that in both 'gully' situations (3070 and 1400 m) the Bromeliad population is much lower than either above or below that altitude. By taking two quadrats at each level with somewhat differing aspects it was hoped to reduce the effect of this factor.

2. Forest age. This appears to have some effect. The only sample where the age of the vegetation is known to differ from elsewhere is in the quadrats at 2600 m. Table B3 shows that the forest is much more dense than at any other altitude but of very much smaller size. The species composition is quite different, with one tree. *Weinmannia pinnata (420)* forming nearly fifty percent of the growth. Thus this region can be expected to contain both tree and epiphyte species that colonise rapidly. There are three species that may be representative of rapid colonization: the fern *Asplenium cuspidatum (418);* the Orchid *Stelis sp (240)* and the climber *number 204 (unidentified).* The tree given above was found nowhere else in the forest and probably represents good colonization.

Apart from this one example the age of the forest is not known. It is probably of uniform age, as there were no signs of clearing in the regions studied.

3. Forest density, and tree size. Testing the significance of the variation in forest density (table B3) shows that in three cases only is the variation important. In the secondary forest at 2600 m it is very high, while the two levels of 1400 and 700 m are significantly low. But in both these latter cases the girths of the trees are greater than average and this will help to outweigh the smaller number of trees. Similarly the average girth for the 2600 m quadrats is very low. Clearly a most important factor in epiphyte cover is the surface area of the trees concerned. Unfortunately the nature of the forest renders it impossible to calculate this.

4. Angle of inclination of the trees. This certainly influenced the ease with which epiphytes could get a hold on the tree. In cases where a tree inclined then a greater growth was observed on the upper side of the trunk than on the lower side. However

on average the tree carried an equivalent load to the same tree in a vertical position since the advantages to epiphyte growth gained on the upper surface were balanced by the disadvantages offered by the underside. Therefore this should have very little overall effect on the epiphyte load.

The altitude, as previously stated may itself influence growth in a number of ways. At 2300 m conditions are highly favourable for epiphyte growth. A sunny morning is usually followed by cloud, which persists throughout the rest of the day. Rain regularly falls in the afternoon. As a result the surface of the trees is continually wet, and where they are covered in moss, which is the usual case, this is always saturated with moisture. That the Bromeliads assist in reserving water is unquestionable, as the axils were always full whenever one was collected. This assists the growth of other epiphytes, and we often observed clumps of Bromeliads with an exuberant growth of mosses and ferns immediately below them on an otherwise bare trunk.

Conditions at 2600 m are not dissimilar except that the rainfall is lower. This may therefore be an important factor in the differences observed. The moss cover on the trees tended to be thinner, although widespread, and this we consider indicative of slightly drier conditions.

Hours of sunshine do not seem to be a limiting factor. The lower regions of the mountain receive more sun than higher altitudes, and yet have smaller epiphyte loads. Further, the lower altitudes have a greater rainfall, and these two factors support the conclusion that the degree of epiphyte cover is greatly dependent on the amount of time the area is under heavy cloud. Combining cloud and rain the optimal conditions are to be found in the lower region of the cloud forest, between 1900 and 2400 metres.

(iv) *Discussion of Bromeliad data*

Table B1 shows these plants to be by far the commonest epiphyte in the area of study. The figures themselves show considerable variation, and the use of a Chi-squared test, as displayed in Table B2 is only a formal verification that zonation does occur.

In table B4 the data relating to the Bromeliaceae is displayed in detail. The total values of Chi-squared obtained in this table both support the conclusion that highly significant variation occurs with altitude. No wholly consistent pattern emerges from a consideration of the individual deviations, but one or two important conclusions can be reached.

1) The secondary forest at 2600 metres is significantly low in Bromeliads of Classes III and IV, while high in Class I. This is consistent with the colonisation of this region occurring recently (the forest was cleared fifteen years ago). An alternative possibility is that this area is almost exclusively composed of smaller trees (see table B3) and therefore the potential for rapid growth to large size is restricted be the detritus and water supplies. But the distinction between these two cannot be made without an idea of the rate of growth of Bromeliads at this altitude zone.

2) However the quadrats at San Pedro, 1400 metres present a problem. They are high in Classes III and IV, but low in Class I. This is not as might be expected, since Class I represents the young plants of the population. An explanation may exist in the meterological records over the last few years, since a period of low rainfall could cause a decrease in the numbers of plants able to establish themselves. However the rainfall data over this period has not been examined. This explanation seems unlikely, as the rainfall, even in 'drought' must be significant in such a high rainfall region. Certainly during our stay in the area there was plenty of rain, and it was considered typical by the local inhabitants!

3) In general the higher levels of the forest support a greater load of Bromeliads than the lower parts of the tree. Some results are anomalous, but such anomalies are probably due, in their entirety, to the difficulty encountered in observing the upper parts of the trees. Frequently undergrowth obscured the view: and it is impossible to record a Bromeliad on top of a branch twenty metres up in the canopy when the epiphyte is five centimetres high! Many plants must have been missed this way, despite the use of binoculars (8 x 30) to record the higher parts of the trees and attempts, where possible to view the tree both from below and above. Such problems will have increased with each three metre section higher up the tree.

However the 1900 metre results show a trend in the opposite direction, with the load steadily decreasing with higher levels on the trees. This may be due to the lack of moss cover on the lower regions, indicating some competition between shade-preferring species for the lower levels. The quadrats here were rather more open than elsewhere, and had the densest undergrowth.

Alternatively these results could be due to increased tree height in the lower quadrats. But 1900 metres had forest of equivalent height to 2300 and 1400 metres, and therefore this possibility can be disregarded.

NOTE: This report displays the data accumulated by the expedition analysed in a preliminary and basic way. It is hoped to publish the data with a more critical analysis elsewhere.

B) PARAMO GRASSLAND COVER QUADRATS

(i) *Method*

A series of these was done in each of two situations on the Paramo grassland. Once a general area was selected the individual metre square quadrats were found by randomly throwing a weight, and placing this as the top left corner of the square in each case, with this in the north-west. The quadrats were constructed with a string and nail square, fitted with a diagonal to maintain the correct shape.

Two methods of scoring were employed.

1. Grass, Broad-leaf, bare ground, exposed rock and moss were recorded on a scale, ranging nought to five, each representing a range of percentage cover:

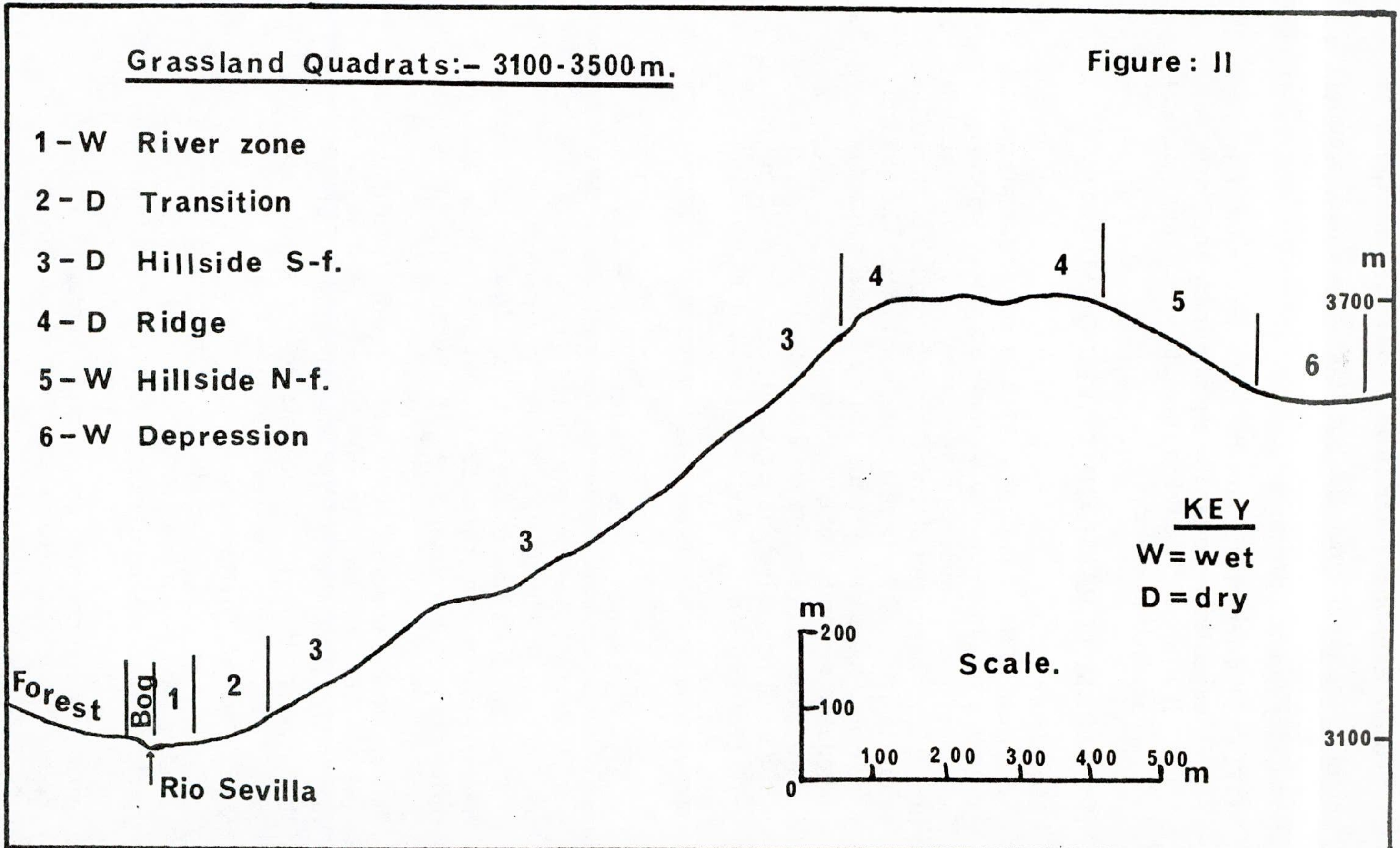
Rating	0	1	2	3	4	5
Percentage cover	0-5	5-25	25-50	50-75	75-90	90-100

2. Individual species were recorded on a Presence/Absence scoring system. This allowed a direct comparison.

The quadrats were grouped in areas that looked homologous within themselves, but showed a marked difference from bordering areas. This permitted an attempt at qualitatively analysing the difference in floral composition. The size of the quadrats may bias the results towards smaller species, but this is offset by the chance of small plants being overlooked. Rushes, sedges etc. were all grouped together with the grasses. It was not possible to score this grouping individually, as very few species were in flower.

