A FLORISTIC STUDY OF VOLCAN MOMBACHO, DEPARTMENT OF GRANADA, NICARAGUA

Thesis for the Degree of M. S.
MICHIGAN STATE UNIVERSITY
JOHN TALMADGE ATWOOD, JR.
1976

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ABSTRACT

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By

John Talmadge Atwood, Jr.

Volcan Mombacho is a much-eroded volcano (1,345 m alt.) vegetated with both deciduous and cloud forests. The cloud forest is emphasized in this study since it is relatively rare in Nicaragua and provides habitats for a number of rare species. As is true of most Central American mountains, the cloud forest is endangered by exploitation of its resources.

The purpose of this study is to provide a list of the vascular plant flora known to occur on Volcan Mombacho. The biogeography, geology, and climate are also considered, and the vegetation is briefly discussed. A number of species of limited geographic range are noted as well as one endemic species.

Collections were made by me on January 27, 1970, April 9, 1971, December 15-17, 1973, and January 15 and 20, 1974. Field work specifically for this study began April 26, 1975 and was terminated July 30, 1975. The collections of other investigators were examined as much as possible.

About 353 species are known from Mombacho including 68 pteridophytes and 285 angiosperms. Mombacho is the apparent range

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limit of at least four orchids, all of which are found to the south. Epiphytes are noted to have negative effects on their hosts. Rare species are observed to be threatened by uncontrolled development, and a plea is made to preserve the remaining cloud forest.

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By

John Talmadge Atwood, Jr.

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Botany and Plant Pathology

1976

Dedicated to Frank C. Seymour,
whose interest and perseverance in botany
inspired this research.

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ACKNOWLEDGMENTS

I wish to express special appreciation to my principal professor, Dr. John H. Beaman, who offered many suggestions during the course of this research, and assisted in the stylistic and organizational matters of scientific writing. I also want to thank Dr. Beaman as well as Michigan State University for an herbarium assistantship.

I wish to thank the members of my graduate committee, Dr. John Beaman, Dr. Stephen Stephenson and Dr. Ralph Taggart for reviewing the final manuscripts and offering their suggestions.

Thanks are extended to Dr. Jaime Incer, Señor Claudio Gutierrez and others at Universidad Centroamericana for providing collecting equipment, drying facilities and transportation while in Nicaragua.

I wish to thank Dr. Stephen C. Bromley for offering me an assistantship, and for his assistance in making field collections in late April, 1975.

Gratitude is extended to Mr. David A. Neill who assisted me in making collections from May to August 1975.

Thanks are also extended to the following people for determining species of difficult plant groups: Dr. J. H. Beaman, Dr. D. B. Lellinger, Dr. J. J. Wurdack, Dr. L. B. Smith, Dr. T. P. Croat, Dr. W. E. Burger, Dr. H. Kennedy, Dr. W. D. Stevens, Mr. M. J. Donoghue and Mr. F. C. Seymour.

And

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me.

And finally sincere appreciation is extended to Mr. Frank C. Seymour, who made his personal collections and notebooks available to me.

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INTRODUCTION

Volcan Mombacho is a vegetated volcano of moderate size located near the cities of Managua and Granada, Nicaragua. The name "Mombacho" is a modification of the Nahuatl name transliterated as "Mopachotepetl" meaning "inclined mountain" (Mantica, 1973). As a volcano it is presently quiescent, but has been active within historic times (Incer, 1973).

The purpose of this research is to provide a checklist of plants known to occur on the mountain and to record observations of the vegetation. The biogeography, climate and geology are considered but this work does not attempt to treat these subjects in detail. In the checklist those floristic elements which are rare, or which occur as geographically marginal populations are indicated so far as they are known.

The Central American cloud forests contain floras which are attractive from a number of standpoints. They contain large assemblages of species, many of which require specialized habitats and are therefore quite rare. The presence of a number of higher altitude species has interesting phytogeographic implications. Many cloud forest species contain aesthetically pleasing elements. These not only include a number of ferns, orchids, and bromeliads but also many species representing other plant groups as well. Viewed on a larger

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scale the forests are very attractive with their towering trees festooned with epiphytes and draped with lianas. They have an awesome and mysterious appearance when clouds filter through them. My study was prompted by the fact that everywhere in Central America the mountain forests are disappearing at alarming rates. Such studies will soon be possible only in limited areas. It is hoped that this work will help bring about an awareness by government officials that the destruction of the Nicaraguan mountain forests must be halted.