(ii) *General Description*

From about 3000 metres the forest gives way to open alpine meadow type vegetation, with forestation reaching to 3500 metres in the sheltered valleys. Cover ranges from almost complete grassland to sparse, patchy grass with a high broad-leaf content and considerable bare rock or earth in places. Numerous streams cut deep channels, and in the


Grassland Quadrats:- 3100-3500m.
Figure: II
1-W River zone
2-D Transition
3-D Hillside S-f.
4-D Ridge
5-W Hillside N-f.
6-W Depression
Forest
Bog
1
2
3
3
3
4
4
5
6
m
3700
3100
Rio Sevilla
KEY
W=wet
D=dry
m
200
100
0
Scale.
100
200
300
400
500
m

shelter of these and exposed rocks stunted shrubs and bushes grow. Specimens were collected randomly in such places but no systematic work was done there.

The work areas were both steep sided valleys with rock crowned ridges along the sides. Soil was generally black, shallow and apparently highly organic, but not peat. Stream water was pH 5-6. The paramo rock weathered to give a fine gravel base to the stream beds. The large and rapid diurnal temperature variations probably create a high rate of weathering. Mornings tend to start clear, clouding over by ten or eleven o'clock. Rain was usual in the afternoon, and sometimes it cleared again in the evening. However we do not know how dry the area gets in the short dry season of December and January.

The area is grazed by herds of cattle belonging to the finceros lower down the trail, and the local Indians of the Don Diego region. Nothing is known of the management of these herds. During the period of study they tended to stay in one valley, except when disturbed, but the presence of droppings over a wide area indicated greater wanderings. In this place the grazing was intense on the flatter parts, especially near the water courses, the steep rocky slopes being less heavily grazed. The dry season conditions are not known, but it appears likely that heavy overgrazing will occur unless the herds are controlled. Some areas have been burned recently, but whether this was accidental or an attempt to improve the pasture is unknown. Burning and overgrazing may be causing some of the erosion seen, and this associated with the low regeneration rate could seriously affect the vegetation. Therefore we considered it important to spend a few days gaining some knowledge of the grassland composition.

Aspect appears to be important in the control of tree-line. In the Río Sevilla valley, and the lesser valleys as well, the north facing slope supported cloud-forest growth to a considerably higher altitude. This slope appeared to be the wetter, and faces the prevailing winds. The forest/paramo boundary has a high bamboo content, with the trees being small and twisted. Towards the top of the transition region the forest is almost entirely bamboo.

A large number of species were flowering in the grassland at the time of our visit. Whether they flower at all times of the year, or we were just fortunate over the timing of the stay is not certain. Representatives of the Compositae seem to be particularly successful, including the magnificent *Espeletia*

TABLE B5 OF DATA FOR PARAMO QUADRATS

SPECIES	SITE										
	I: 3100 to 3300 m slopes *						II: 4100 to 4200 m slopes **				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
a 299	10	6		10	4	7	10		10	10	1
315	9	2	5	10			9	10	8	10	8
b 339	7	7	1	3			2	1	10	9	
c 296	7	6	5	8	2	3	10	10	8	10	10
d 297	6		8	10	10						
303	5					2					
310	5	4		3	1	2				1	
334	4	7	5	8	8	10					
e 295	3	9	8	9	10	8	7	9	6	7	7
353	3	4	3	1							
298	1	10	10	10			1	10	4	1	9
309	1				5	4					
300	1	6	1	1		2				1	
349	1										
f 305	1	3		4	7	8					
g 335	1	10	7	3						1	7
302		9	1								
h 333		7								2	3
317		1									
336		1									
346			4								
354				4							
358						2	3	1	1		2
344						1					
356								8			
355								5			
357							3	7			1
360										1	
Unid.	1	3	2								
Puya sp.	1										
Total spp. represented	18	18	12	13	8	12	10	7	8	11	8

* See Figure II for details of the areas numbered '1' to '6'.

** Areas '7' to '11' are as follows: '7' — Wet — 4100 m on valley bottom; '8' — Dry — 4200 m on plain just beyond saddle; 9 — Wet — 4100 m on North facing slope on side of valley; 10 — Wet — 4150 m on same hillside as 9 but higher up in rockier region; 11 — Dry — South facing slope, heavily grazed, not steep and with short grass.

a *299 Rhizocephalum sp.* (Lobeliaceae)
b *339 Ranunculus sp.* (Ranunculaceae)
c *296 Lachemilla sp.* (Rosaceae)
d *297 Hydrocotyle sp.* (Umbilliferae)
e *295 Antenaria gnaphalioides* (HBK.) Standl. ex R. Knuth (Compositae)
f *305 Orithropium sp.* (Compositae)
g *355 Gnaphalium cf. purpureum* L. (Compositae)
h *333 Lupinus sp.* (Leguminocae)

TABLE B6 COVER SCORINGS

Shows the scorings for the four categories below in each set of *ten* quadrats. Maximum score in every case is FIFTY.

Criteria	Sites										
	I: 3100—3300 m.						II: 4100—4200 m.				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
grass *	36	28	29	23	25	33	20	11	17	31	18
broad-leaf	17	20	24	29	24	26	22	24	30	20	30
rock	2	9	4	3	0	1	0	1	1	9	6
Moss	13	—	—	9	4	4	18	28	16	10	21
Bare **	15	28	26	22	19	21	18	18	13	21	15

*Including rushes and Sedges. Mostly material not in flower and thus a detailed break-down was not possible.

**Does not include the area scored under 'Rock'. i.e. Represents possible ground for new growth.

TABLE B7 SHOWING SPECIES DISTRIBUTION IN QUADRATS AT 3100 TO 3600 METRES.

Species	Quadrat Group					
	1	**2**	**3**	**4**	**5**	**6**
299	10	6		10	7	4
315	9	2	5	10		
339	7	7	1	3		
296	7	6	5	8	3	2
297	6			8	10	10
295	3	9	8	9	10	10
298	1	10	10	10		
300	1	6	1	1	2	
335	1	10	7	3		
302		9	1			
333		7				
305	1	3		4	8	7
Wet	W				W	W
Dry		D	D	D		

TABLE B8 SHOWING THE ASSOCIATION OF FOUR SPECIES

Association is displayed as a Chi-squared association table.
The species numbers **299** and **297** are representative of WET areas.
The species numbers **335** and **298** are representative of DRY areas.

299 297 335 298

	299	297	335	298
299	X	X	X	X
297	NS	X	X	X
335	– –	– –	X	X
298	– – –	– – –	+ + +	X

TABLE B9 SHOWING COMPARISONS OF DATA

Comparisons shown are of 'Wet' versus 'Dry' sites and the two altitude levels.

Species	WET *	DRY **	Cf *** (Chi-test)	3100/300	4100/200	Cf (Chi-test)
299	51	17	+ + +	37	31	NS
315	36	35	NS	26	45	– – –
339	28	12	+	18	22	NS
296	40	39	NS	31	48	– – –
297	26	8	+ + +	34	0	+ + +
310	9	7	NS	15	1	+ + +
334	22	20	NS	42	0	+ + +
295	41	42	NS	47	36	NS
353	3	8	NS	11	0	+ +
298	7	49	– – –	31	25	NS
300	4	8	NS	11	1	+ +
305	16	7	NS	23	0	+ + +
335	2	27	– – –	21	8	+
333	5	7	NS	7	5	NS
reps.	25	23	NS	28	15	+
unique	9	7	NS	17	4	+

NOTE:
The division of sites into 'Wet' and 'Dry' is purely subjective.
* WET sites are 1, 5, 6, 7, 9, 10; total six.
** DRY sites are 2, 3, 4, 8, 11. total five.
The above results allow for the variation in the number of sites in each category.
Although the grouping to 'Wet' and 'Dry' is arbitrary it is supported by the results of the association tests, displayed in Table B8.
*** 'Cf.' stands for 'Comparison'.

subneriifolia in some areas. Their success may be partially due to their independence from an external pollenating agent. Also the rosette type habit adopted by many may prove especially favourable in the prevailing low temperature conditions. In many cases the leaves formed a surface rosette with the growing point one or two centimetres below the ground. This could help stabilise the surrounding temperature despite large daily fluctuations. However the population may have been badly influenced by grazing.

(iii) *Sample areas*

SITE I: At about 3100 to 3300 metres samples were conducted up the south-facing side of the Río Sevilla valley, opposite the high altitude cloud forest (see Figure II). In the bottom of the valley is a small river bordered by a flat wet area of *Sphagnum* moss and tussock grasses (nos. *311* & *312*) the ground being wet with shallow pools. Fifteen metres from the stream the ground rises, sloping ten to twenty degrees and passes through a very rocky region. Above here the slope increased to between thirty and forty degrees to the ridge. Soil on the slope was shallow, often less than ten centimetres. Beyond the ridge is a north-facing slope of about fifteen degrees. This had been extensively grazed, but no cattle were present during the sampling. There was a shallow runnel at the bottom of the slope.

Quadrats were thrown in the following regions: the river flat; the transition zone fifteen metres from the stream; a scatter across the south-facing slope; along the ridge; a scatter on the north-facing slope; the bottom of the north-facing slope within five metres of the runnel.

SITE II. At 4100 metres in a wide shallow valley. The valley floor was flat, about 300 metres wide, disected by many small deep-cut water channels. The whole area had low vegetation, seldom more than ten centimetres high. The soil appears about thirty centimetres deep, in stream cuts. The sides of the valley are about twenty degrees and rocky. Grass tended to be longer and less grazed. The cattle were in this valley at the time of sampling. To the north-east the valley rose to 4150 metres and here was a rock-strewn saddle. Beyond the saddle the ground rapidly fell away to the lake, Lago Río Frío.

Quadrats were thrown in the following regions: a scatter on the flat bottom plain; a scatter on the south-facing slope; a scatter on the north facing slope, rocky parts; a scatter on the north-facing slope, grassy parts; a scatter on the saddle.

(iv) *Results*

These are all displayed in tabulated form. In each section (i.e. '1', '2' etc.) the number given is the total for all ten quadrats scored in that zone.

(v) *Conclusions*

Wider observation showed that not all species represented at each area sampled fell into the quadrat squares. This was due to the limited time available, causing a small sample to be taken.

Although some deviation with altitude does appear to occur (see Table B9) it is difficult to draw any conclusions in terms of variations with altitude. The factors differing between the two altitudes sampled were various and plentiful, and one or more of these could equally well be the major reason for the variation. The aspect and type of region in the two cases studied differ widely. Further investigations are required into this field, including studies of the distribution of the cattle and their effect on the vegetation.