Volcan Mombacho was selected partly because it contains a substantial amount of extant virgin forest, although deforestation has proceeded rapidly in local areas. Mombacho is close to urban areas so that it is relatively accessible, and it has educational, recreational and economic potential. For these reasons it seemed that a survey of the flora of this particular volcano would be a greater contribution than a similar work on a more remote mountain.

The checklist will have utility principally to those who know Central American floras, as this work contains no keys, descriptions nor illustrations. In many cases only one or two species are represented in a genus. If the investigator can recognize the genus, then he can more easily determine the species. The best way to use the checklist in Nicaragua is to consult voucher specimens housed at Universidad Centroamericana in Managua. The most complete set of specimens deposited in the Beal-Darlington Herbarium of Michigan State University.

Collections specifically for this work were made during the months of May through July, 1975. It is hoped that with more collecting a more thorough analysis of Mombacho's flora can be made.

GEOGRAPHY

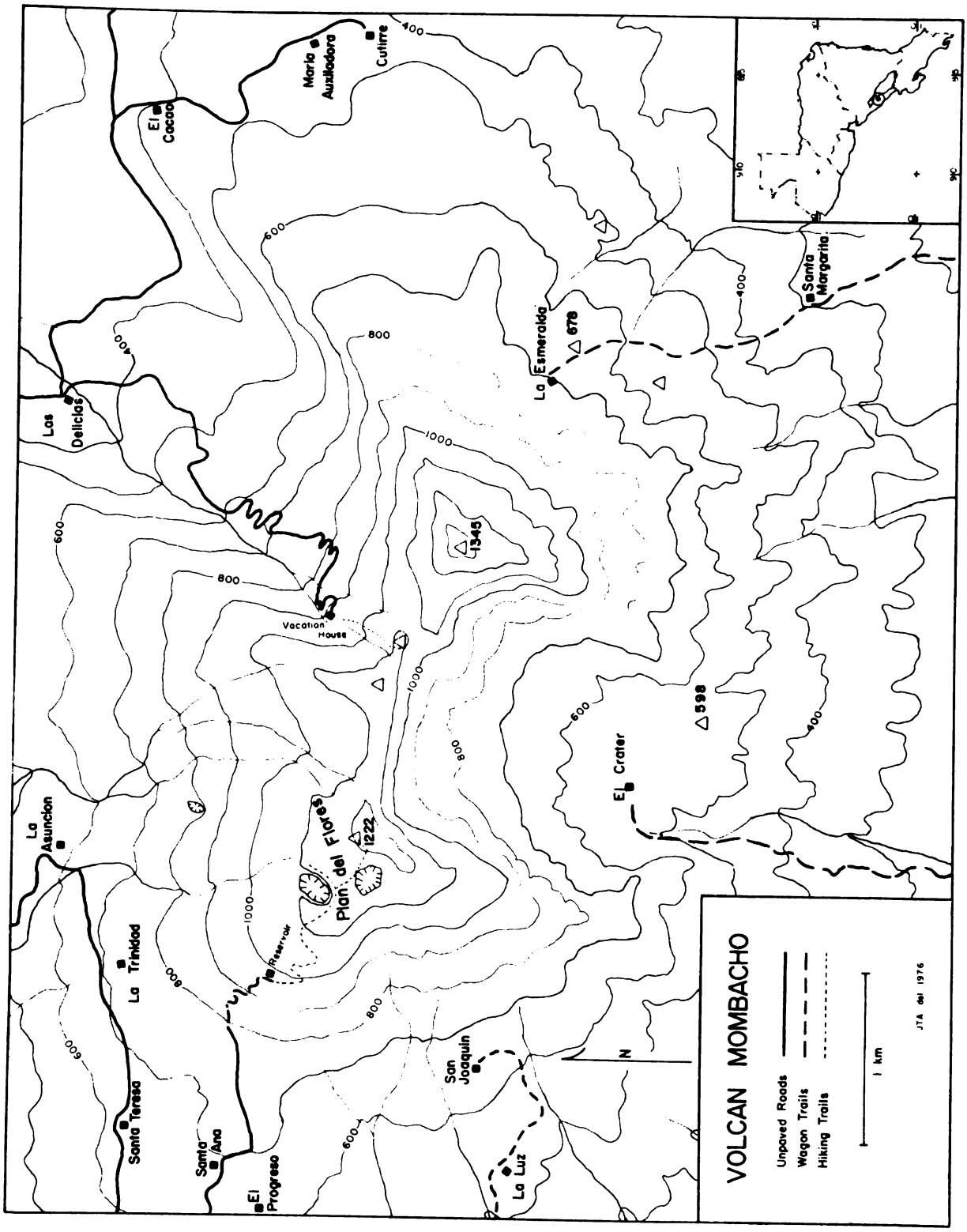
Physiognomy and Geology

Volcan Mombacho is located at 11° 50' N latitude, 85° 59' W longitude (See map, Figure 1). It is the fifth largest of 12 active quaternary (Mooser et al., 1958, Introduction) volcanos forming a chain in western Nicaragua which extends northwestward into El Salvador and southeastward into Costa Rica. With a maximum altitude of 1,345 m, Mombacho is somewhat lower than several other Nicaraguan volcanos, the highest of which is 1,745 m. It is, however, perhaps the most massive with a basal diameter of about seven km. Its U-shaped crater rim is 1.5 km in diameter and the floor is about 750 m lower than the highest peak (Figure 5). The lowest point on the present much-eroded crater rim is 1,080 m. The rim has a very rough topography and is practically impossible to traverse.

Besides the highest peak of the southeast crater rim, there is a second peak on the northwest rim at 1,222 m altitude. Adjacent to this peak is a large flat area locally referred to as "Plan del Flores." Within this area are two small vegetated craters each of unknown depth and about 200 m in diameter. Eastward from Plan del Flores is a trough-shaped valley (Figure 4) over 1.5 km across extending northeast from the crater for a distance of about 3.5 km.

Aerial photographs reveal a number of lava flows extending down the sides of Mombacho, but these features are obscured in the northeast

Figure 1. Map of Volcan Mombacho (after Hoja 3051 III and Hoja 3051 IV published by Instituto Geografico Nacional and Servicio Geodesico Interamericano, 1972 edition, scale 1:50,000).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La Trinidad
Santa Teresa
Santa Ana
El Progreso
Las Delicias
El Cacao
Maria Auxiliadora
Cutirre
Vacation House
Reservoir
Plan del Flores
1222
1345
La Esmeralda
678
Santa Margarita
El Crater
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San Joaquin
La Luz
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Figure 1

valley and the open south side of the crater rim where other volcanic events have destroyed them. The lava flows are for the most part fully vegetated, and their basal limits are easily observed where they meet pastured savanna areas containing scattered trees.

Certain areas of Mombacho, especially the flanks of the crater rim and the sides of the valley extending northeastward are extremely steep. These areas, often with a slope well over 100 percent, are mostly vegetated, but frequent landslides have left conspicuous scars (Figures 2,3). Much of the crater rim is disturbed by landslides, which are major causes for the rough terrain.

Very few permanent streams can be found on Mombacho, although stream beds occur in various ravines. These are filled with water during times of heavy precipitation in the rainy season. Apparently most of the precipitation seeps down through the loose volcanic substrate leaving little runoff. As a further manifestation of the porous substrate the two craters at Plan del Flores do not contain reservoirs of water as does the nearby crater at Apoyo.

Viewed from Granada, Mombacho appears as a rich green, broadly truncated and much eroded volcanic cone. The highest peak and the broad Plan del Flores area can be seen on a clear day. When not beclouded, Mombacho is most impressive in late afternoon when the various physical features cast shadows pointing up the rough topography (Figure 6). A number of cut-over areas mar the slopes and much of the lower areas have been deforested or severely disturbed (Figure 7).

The flanks have a number of access roads (Figure 1), but they are unpaved and rarely graded. One such road from Granada to the northeast valley above Finca Las Delicias requires about an hour for a

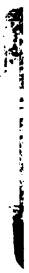

Figure 2. View of highest south peak from elfin forest at Plan del Flores. The tree in the foreground is Clusia salvinii.