Certain conclusions can however be reached over the species distribution. Thus the herb *number 298* (unident.) is found mainly in dry short grass (heavily grazed) regions. *Rhizocephalum sp (299)* haunts wetter areas (see Table B9). On the slope of the south-facing side of the Río Sevilla valley the changing vegetation probably represents alterations in the drainage of the hillside. In the *General Description* it is proposed that the forestation of the north-facing slope is due to improved rainfall, and this is born out by the ground quadrat results. The wetter-ground species, typified by *Rhizocephalum sp (299)* and the succulent leaved *Hydrocotyle sp. (297)* (see Table B8), occur preferentially in regions 1, 5 and 6 (see Figure II). Similarly Table B7 shows *Gnaphalium cf. purpureum (335)* and *298* (unidentified) to occur in the south-facing regions 2, 3, and 4 of Figure II. Regions 2 and 4 are occupied by representatives of both types of soil-water conditions, which confirms the original hypothesis that these are Transition zones. That region 4 is in this category is further evidence for rainfall not being even on north and south-facing slopes. In both regions the total number of species represented is greater than to either side, adding weight to their being considered 'Transition' zones.

Table B5 showing the distribution of all species scored indicates the expected situation of a few common species in each site with a 'tail-off' of rarer species. In this context it is interesting to compare the flood-plain of the river at 3100 metres and the drier plain at 4100 metres. The lower area appears more favourable for plant growth, and this is borne out by the greater number of species being found there. However this effect could be due to the altitude difference.

Lupinus sp. (333) , although poorly represented in the quadrats was quite common elsewhere. It showed a preference for regions of longer grass, and this could be indicative of a susceptibility to grazing.

ZOOLOGY SECTION (C.W.D.G. & S.M.B.)

A full write-up of our zoological work cannot be attempted until all our material has been identified. This consists of some 3000 Lepidoptera and a large number of animals from our bromeliad work. Since little insect collecting has been done in the Sierra Nevada the number of undescribed species is likely to be high, and this work will probably take some time. In view of this a preliminary sketch is given below.

A) LEPIDOPTERA

(i) *General Introduction*

Butterflies were first collected from the Sierra Nevada by Simons (11) in the 1870s. Among their discoveries were *Morpho rhodopteron* and the metallic blue Satyrid, *Lymanopoda caeruleata,* which is endemic to the area. Both these species were found in numbers by the present expedition; the *Morpho* from 800 to 1600 m, and *L.caeruleata* from 1800 to 2300 m.

Little collecting appears to have been done from Simons' time until 1967, when an expedition from Shizokua University, Japan, took some 500 species and a small number of moths. Their material is in the state of processing (2, 12, 13, 14, 15).

In 1970 and 1972 Adams and Bernard collected butterflies and some day flying moths from all over the Sierra. Their total so far is some 620 butterfly species (16).

Very few moths have been collected in the Sierra Nevada, and there is no record of night flying moths being taken. We therefore decided to concentrate on nocturnal moths, including "micros" although also taking some day-flying moths and butterflies to supplement material in the British Museum.

(ii) *Collecting methods*

Day flying insects were netted: an attractant trap proved ineffective at the altitudes which we were working most of the time. This type of trap is most effective for catching large showy species of *Morpho, Priamides* and other Papilionidae which are, in the main, restricted to the tropical and subtropical zones and rarely come within reach of the net. Fresh mule dung also proved attractive to some species, notably *Corades* up to 2800 m.

Night flying moths were taken around lights in San Pedro — fluorescent strip lights in the mission school-house proving most effective. A home-made light trap incorporating a hundred watt tungsten bulb proved efficient, and Tilley lamps were also used. At altitudes above San Pedro Tilley light alone was used, as we lacked a portable source of electricity. Even this had to be abandoned above 3000 m, as the local alcohol would not burn well enough to prime the mantles above this altitude. Thus on the paramo collecting was restricted to daytime and dusk.

(iii) *Results*

In all, some 2700 moths, including "micros" were taken, and some 500 butterflies. Numbers were limited less by our ability to catch specimens than by the time taken to preserve them adequately in the damp atmosphere. Any specimen left lying around at the base overnight would be dismembered by ants or mouldy by the morning.

Few of the moths have yet been identified, but Messrs. Adams and Bernard have very kindly identified most of our butterflies already. The species so far determined are listed below.

LIST OF BUTTERFLY SPECIES TAKEN DURING THE EXPEDITION

With many thanks to Messrs. Adams and Bernard who have carried out these identifications.

Danaidae (3)

1. *Danaus plexippus* L.
2. *D.gilippus* Cr.
3. *D.eresimus* Cr.

Satyridae (25)

4. *Corades c. chelonis* Hew.
5. *C.c.cybele* Btlr.
6. *C. eryo* Hew. *alsio* Thieme

7. *Euptychia calixto* Btlr
8. *E. jesia* Btlr
9. *E. polyphemus* Btlr
10. *Euptychoides saturnus* Btlr
11. *Hemeuptychia hermes* F.
12. *Lasiophila* sp. n.
13. *Lymanopoda caeruleata* G & S
14. *L. kruegeri* Rober
15. *Magneuptychia libye* L.
16. *Pareuptychia binocula* Btlr
17. *P. hesione* Sulz
18. *Paryapedaliodes paryasis* Hew.
19. *Pedaliodes leucocleilus* G & S.
20. *P.manis* Feld.
21. *P. "manarcana"* sp. n.
22. *P. phazaria* Gr-S.
23. *P. symmachus* G & S.
24. *P. tyrrheus "tairona"* ssp. n.
25. *Pronophila "juliani"* sp. n.
26. *Steremnia polyxo* G & S
27. *Taygetis kerea* Btlr.
28. *Catargynis "gibsoni"* sp. n.

Morphinae (1)

29. *Morpho rhodopteron* G & S *schultzei* Le Moult

Brassolinae (1)

30. *Opsiphanes bogotanus*

Ithomiinae (6)

31. *Ceratinia tutia* Bates
32. *Dicerna jeruvia* Geyer f. *bairdii* Rkt.
33. *Hypoleria a. andronica* Hew.
34. *Hypothyris lycaste* f.*phianassa* W.D. & H.
35. *Ithomia langusa* Hew.
36. *Oleria a. anelda* Hew.

Nymphalidae (28)

37. *Actinote stratonica* Latr.
38. *Anartia amathea* L.
39. *A.jatrophae L.*
40. *Catonephele c. chromis* D & H.

41. *Chlosyne narva* F. f. *bonpland* Latr.
42. *C.saundersi* D & H.
43. *Diaethria clymena* Cr. ssp. n.
44. *D.galazina* Oberthur
45. *Eunica monima* Cr.
46. *Euptoieta hegesia* Cr.
47. *Hamadryas februa* Hbn. *icilia* Fruh.
48. *Hypanartia dione* Latr.
49. *H.kefersteinii* D & H.
50. *H.lethe* F.
51. *Junone lavinia* Cr.
52. *Limenitis egregia* Rober
53. *Marpesia chiron* F.
54. *M. coresia* Godt.
55. *M. corinna* Latr.
56. *Metamorpha epaphus* Latr.
57. *Microtia elva* Bates
58. *Phyciodes anieta*
59. *P.castianina* G & S.
60. *P.drusilla* Bates
61. *P.eranites* Hew.
62. *P.ofella* Hew.
63. *Pyrrogyra edocla* D & M.
64. *Vanessa virginiensis* Druce *iole* Cr.

Heliconiinae (10)

65. *Agraulis vanillae* L.
66. *Dione glycera* Feld.
67. *Dryadula phaetusa* L.-
68. *Dryas iulia* F.
69. *Heliconius charithonia* L.
70. *H.clysonimus* Latr.
71. *H.erato* L. *hydara* Hew
72. *H.m.melpomene* L.
73. *H.primularis* Btlr. *eleuchia* Hew.
74. *H.edias* Hew.

Riodinidae (7)

75. *Amphiselerus charia* Stgr.
76. *Charis arius* Cr.
77. *C.hermodora* Feld.
78. *"Charmona caerieus L"* (after BM coll.)
79. *Mesosemia t. telegone* Bdr.

80. *Nymphidium cachrus* F. *ascolides* Bdv.
81. *Perophthalma tullius* F.

* **Lycanidae (12)**

82. *Thecla* sp. n. (nr. *arria* Hew.)
83. *Thecla* sp. n. (nr. *carnica* Hew.)
84. *Callicista beon* Cr.
85. *C.bubastus* Cr.
86. *"Thecla" commodus* Feld.
87. *"T" gibberosa* Hew.
88. *"T" leucogyna* Feld.
89. *"T" melinus* Hbn.
90. *"T" sethon* G & S.
91. *"T" togarna* Hew.
92. *Leptotes cassius* Cr.
93. Unidentified *"Thecla"*

Papilionidae (2)

94. *Papilio paeon* Bdv. *thrason* Feld
95. *Parides lycimenes* Bdv. *erythrus* R & J.

Pieridae (21)

96. *Anteos maerula* F.
97. *Dismorphia core* Feld
98. *D.crisia* Drury *foedora* Lucas
99. *D.m.medora* Dbl.
100. *D.nemesis* Latr.
101. *Eurema athalia* Feld
102. *E.elathea* Cr. *vitellina* Feld
103. *E.marginella* Feld
104. *E.proterpia* F.
105. *E.venusta* Bdv. *limbia* Feld.
106. *Leodonta dysoni* Dbl.
107. *Leptophobia aripa* Bdv.
108. *L.eleone* Dbl. 109. *L.eleusis* Lucas
110. *L.maruga* Fruh
111. *Nathalis iole* Bdv.
112. *Phoebis argante* F.
113. *P.rurina* Feld.
114. *P.sennae* L. *marcellina* Cr.
115. *Pieris d. drusilla* Cr.
116. *Tatochila* sp. n.