Figure 3. View of steep flank of northwest valley. The distinct crowns of the lower cloud forest can be seen, and the more uniform upper cloud forest (upper right).

Figure 2

Figure 3

Figure 4. Aerial view of Mombacho from the east.

Figure 5. Aerial view of El Crater from the south. Elfin forests can be seen on the crater rim.

Figure 4

Figure 5

Figure 6. View of Mombacho from the north showing relief.

Figure 7. Aerial view of Mombacho from the north showing cloud forests and a number of disturbed areas.

Figure 6

Figure 7

four-wheel-drive vehicle to traverse. Other routes which were found to be useful are from the northwest side through the coffee plantations of Santa Ana and El Progreso, and from the north via the coffee plantations of La Asuncion and La Trinidad. Other roads extend from the south, but are unmarked and difficult to traverse. For the purposes of this study only the roads on the northeast to northwest sides were used.

Geological History

Mombacho is a densely vegetated volcano showing strong erosion features. Its violent past is reflected in the size of the crater and the general topography. Little is known of its geological history, but a few volcanic events have been documented since the time of the Spanish conquest.

As a member of the quaternary volcanic chain in western Nicaragua, Mombacho is not older than 2 million years and may be considerably younger. Mooser et al. (1958) report that the most recent authenticated eruption occurred in 1560. Incer (1973) indicates that during the same century the south crater rim avalanched away, resulting in the destruction of the south flank, and destroying an Indian village of 400 inhabitants. Crawford (1902) reports that an eruption took place in 1850, but Mooser et al. believe this to be confused with the eruption of Cerro Negro located to the north of Lake Managua. Mooser et al. also indicate that a small parasitic cone called "Pilas" formed on the north flank of Mombacho in 1850. No such volcanic cone was observed on the north flank in the present study, and since a volcanic cone by the same name occurs to the north of Lake Managua, this report relating the activity of Pilas to Mombacho is probably erroneous. A

small cone northeast of Mombacho may have been active in historic times.

The uniform texture of the crater walls suggests that in its early development Mombacho was built up primarily from ash screes rather than lava flows. The volcanic ash probably built up into the traditional conical shape exhibited by Mombotombo to the north and Concepcion to the south. If lines following the existing flanks of Mombacho are projected upward they meet an altitude of about 2,000 m (Incer, 1973), a possible altitude which Mombacho may have attained in its geological past. Apparently the more recent volcanism was manifested as lava flows which seem to nearly cover the surface of the mountain.

It is not clear exactly how the crater was formed, but the very steep sides suggest that an internal collapse occurred due to subsiding lava, rather than being caused by an explosive type of event which took place on Krakatoa and Volcan Cosiguina in northwest Nicaragua. The crater of the latter volcano has walls with a slope of approximately 45°. The two craters at Plan del Flores apparently formed by collapse (Incer, personal communication).

Exactly what events took place in the sixteenth century causing the destruction of the south crater wall is not clear. It is known that a lake once occurred within the crater (Incer, 1973) before the south wall was destroyed. Either of two explanations could account for the destruction: (1) A higher-than-normal rainfall could have loosened the already poorly-bound substrate to the point of collapse releasing the contents of the lake. The result would have been a cold mud flow. (2) An eruption (perhaps the eruption of 1560) may have

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taken place, heating the crater lake to boiling. The boiling lake could then have mixed with the substrate of the south wall causing a collapse in the form of a hot mud flow. In relation to the latter explanation, a volcanic explosion could have taken place, the force of which was directed southward. Considering the magnitude of the destruction, I would favor an explanation involving volcanism for the destruction of the south flank. A similar event probably took place much earlier on the northeast flank, leaving the trough-shaped valley.

Since the occurrence of this last major event, Mombacho has remained relatively quiescent, but the rough topography and fumaroles of the crater rim attest to its violent past. The mountain may have entered a period of senescence, but there is the possibility that it may yet have volcanic surprises in store.

Climate

The climate of lowland Nicaragua on the Pacific slope could be described as "tropical dry." No single mean monthly temperature below 17.1 C° has been calculated at stations reported by Incer. The maximum range of variation of monthly means at any station is less than 4 C°. Incer indicates that the temperature at Managua can fall as low as 19 C° in January, which is 7.3 C° lower than the monthly mean of 26.3 C°. The temperature regime is therefore even throughout the year and frost never occurs, at least in the lowlands. After the rains cease in December a dry season ensues with essentially no rainfall and lasts until May. As noted by Miranda and Sharp (1950) in Mexico, this period of drought roughly corresponds to the winter season of the north.

Since no climatological data for Volcan Mombacho are available, information from surrounding lowland areas will be used when applicable. A climatic portrayal must be based on generalities drawn partly from the scanty data available, and personal observation.

Temperature

The most complete temperature data of an area most proximal to Mombacho are taken from the village of Nandaime (Incer, 1973), which lies southwest of Mombacho at a distance of about 12 km and at an altitude of 150 m. Nandaime lies almost directly in Mombacho's rain shadow. Figure 8 is a graph of the mean monthly temperatures at Nandaime. As with all of western Nicaragua, the temperature regime is observed to vary little throughout the year. This is probably also true for the air temperature at 1,200 meters, the altitude at which much of the elfin forest is located. If we take the mean adiabatic dry and wet rates we should obtain a range of values for the mean annual temperatures at a given altitude. If the dry adiabatic rate of 1 C° per 100 meters (from Strahler, 1973) is applied to the mean annual temperature at Nandaime, then the mean annual temperature at the level of 1,200 meters could be depressed 11.5 C° to a minimum possible 16.9 C°. The wet adiabatic rate of 0.6 C° per 100 meters would be applicable if general precipitation were occurring at all altitudinal levels. Such a rate would depress the mean annual temperature at the elfin forest to 21.1 C°. Thus the calculated range of mean annual temperature at the elfin forest falls between 16.9 C° and 21.1 C°, a range of 3.2 C° based on adiabatic rates. Since solar radiation tends to heat the land surface and hence the overriding air mass, the air

Figure 8. Graph of mean monthly temperatures at Nandaime (from Incer, 1973).