Hesperiidae (32)

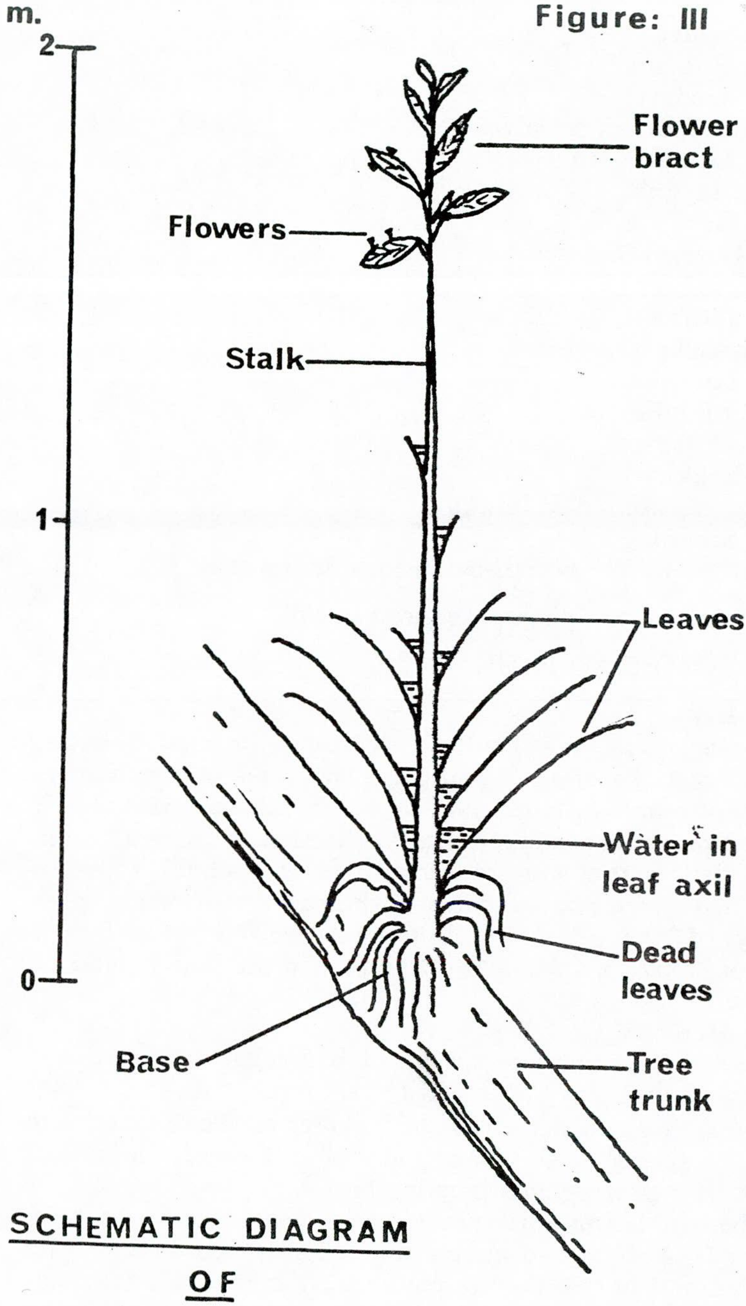
117. *Arita arita* Schaus
118. *Autochton longipennis* Plotz
119. *Bolla zorilla* Plotz
120. *Calaenorrhinus similis* Hwd. *bifurcus* Bell.
121. *Callimormus saturnus* H-S.
122. *Calpodes ethlius* Stoll
123. *Chiodes zilpa* Btlr.
124. *Chiomara asychis* Stoll *simon* Evans
125. *Conga chydea* Btlr.
126. *Cymaeus tripunctata* Latr. *alumna* Btlr.
127. *Dalla* sp. n.
128. *Dalla* sp. n.
129. *Dalla ceicus* Hew ssp. n.
130. *D.merida* Evans
131. *Gorgythion b. begga* Pritt
132. *Heliopetes a. asalta* L.
133. *H.l.lavinia* Hew.
134. *Nisoniades castolus* Hew.
135. *Noctuana n. noctua* Feld.
136. *Ouleus f. fridericus* Geyer
137. *Panoquina sylvicola* H-S.
138. *Parphorus* sp. n.
139. *Psoralis exclamationis* Mab.
140. *Pyrgus oileus* L. *orcus* Stoll
141. *Pyrrhopyge aerata* G & S.
142. *Sostrata p.purilla* G & S.
143. *Tirnochares t. trifasciata* Hew.
144. *Tisias caesena* Hew.
145. *Urbanus d. dorantes* Stoll
146. *U.pronus* Evans
147. *U.teleus* Hbn.
148. *Zalomes* sp. n.
149. *Zopyrion satyrina* Feld.

* The genus *Thecla* has recently been split up.

Abbreviations of authors

Bdv.: Boisduval
Btlr.: Butler
Cr.: Cramer
Dbl.: Doubleday
F.: Fabricius

Figure: III



SCHEMATIC DIAGRAM
OF
BROMELIAD GROWTH

Feld.: Felder
Fruh.: Fruhstorfer
Godt.: Godart
G & S.: Godman & Salvin
Gr-S.: Grose-Smith
Hwd.: Hayward
Hew.: Hewitson
H-S.: Herrich-Schaeffer
Hbn.: Hubner
Jord.: Jordan
L.: Linnaeus
Latr.: Latreille
Mab.: Mabille
Pritt.: Prittwitz
Rkt.: Reakirt
R & J.: Rothschild & Jordan
Stgr.: Staudinger
(W), D & H.: Westwood, Doubleday & Hewitson

All other authors' names are given in full.

B) BROMELIAD FAUNA

(i) *Aim*

Due largely to the difficulty of identifying Bromeliad species in the vegetative state, the original aims of a comprehensive survey of epiphyte fauna had to be abandoned. However it seemed practical to make general collections of animals from Bromeliads so that a future study would have a background of identified species on which to work, and to perform a pilot survey of one genus of Bromeliad growing at different altitudes to see if any major differences in the fauna could be detected.

(ii) *Methods*

It was found that one species of Bromeliad *(Achmea sp.)* was abundant in the cloud-forest near both the 2300 metre station and the camp at 2800 metres. The plants were found in accessible situations and was in flower at the time of our stay, rendering identification easier.

When in flower this species carries a flower spike from one-and-a-half to two metres tall, bearing red bracts from which small purple flowers emerge. At both stations it was found from the crowns of the trees to the bases, as well as on fallen trunks, although the plants in the latter position were less often seen in flower. All the specimens used in our study came from an epiphytic position, growing on live trees at between two and four metres above ground level.

Ten flowering individuals were selected from each locality and were removed as gently as possible from their points of fixture to the tree.

The plants were then dissected totally and the animals found recorded in the following manner:

It was found that the plant could be divided into sectors as laid out below, and the position of each animal found was noted according to the sector in which it occurred. All plants selected were in flower, so the 'flower and stalk' division includes all plants used.

1. Base. This was taken as the roots and accumulation of organic matter between them, including dead bromeliad leaves — continually moist in our study period, but containing no standing water.

2. Axils. Where the leaf base curls round the stem of the plant, a pocket is formed which in the cloud forest environment is filled with water. Detritus often falls into these pockets, forming a moist accumulation of litter. All animals found up to the water line (or in wet detritus when the water line was obscured) were classed under 'axils'. These areas support a very rich fauna.

3. Leaves. Animals found on living leaves above the water line were included here.

4. Flowers and stalk. Animals found on the flower bracts and internal feeders in stalk and flowers were included here. These situations were noted and separated.

Figure III shows a 'typical' bromeliad growth form and the classifications used.

At our 1900 m station, just above the montane rain forest/cloud forest boundary, the experimental species did not occur, and a random sample of several bromeliad species was dissected to provide material for comparison and taxonomic purposes.

(iii) *Results*

Whenever an animal was found, its name and position on the plant were noted. Unfortunately only taxa ranging from order upwards can be given at this stage, and until all our animals have been identified.

The results are given in the form of tables as set out below. Table Z1 gives the totals of all taxa found according to altitude and to the part of the plant on which they live, and table Z2 gives all taxa according to each sample plant.

TABLE Z1

Total numbers of different taxa present at altitudes of 2300 m and 2800 m in different parts of *Aechmea* spp.

TAXA	ALTITUDE (m) Base		Axils		Leaves		Fl. & stem		Totals	
	2300	2800	2300	2800	2300	2800	2300	2800	2300	2800
PHYLUM										
Platyhelminthes										
Land planarians	1	—	—	—	—	—	—	—	1	—
PHYLUM										
Nematoda	1	1	1	—	—	—	—	—	2	1
PHYLUM										
Annelida										
Oligochaeta	6	7	1	11	—	—	—	—	7	18
Hirudinea	10	1	5	11	—	—	—	—	15	12
PHYLUM										
Arthropoda										
Crustacea										
Isopoda adult	5	1	29	90	—	5	—	—	34	96
juv.	—	—	—	6	—	—	—	—	—	6
PHYLUM										
Arthropoda										
Insecta										
Collembola	1	9	6	44	3	7	—	—	10	60
Thysanura	19	6	1	—	—	—	—	1	20	7
Other apterygota	—	21	—	21	—	3	—	1	—	46
Blattodea	3	4	10	29	6	8	—	1	19	42
Do. oothecae	—	—	2	1	—	2	—	—	2	3
Orthoptera	—	—	2	6	1	4	—	—	3	10
Dermaptera	—	11	3	19	—	1	—	—	3	31
Do. eggs	—	—	—	98	—	—	—	—	—	98
Homoptera										
Aphidae	—	—	—	1	2	11	—	—	2	12

Other	2	—	6	2	—	1	—	—	8	3
Heteroptera	—	3	2	10	—	1	—	—	2	14
Diptera										
All adults	—	—	1	7	—	4	—	—	1	11
All pupae	—	1	—	5	1	3	—	—	1	9
Eristalis larvae	1	1	1	24	—	—	—	—	2	25
Chironomid larvae prob. *Metriocnemus*	—	2	11	23	—	—	—	—	11	25
Other larvae	2	1	37	16	13	2		1	52	20
Coleoptera adults	9	7	16	49	1	8	5	13	31	77
do. larvae		2		26	—	—	—	—		26
Hymenoptera adults	—	—	—	z9	z9	2	—	—	—	2
larvae (sawfly)	—	—	—	1	—	—	1	—	1	1
All pupae	—	—	—	—	—	—	—	1	—	1
Lepidoptera imago	—	—	—	1	—	—	—	—	—	1
All pupae	—	—	—	1	1	—	—	—	1	1
All larvae	—	—	3	2	4	1	—	2	7	5
Chilopoda	1	1	—	1	2	—	—	—	3	2
Diplopoda	1	3	1	2	—	1	—	—	2	6
Chelicerata										
Arachnida										
Scorpionida	—	—	4	—	—	—	—	—	4	—
Pseudoscorpionida	—	—	1	—	3	—	—	—	4	—
Acarina	7	1	5	4	3	—	—	—	15	5
Araneida	2	24	43	51	23	14	—	—	68	89
PHYLUM										
Chordata										
Amphibia										
Salamanders	—	—	3	—	—	—	—	—	3	—
Treefrogs	—	—	3	13	—	—	—	—	3	13
Others	1	—	1	3	2	—	—	—	4	3
TOTALS	72*	107	198*	578	65	78	6**	20	341**	783
									1130	

*,** These totals include cases where animals were too abundant to be counted individually and an interval score was used. This is explained below.