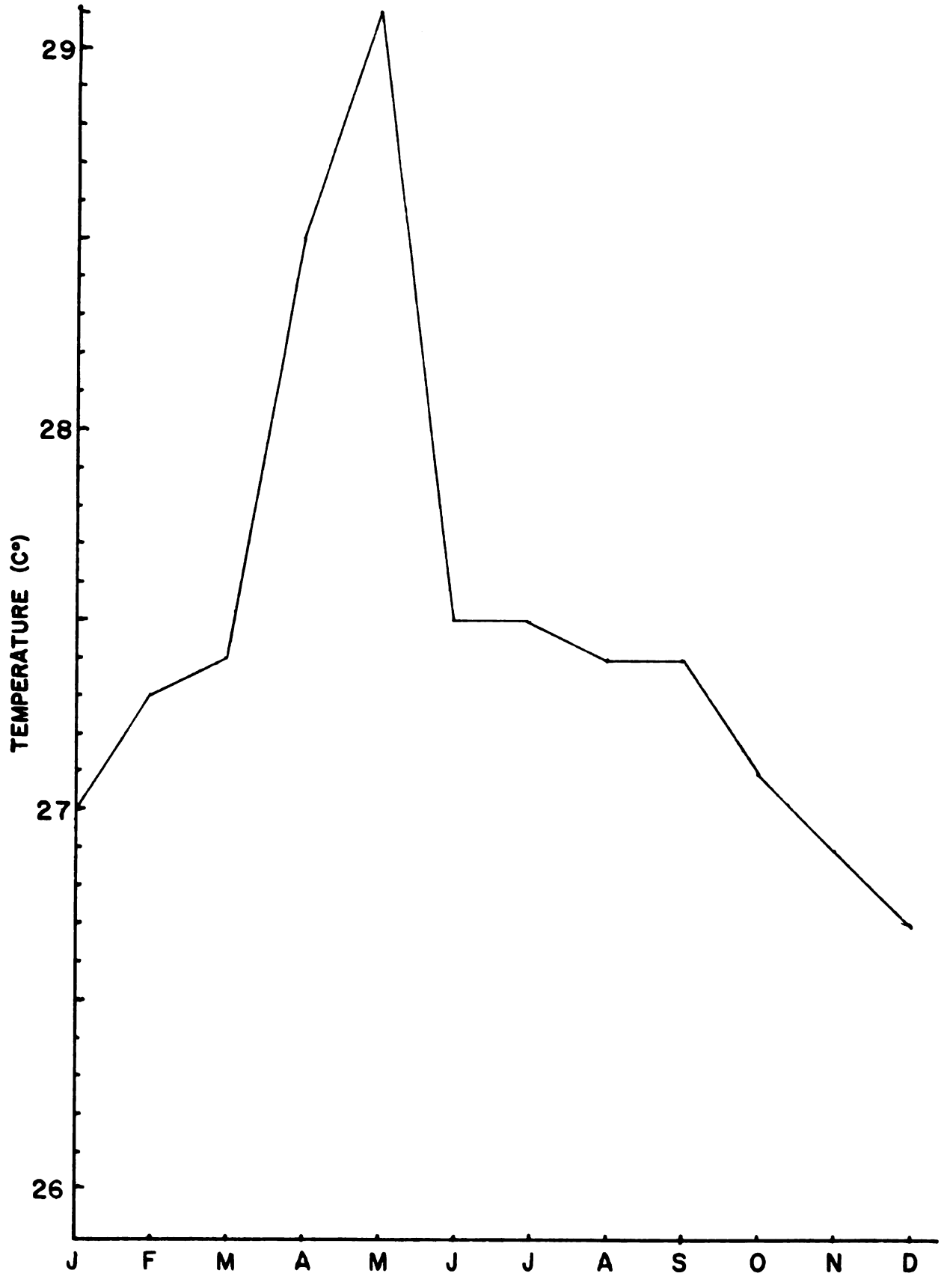

Figure 8

temperature at 1,200 m according to the dry adiabatic rate is probably lower than the actual air temperature at the elfin forest.

The question then arises as to what are the daily fluctuations in temperature which are not reflected in mean monthly temperatures. Camping experience in the elfin forest indicated a decisive nocturnal temperature drop as expected, but we never experienced extreme discomfort from cold. To determine a possible minimum summit temperature, the dry adiabatic rate can be applied to the minimum January temperature of 19 C° at Managua (50 m alt.). The difference between Managua and Mombacho's elfin forest is then 11.5 C°, lowering the temperature to 7.5 C°. Nothing is known about other factors which may depress the air temperature below 7.5 C° on Mombacho, but cooling due to evaporation or the presence of an unusually cold air mass could drive the temperature lower, perhaps even to freezing. If frost occurs on the upper flanks of Mombacho, however, it must be a rare event.

Precipitation

There are two components of precipitation in tropical mountainous areas of moderate altitude. The first and usually major component is direct convectional and orographic rainfall. The second, usually less important yet often significant, is derived from fog. The vegetation acts as a screen collecting droplets of water which coalesce and drop to the soil (Oberlander, 1956; Twomey, 1957; Vogelmann et al., 1968; Vogelmann, 1973). Miranda and Sharp (1950) noted that even during the dry season in Mexican mountains there is abundant drizzle and fog which may maintain the moisture requirements of certain species. Oberlander (1956) noted that significant condensation occurs only where