Classification according to Hegner & Engemann (17).

TABLE Z2 RELATIVE ABUNDANCE OF DIFFERENT TAXA IN EACH BROMELIAD SAMPLED

Nos. 1—10 from 2300 m, 11—20 from 2800 m, 21—26 from 1900 m.

Bromeliad No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Planaria	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	6	—
Nematoda	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Oligochaeta	1	—	—	—	—	2	—	3	1	2	1	2	2	1	3	—	3	3	1	3	—	—	1	—	—	—
Hirudinea	—	—	—	—	1	—	4	1	1	—	1	1	—	4	—	1	—	1	2	1	1	—	1	—	—	—
Pseudoscorpionida	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—
Aranea	—	—	10	—	2	—	1	1	1	1	—	1	—	—	—	1	—	1	1	1	—	1	—	—	3	—
Arachnida	1	5	10	12	3	7	12	7	6	7	4	11	13	10	6	9	12	5	10	11	1	2	4	3	10	—
Scorpions	—	—	—	—	—	—	1	2	1	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	—	—
Chilopoda	—	—	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
Diplopoda	—	—	—	—	—	1	—	1	—	—	1	—	—	2	—	2	—	—	—	1	1	—	—	1	1	—
Isopoda	15	2	6	—	—	—	7	6	7	—	2	2	16	17	31	16	1	5	6	15	—	—	6	—	—	—
Collembola	2	1	3	—	1	—	—	—	—	2	1	1	2	—	8	19	—	14	6	12	—	1	—	—	1	1
Thysanura	—	—	—	10	—	5	3	2	—	—	—	—	—	1	—	3	—	—	1	2	—	—	—	—	—	—
Other apterygotes	—	—	—	—	—	—	—	—	—	—	13	—	8	1	—	4	6	—	12	1	—	1	2	—	2	—
Blattodea	—	1	1	1	1	1	7	3	3	4	—	8	4	8	3	1	—	—	5	8	1	1	—	7	6	—
Do oothecae	—	—	1	—	1	—	—	—	—	—	—	—	1	—	—	—	1	—	1	—	—	—	—	—	—	—
Orthoptera	—	—	—	—	1	—	1	—	1	—	3	—	—	1	3	2	1	—	—	—	—	—	—	—	—	—
Dermaptera	—	—	3	—	—	—	—	—	—	—	—	—	—	14	4	3	2	—	—	7	—	13	—	3	3	—
Do. eggs	—	—	—	—	—	—	—	—	—	—	—	—	—	28	50	20	—	—	—	—	—	—	—	—	—	—
Mealy bugs	—	—	—	—	—	1	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Aphids	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7	1	—	—	—	—	—	—	—	—	—
Other Homoptera	—	1	1	—	1	—	2	3	2	2	—	—	4	1	—	—	1	1	—	—	—	2	1	—	1	—

Bromeliad No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
Heteroptera	—	—	—	—	—	—	2	—	—	—	2	—	4	1	—	4	2	1	—	—	—	1	1	—	3	—
Diptera imagines	—	—	—	—	—	—	1	—	—	—	—	—	—	—	3	—	5	—	1	—	2	—	—	—	—	—
"Eristalis" larvae	1	1	—	—	—	—	—	—	—	—	—	6	1	12	2	—	1	—	—	—	—	—	—	—	—	—
Chironomid larvae	—	—	—	—	—	—	9	—	2	11	—	—	3	12	—	—	3	—	—	6	—	—	—	—	5	—
Other dip. larvae	—	—	3	—	—	—	16	7	5	3	3	1	3	1	4	4	1	1	—	7	—	4	4	1	12	2
Flowerhead dip. larvae **	0	1	8	5	8	2	0	0	0	1	0	6	5	9	1	1	8	10	5	2	—	—	—	—	—	—
Bipteran pupae	—	—	—	—	—	—	—	1	—	—	—	2	1	1	—	—	1	1	1	—	—	—	—	3	—	—
Coleopteran imagines	—	2	6	5	4	—	6	4	3	1	15	—	5	4	6	22	9	—	3	7	3	—	1	2	11	—
Coleoptera larvae *	0	4	0	0	0	1	3	1	1	1	—	2	3	6	3	2	9	2	5	—	—	4	8	4	12	2
Hymenoptera adult	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	1	—
Sawfly larvae	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Hymenopteran pupae	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Lepidopteran imago	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—
Lepidopteran larvae	—	2	—	—	—	—	2	—	—	3	—	—	—	—	—	—	—	—	—	1	—	—	2	—	4	—
Lepidopteran pupae	—	1	—	—	—	—	2	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Salamanders	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—
Treefrogs	—	—	—	3	1	—	—	—	—	—	2	—	—	1	—	2	1	1	1	5	—	1	—	—	—	—
Others	—	—	—	—	1	1	—	—	—	1	—	—	—	1	2	—	—	—	—	—	—	1	—	—	—	—
Totals ***	20	17	57	32	19	18	80	43	33	37	47	42	67	127	143	81	62	37	64	91	15	34	31	26	83	5

* Bromeliads 0—10 scored using an interval score: see text
** Bromeliads 0—20 scored using an interval score: see text
*** All totals except 21—26 exclude animals scored by interval.

Three different taxa were found to be so abundant at one altitude that an interval score had to be used to index their numbers. In the case of mealy bugs and the Coleoptera larvae occurring in the axils of plants at 2300 m, we used a 0,1,2,3,4, system, as follows:

Score	Mealy bugs	Coleopteran larvae
0	0	0–10
1	0–10	10–20
2	10–20	20–30
3	20–30	30–40
4	30–40	40–50

In the case of one Dipteran larva infesting the flowers at 2300 m, a score from 1-10 was used depending on the percentage infestation of a random sample of flowerbuds.

Identification to species has not been carried out yet; with such a wide range of taxa this must await our finding a large number of people willing to work on different animals. The Chiromomid larvae are probably nearly all *Metriocnemus* spp., and all except one of our oligochaetes are very similar to those found by Picado in 1913 (18).

Using groups that can be confidently assigned to carnivores, herbivores, and detritus feeders, percentage composition of the fauna appears as follows:

Carnivores	25%
Herbivores	11%
Detritivores	64%

Two series of tests were carried out as a guideline for future research. Chi-square tests were performed on the two samples of ten bromeliads from 2300 m and 2600 m, to show any significant differences in the fauna. Each animal was taken separately, and the numbers in each bromeliad expressed as a percentage of the total number of animals in that plant, to eliminate size bias and other extraneous factors besides altitude affecting the number of animals in a plant. The frequency of repeats in each percentage range at the different altitudes was used as data for the chi-square test.

Results were as follows (where p is greater than 0.1 it is not given).

Animal	Probability of no difference between altitudes from chi-square
Oligochaetes	$0.05 < p < 0.1$
Isopods	$0.02 < p < 0.05$
Apterygota (other than Collembola, Thysanura)	$0.01 < p < 0.02$

Treefrogs	$0.05<p<0.1$
Dermaptera	$0.05<p<0.1$

The Friedman non-parametric two-way analysis of variance was used to test the significance of distributions of animals within the plants. The test was run for nine of the commonest groups, using the raw data from the four plant divisions of the plants from 2300 and 2800 m. A programme written in BASIC for the Nova 1200 computer in the Zoology Dept., Oxford was used for running the test.

Taking a rejection level of p under H_0 0.05, the results of the tests were as follows.

TABLE Z3

Results of the Friedman two-way analysis of variance

Animal	**Xr^2**	**p under H_0**
Oligochaetes	10.295	$0.01 < p<0.02$
Aranea	2.621	— —
Arachnida	30.111	$p<0.001$
Isopoda	11.400	$p=0.01$
Collembola	3.426	— —
Other apterygotes (excl. Thysanura)	0.995	— —
Blattoidea	15.079	$0.001<p<0.01$
Eristalis type	4.137	— —
Assorted Diptera larvae	9.253	$0.02 <p< 0.05$

This confirms that several groups are largely confined to specific parts of the plant.

(iv) *Discussion*

This study confirms that the tank bromeliad fauna is a largely detritus-based system, with 64% of the animals by numbers being detritus feeders, and only 11% herbivores. The percentage of carnivores is within the normal range for this type of community (18). In fact the numbers of carnivores and herbivores may well be biased upward due to our inability to distinguish between animals totally dependent on bromeliads and those which use them for shelter or breeding or merely adventitious fall-offs from other plants. It is likely that few of the detritus feeders, which are mostly aquatic or semi-aquatic, are not true members of the bromeliad fauna. Vandemeer et al (19) have shown that *Paramecium* spp are unable to colonise wild bromeliads due to competition with other members of the bromeliad flora, but any estimate of the community status of our bromeliad fauna will have to wait until all our animals have been identified and further work has been done.

Among those animals which may be purely adventitious are Lepidopterous larvae found on the leaves as opposed to internal stem feeders, and also adult flying insects.

At least one species of treefrog appears to breed in the bromeliads: on more than one occasion eggs were found just above the water level in the axils. Compared to those of temperate aquatic frogs, these eggs were very large and few in number. The largest frogs found in the bromeliads were less than five cm long, and only three or four eggs of seven to eight mm diameter were found at one time. Lutz (20) describes a similar situation in the bromeliad frogs of Brazil.

Besides animals only fond as larvae in the bromeliads, several others breed there. Both the young and eggs of Dermaptera were found in large numbers with the adults, and on two occasions scorpions were observed with young. It is possible that the tank bromeliads provide a relatively sheltered microclimate in which animals breed at higher altitudes.

Picado (18) and others have shown that tank bromeliads are capable of absorbing nutrients through trichomes (specialised scales) on the leaves. Tank bromeliads of the type in our study have these concentrated in the leaf axils, and are largely dependent on this method of nutrient uptake. There would seem to be a degree of mutual adaptation in that the growth form of tank bromeliads provides a funnel by which detritus falling from above is channelled into the water bodies of the leaf axils, providing an ideal habitat for a range of detritivores. Only a few of our animals were abundant enough to show this conclusively, such as Oligochaetes restricted to the bases and axils, "Diptera larvae", mostly mosquito larvae, in the water of the leaf axils, and Isopoda and Blattodea in the axils, but above the water level in drier detritus, or among the detritus around the base of the plant. *Eristalis* type larvae (rat-tailed maggots) are completely restricted to the axil water, but the small sample and the nature of the Friedman test preclude this being demonstrated significantly. The test is based on a ranking procedure which masks the effect of relatively large numbers in only a few plants, so animals such as *Eristalis* which appear to have a clumped distribution cannot be effectively analysed on our small sample.

Laessle (21) working in Jamaica, found that the pH of tank bromeliad axils varied considerably with the position of the plant and with the position of the axil within the plant. Our constant pH readings (using the same method) could be an effect of the small sample size, but may also be due to the heavy rainfall in the Sierra, causing a rapid turnover of water within the axils, and stabilising the pH to near that of the rainwater.

Although only five groups of animals approach a rejection level of p=0.05 for differences in altitude distribution, there are indications that larger samples might reveal important differences in the faunal composition between the two altitudes. All the groups (tree frogs, Dermaptera, isopods, apterygota and oligochaetes, which approach significance under chi-square are more abundant at higher altitudes, but there are many other groups, which although present in too small numbers to show significance under chi-square may be completely absent from one altitude sample. For instance, planaria are absent at 2800 m, as are scorpions, salamanders and mealy bugs. Where mealy bugs occurred at 2300 m, they had to be interval scored, but they only occurred in four bromeliads and could not be analysed statistically. *Thysanura* appear to be much commoner at the lower altitude, whilst the other two groups of apterygotes are commoner at 2800 m. This is particularly interesting as these groups all belong to the same 'guild' (18) and a switch in importance would deserve further investigation. A similar situation may occur with tree-frogs and salamanders, but the numbers are far too small to draw any conclusions.

Although the overall diversity of groups present at lower altitude is greater than that at the higher station, the numbers of animals per bromeliad appears to be greater at higher altitude. However, this is biased to some extent by the distribution of interval scored taxa, which were not included in the numerical count, and is probably not significant. The lower diversity of taxa at high altitude is as expected.

Summary

Samples of an epiphytic tank bromeliad were taken at two different altitudes in the cloud forest on the western side of the Sierra Nevada de Santa Marta in Colombia, and their macrofauna was estimated by direct counting. pH measurements were also taken. It was found that the fauna represented a largely detritus-based community, and that the base and axils of the plant supported the richest fauna. Shifts also appear to take place in the composition of the fauna at different altitudes, although larger samples are needed to show this conclusively in most cases.

Further lines of research are suggested for future studies.

A very small sample of mixed species was taken at a lower altitude on the cloud forest boundary.

METEOROLOGICAL SECTION (R.J.R.)

(i) *General*

This survey was conducted to enable the data obtained in the other investigations to be related to the prevailing climatic conditions. As far as we know no such results have been obtained in the Sierra Nevada de Santa Marta on this trail before, and thus we were required to take readings ourselves. INDERENA operates a weather station at San Pedro (1400 m), but do not have recording stations above the village. The information from this station is available on request to the Santa Marta office.

(ii) *Methods*

Records were taken as follows:

a) *Temperature:* — a standard maximum-minimum thermometer was used to record shade temperatures. Readings were taken morning, noon and night. The table below shows the averages of these figures over the period recorded.

b) *Rainfall:* — recorded with a standard three inch gauge and converted to centimetres per day. Readings below are the average for the days recorded.

c) *Humidity:* — measured using a hand-rotated wet-dry thermometer. The instrument unfortunately broke before sufficient data could be collected to render the results meaningful.

Records were taken at the four altitudes where 'base' camps were established, that is 1400 m, 2300 m, 2700 m, 4000 m. It was not possible to set-up equipment at all working levels, and it was considered preferable to obtain meaningful results at these four wide-spread altitudes than to scatter the records over a wider number of recording stations.

The Cabot Expedition to the Sierra Nevada de Santa Marta in the 1930's took some meterological records in other regions (22).

(iii) *Results*

	Altitude (m)			
	1400	2300	2700	4000
Number of days [1]	6	4	11	8
Time (hrs) [2]				
06—08 max° C.	22.2	13.8	11.5	8.4
06—08 min° C.	19.3	12.6	6.9	0.81

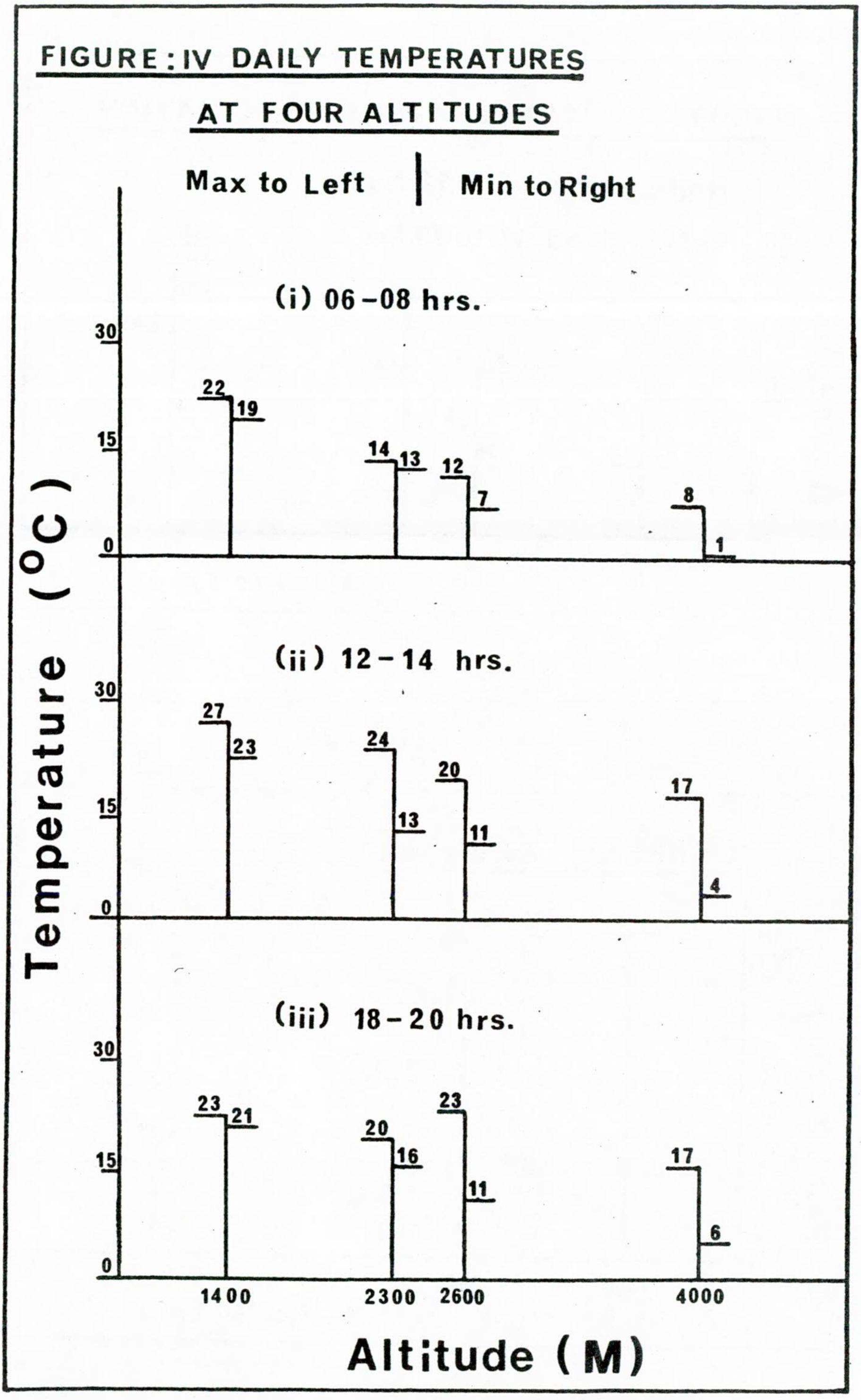


FIGURE : IV DAILY TEMPERATURES
AT FOUR ALTITUDES
Max to Left
Min to Right
(i) 06-08 hrs.
(ii) 12-14 hrs.
(iii) 18-20 hrs.
30
15
0
22
19
14
13
12
7
8
1
27
23
24
13
20
11
17
4
23
21
20
16
23
11
17
6
1400
2300
2600
4000
Temperature (°C)
Altitude (M)

FIGURE: V TEMPERATURE FLUCTUATION

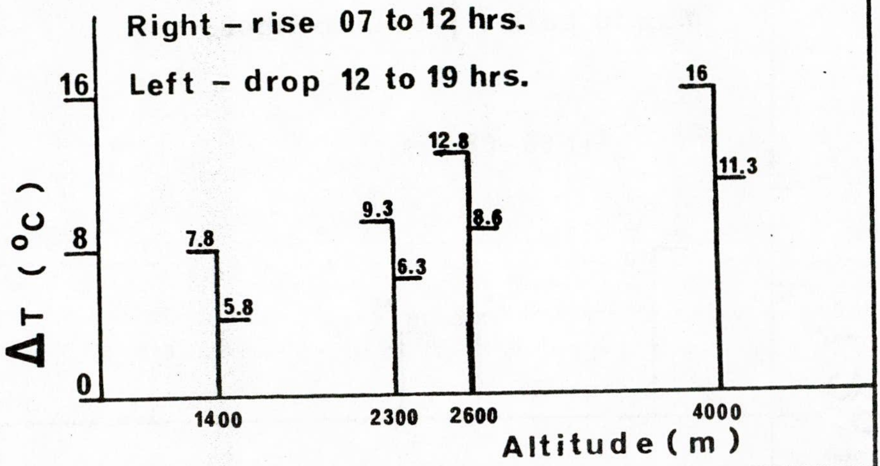
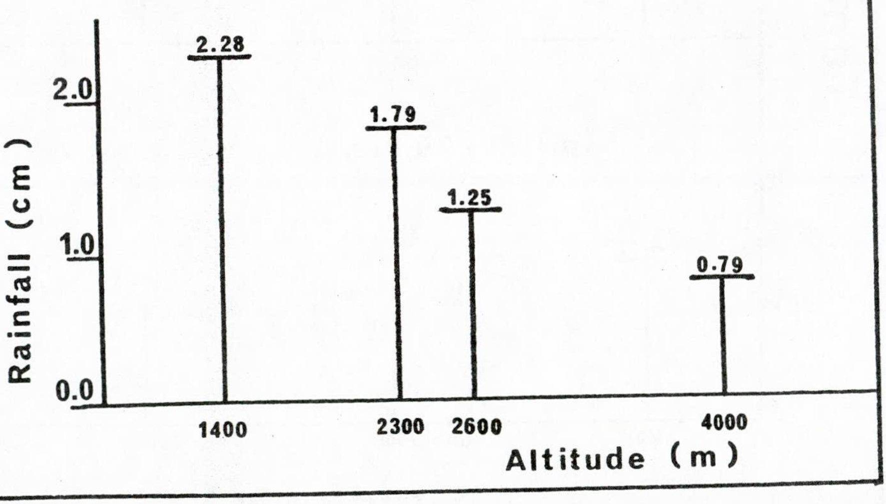


FIGURE VI RAINFALL



07–12	increase[3]	7.8	9.3	12.8	16.0
12–14	max °C.	27.1	22.3	19.7	16.8
	min °C.	22.7	12.5	10.7	3.8
12–19	decrease[4]	5.8	6.3	8.6	11.3
18–20	max °C.	22.8	19.8	23.2	16.8
	min °C.	21.3	16.0	11.1	5.5
Rainfall (cm)		2.28	1.79	1.25	0.79

Notes

1. This gives the total number of days recorded at this altitude, and the figure given is thus an average of this number of readings.
2. Since readings were not taken at exactly the same time every day it was necessary to use a span of two hours to cover all the results.
3. The morning increase is the difference between the 12–14 period maximum and the 06–08 period minimum.
4. The afternoon decrease is the difference between the 12–14 maximum and the 18–20 minimum.
5. All results are recorded during the period July 10th to August 26th 1973.

(iv) *Discussion*

The meterological data collected by the expedition is seriously deficient as to the period of time for which it was collected. It cannot be considered as any more than the average during the period that we spent in the Sierra Nevada. However it was for the purpose of applying these figures to a correlation of the climate and the faunal activity that the readings were taken, and they are valid for this purpose, since they show the trends occurring at the time of collecting.

As expected the data shows the typical characteristics of temperature variation with altitude (Figure IV). At any given time of day there is almost without exception a lower temperature at a higher altitude, indicating a daily temperature gradient up the mountain. At the higher altitudes a greater degree of variation occurs between the individual records, and this must be considered to reduce the reliability of the average readings. But the general trend seems clear.

Associated with the general decrease of temperature with altitude is an increased daily fluctuation. The display of data as a morning rise in temperature and the afternoon decrease, in Figure V, clearly shows this. Such changes reflect the ability of the environment to hold heat, and can be expected to have important effects on the plant and animal life of the region.

Similarly the rainfall decreases with altitude increasing (Figure VI). At higher altitudes the certainty of having rain in the afternoon was much less than in the lower zones, and on the paramo some days had little or no rain. It is likely that the variation in rain is an important factor in the type of forest growth in different parts of the mountain. Herrmann (23) has analysed the correlation between the rainfall of the coastal regions at the base of the Sierra Nevada and the forest type, and shows a strict dependence of the vegetation on the precipitation levels. Adams (16) describes all the types of forest found in the range, and suggests the differences to be at least partially due to the prevailing rain-bearing wind conditions. No detailed analysis has been done on the upper parts of the mountain, due to the paucity of data, but I suggest that similar correlations will be found. Herrmann (24,25) also analyses the weather in terms of the wind and rain conditions along the northern side of the range.

The importance of rain in forest growth is clearly demonstrated in the situation found in the Río Sevilla valley, mentioned earlier. The "Wetness" of the forest seems the most important factor in Epiphyte growth, and possibly will prove important in the investigations on Bromeliad fauna to be performed in the future. The cloud-forest, although receiving less rain (at least during our stay there) than the rain-forest of the lower slopes, bears a heavier epiphyte load. This must be due to the continually wet tree surfaces presenting the best environment and most favourable situation for plant growth.

Thus, within the limits of the data collected, it can be considered that the rainfall and temperature dependence expected from the observations on plant and insect life is supported by the data presented in this section.

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ADVICE FOR EXPEDITIONS TO COLOMBIA (R.J.R. & S.M.B.)

There is a comprehensive section on this topic published by the 'Oxford expedition to Colombia, 1971' covering the more general points. This is to be found in the *Bulletin of the Oxford University Exploration Club* **20** 14-36 (1971). However certain points can be added to these.

1. Botanical and Zoological expeditions should contact the Instituto de Ciencias Naturales, Bogotá. The director is Dr. A. Fernandez-P: the Director of the Herbarium is Dr. E. Forero. Address: Universidad Nacional de Colombia, Apartado Aéreo 7495, Bogotá. The Institute publishes the journal *Caldasia*, which can be found in the Library, Botany Department, Oxford University, Oxford.

2. INDERENA, Director Dr. Lopez, is the Government Department in charge of all Natural Resources and applications for permission to work in this field should be submitted to them. Address: Apartado aéreo 13458, Bogotá, Colombia.

3. If the Expedition wishes to engage students from the University to work with them the Expedition will be expected to pay their travel, accommodation, food, and a little 'spending money'.

4. In Santa Marta is the Insituto Colombo-Aleman. This is a German run and financed institute and has laboratory and living facilities that can be hired at DM 5.00 per diem. Address: The Director, Instituto Colombo-Aleman, Apartado aéreo 1016, Santa Marta, Colombia.

5. Passage to South America is best made via the USA. Student flights can be obtained to New York or Miami (book early) and at either of these cities one of the cheap South

American airlines can be picked up. The most regular is Aero Condor. Tickets cannot be bought here, and must be bought in advance from Colombia. Address: Carrera 7a No. 19-22, Bogotá, Colombia.

6. The British Embassy in Bogotá should be contacted during the planning of an expedition. They are very helpful concerning visas etc.

Address: c/o Foreign Office, King Charles Street, London.
and: Carrera 10 No. 19-65P7, Bogotá. D.E.

7. For expeditions in the northern part of the country the British Consul in Barranquilla should also be contacted. He is well known in the town and can be of great help. Address: G. N. Hutchinson, British Consulate, Apatardo Aéreo 706, Barranquilla, Colombia.

8. The National Tourist Office has branches all over Colombia, including Santa Marta, where there is one in Rodadero. They may be of help: Address: Corporacion Nacional de Turismo-Colombia, Calle 19, No. 6-68, 7°Piso, Bogotá D.E.

9. A pleasant and inexpensive hotel in Santa Marta is the Hotel Bucanero, Calle 22, Santa Marta.

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The following firms rendered assistance to the expedition:

Bryant and May supplied free matches; CEAG Ltd. supplied free waterproof torches; HO and WD Wills Ltd. supplied plastic boxes; Silica Gel Ltd. supplied free Silica Gel; Silva Compasses Ltd. gave twenty-five percent off their products; the Tilley Lamp Company Ltd. gave twenty-five percent off their products; Three-M Tapes Ltd. supplied free waterproof adhesive tape samples; McNeil (Cameras) Ltd., Turl St., Oxford gave ten percent off all types of film.

The British Museum (Natural History) supplied the expedition with glass collecting tubes, butterfly-nets and paper packets.

The Forestry Department, Oxford University, kindly loaned a Clinometer and thirty metre tape.

Dr. R. M. Harley, Royal Botanical Gardens, Kew, Surrey, was most generous with his supply of press corrugates, press straps, and note-books.

We are greatly indebted to many people in both Britain and Colombia whose help smoothed the path of the expedition at every stage.

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Throughout our stay in Colombia we were very impressed with the intrinsic kindness and generosity of the Colombian people. In particular the families Martinez and Rodriguez who showed us the true meaning of hospitality, sharing their food, water, land and houses with us.

We find it difficult to sufficiently express our thanks to the members of the Colonia Carmelo Mission in San Pedro de la Siera. They gave us every assistance, and supplied us with accommodation throughout our stay. To the Reverend and Mrs. Victor E. Leng, Miss Edith Winstanley, and the other residents of this mission station we are very deeply indebted. Also to the members of the missions in Santa Marta and Barranquilla.

We should like to thank the British Consul in Barranquilla, G. N. Hutchinson esquire, and the British Embassy, Bogotá for their helpful advice concerning visas and other documents.

ACCOUNTS

Income	£
The University of Oxford	45.00
Barbinder Trust	350.00
Alexander Allan Paton Fund	210.00
Godman Exploration Fund Brit.Mus.(Nat.Hist.)	100.00
Royal Geographic Soc. Stephens Bequest	100.00
Mount Everest Foundation	100.00
BUSTA	100.00
Drapers' Company	80.00
WEXAS	75.00
Brasenose College, Oxford	50.00
Gilchrist Educational Trust	50.00
St. Catherine's College, Oxford	40.00
Pembroke College, Oxford (Hansell benefaction)	30.00
Oxford Society	20.00
Vickers Instruments Ltd.	5.00
Personal Contributions	320.00
Total	£1675.00

Expenditure	£
Four flights London—Miami—London	562.20
Four flights Miami—Barranquilla—Miami	341.20
Transport Oxford—London—Oxford	15.24
Three flights Bogotá—Santa Marta	31.36
Five train fares Santa Marta—Bogotá	20.94
Bus and taxi travel in Colombia	55.28
Mule hire	17.75
Provisions	167.61
Accommodation in Colombia	89.43
Purchase of equipment in Colombia	58.11
Purchase of equipment in England	28.33
Hire of equipment from R.G.S.	5.24
Purchase of film	55.30

Processing of film	15.00
Report publication	100.00
Administration in England	30.41
Administration in Colombia	19.97
Insurance	45.80
Exchange commission	8.87
Gifts	30.00
Miscellaneous	6.96
Total	£1675.00

Note: £1.00 sterling is about equivalent to 58 Colombian Pesos.

GENERAL ADVICE FOR THE ORGANISATION OF EXPEDITIONS (S.M.B. & R.J.R.)

Preparation

1. If you have a suitable project in mind, contact experts in your field of study, they may be able to supply invaluable information on the methods of approach most applicable to your chosen area of investigation. At this early stage you should gather as much information and as many useful contacts as you can; you should start writing to people as early as possible, at least a year before the expedition. This will prove invaluable at a later date when the prospectus has to be produced and for when you may have to attend interviews for sponsorship.

Ensure that your project is feasible within the short time of the expedition, it is best to decide on a simple project that may produce meaningful results within the 6-8 weeks available in the field. (General length of expeditions are from two to three months of which six to eight weeks are spent in the field.)

Be prepared to adapt the expedition to meet other's needs. i.e. diversify, take personnel with varying skills, collect specific items for sponsors. Some sponsors have specific rules for sponsorship, e.g. will only support expeditions with undergraduate members, botanical aspects etc.

2. If you do not have a suitable project in mind but would perhaps like to go to a specific area contact someone who has worked in the area, he can usually suggest a fruitful project or can put you in contact with other experts. (Bear in mind that by modifying your project you may obtain financial support in return for some results or specimens for the expert concerned.)

Membership of the Oxford University Exploration Club will be of great help both for organising the expedition or providing you with an opportunity to join other expeditions.

3. With a definite idea of your project proceed to gather as much information as possible. Find out whether or not a previous expedition has gone to the same area, expert contacts are invaluable. The Embassies and Consulates in the country concerned should have records of any such expeditions. Official organisations such as INDERENA in Colombia may also be able to help and must always be contacted. Make sure you have all the necessary clearances, visas, permits etc. It is always an advantage to have official documents with impressive letterheads, signatures and a translation if possible.

The Prospectus

Having obtained a good idea of what you hope to do you should produce a prospectus. As this is often the basis of a prospective sponsor's assessment it should be as efficient, informative, and impressive as possible. It should contain a list of personnel, the expedition's home agents and scientific advisors. A full reference list and a short resume of why you have chosen your specific area and project will show that the expedition has been well prepared. You should suggest the form you expect the expedition to take (obviously provisional at this stage but still as exactly as possible). Give a breakdown of the expected costs and the amount of money to be raised. If the expedition is likely to be of any direct benefit to any specific body or cause (i.e. conservation, specimens for the B.M. etc.), stress this in the prospectus.

When the prospectus has been produced it must be assessed by Oxford University Exploration Society which may give you approval and official backing which you may find essential when applying for sponsorship. Finally the approval and backing of the Hebdominal Council is sought through an interview with the Expeditions Council.

Funds

This is the most necessary, but also the most discouraging aspect of organising an expedition. You should allow for a minimum of £80.00 personal contribution, the amount depending on the scope of the expedition.

The prospectus is then sent, with a covering letter (typed but not duplicated), to all possible sponsors. A personal but efficient approach is most likely to obtain results.

Try the most likely sources of finance first as you may be lucky but usually many applications have to be made for every offer of sponsorship. A directory of charitable institutions can be found in most public libraries, reports of past expeditions can also provide many ideas. If your expedition can be adapted to perform a service then do so, i.e. collect seeds for seed firms, specimens for museums etc. The addresses of most firms can be found in the yellow pages of London telephone directories. Personal contacts, colleges etc. may also give support. The O.U.E.C. has a long list of possible financeers.

All sponsorship must be acknowledged in the final report or you may jeopardise the chances of later expeditions. This includes reductions on equipment given by firms.

At an early stage open an expedition bank account on the Treasurer's signature only. If approached correctly some banks may not charge for their services.

All money that you take abroad should be in travellers cheques — find out which currency is most acceptable — dollars in American Express are the most widely used. Ensure that you can cash them at your destination before you leave.

On leaving Britain you should leave enough money in the bank for the report and a contingency of approx. 10% of the total cost of the expedition, and should ensure that your home agent has easy access to this money in case of emergency.

While abroad the expedition must always bear in mind that they are leaving an impression with every person they meet or deal with, and that this should be favourable. One expedition that 'rubs the wrong people up the wrong way' can cause serious problems for others attempting to visit that country or expedition there. Although the expedition is legally responsible for its own upkeep any trouble, political, financial or otherwise that they have while away must immediately be communicated in full to the Home Agent. This is agreed before the expedition leaves Oxford, and is extremely important.

PLATES

1. View to the North from path at about 2000 metres.

2 to 5. The members of the expedition 'in situ':

2. Richard Robins, leader (botany);
3. Charles Gibson, treasurer (entomology);
4. Keith Kirby, equipment (botany);
5. Stuart Bunt, secretary (entomology).
6. Tree in cloud-forest, showing epiphyte load. Note the size and quantity of Bromeliads.
7. Bromeliad in close-up.
8. Butterflies feeding on moisture in mud.
9. The path at about 2000 metres.
10. The Martinez Finca; wood-built house and surroundings. 2600 metres.
11. Campsite on the Paramo at 4000 metres.
12. Paramo; stream-bed and surrounds, about 4100 metres.
13. Paramo; view to north-east from 'The Saddle' with Lago Río Frío in foreground. 4200 metres.


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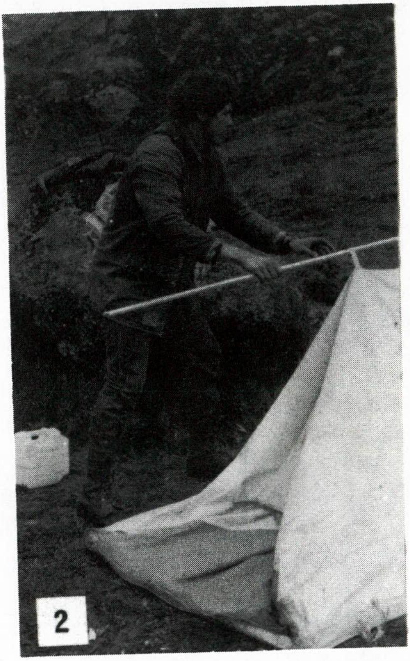
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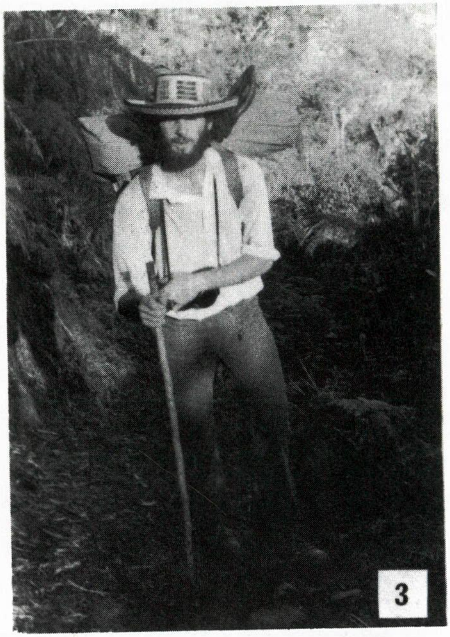
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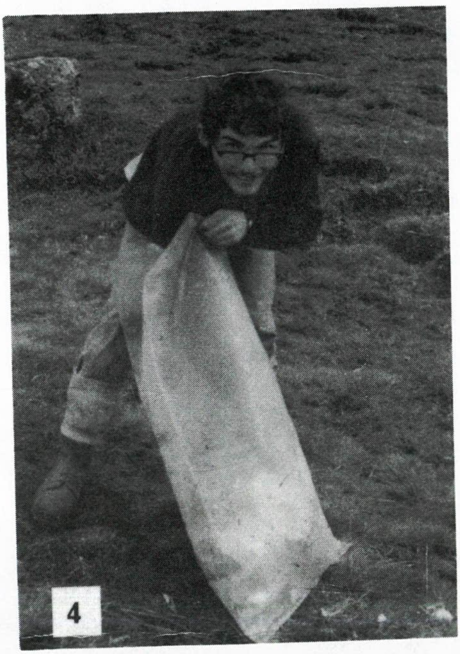
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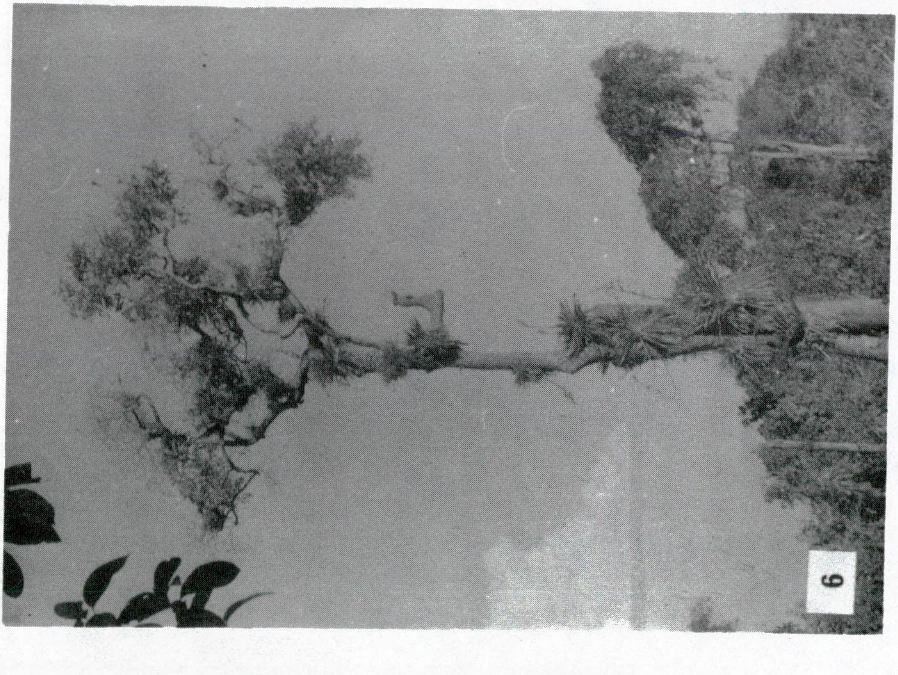
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The object of the club is to provide facilities and advice for members organising expeditions It holds regular meetings throughout term and also holds an annual dinner in Michaelmas Term.

Expeditions are initiated by members of the Club. It is important that detailed plans be drawn up as early as possible. Expedition organisers would be well advised to seek the advice of Club officers and senior members, and in particular members of the Advisory Committee, at an early stage. Expeditions wishing to receive Club support will be interviewed by the Advisory Committee which meets on the Wednesdays of the fourth week of Michaelmas Term and the first week of Hilary term. Expeditions which require University support are interviewed by the University Expedition Council on the Mondays of the seventh week of Michaelmas Term or the third week of Hilary Term, having presented their plans to the Secretary of the Expedition Council on the preceding Wednesday. The Secretary should be informed in advance by groups who propose to submit plans. The Club maintains an equipment store which is available to expeditions and to individual Club members; it has some degree of liaison with manufacturers.

Membership. The subscription of the Club is £3 for life or £1 annually. Members become Life Members when their total contributions reach £3. Members going on expeditions pay a supplement of 50p.

The Bulletin is listed in the World List of Scientific publications (No. 11466) and is deposited in the Libraries of the British Museum, the Natural History Museum, Royal Geographical Society, Scott Polar Research Institute, Cambridge, National Library of Scotland, Bureau of Animal Populations, Oxford, and the Zoological Society, London and others.

The Bulletin is produced annually and distributed in sections, about ten usually comprising one number. Apart from libraries it is distributed free to all members of the club resident in Oxford. It is also distributed to members who have gone down and have opted to subscribe to it and other subscribers (about 300). This costs £1.25 per annum. Banker's Order forms are available from the Bulletin Business Manager, O.U.E.C., 4 Keble Road, Oxford.

Advertisements. All inquiries for advertisement space in the Bulletin should be addressed to The Business Manager, 4 Keble Road, Oxford.

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