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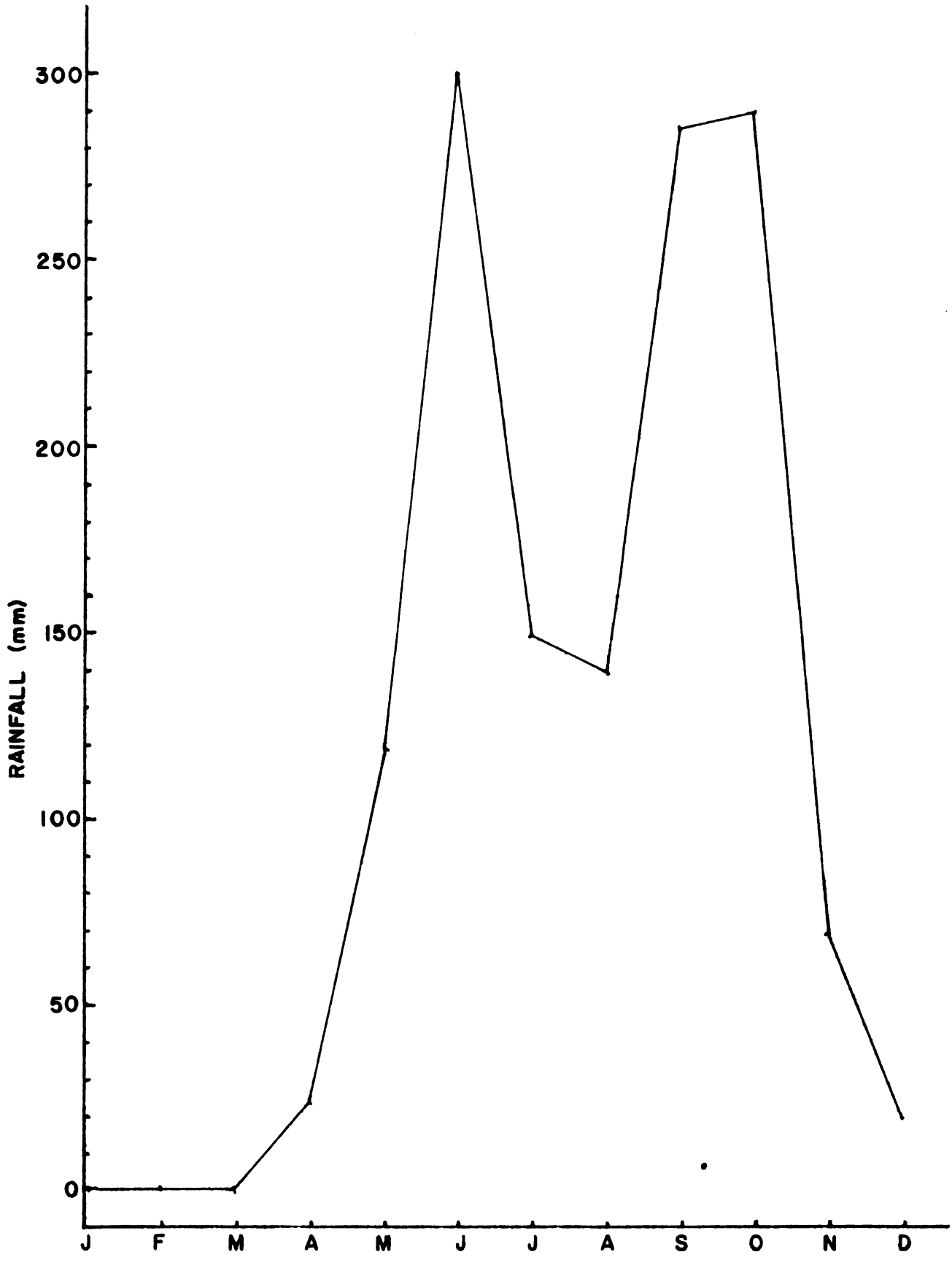
trees are tall and fog-laden winds are strong. He also accounts for the presence of moisture-requiring orchids on ridges of the San Francisco Peninsula as a manifestation of the greater amount of rainfall due to cloud drip.

Baynton (1969) indicated that at Pico del Oeste, Puerto Rico, rainfall is more frequent at night, but more intense during the day. His studies further indicate that precipitation from fog on elfin forest vegetation amounts to only 10 percent of the total rainfall. This low percentage probably reflects the low stature of the vegetation, and therefore the smaller screening effect as opposed to taller forests. No rainfall data are available for Mombacho, but personal observation of Mombacho's weather seems consistent with Baynton's more detailed considerations at Pico del Oeste.

Due to the effects of Lake Nicaragua, Volcan Mombacho probably receives more precipitation than do the mountains to the north. The common occurrence of fog in the upper forests is probably also partly due to this source of moisture.

There is no reason to believe that the monthly precipitation maxima and minima vary between the upper flanks of Mombacho and the surrounding lowlands, although orography is expected to play a significant role in increasing the rainfall. Figure 9 is a graph of the monthly precipitation at Nandaime (taken from Incer, 1973). Here clearly the dry season is evident from mid-December to mid-April. The rainy reason from mid-April to mid-December contains two peak months, the first in June, the second in October. Although precipitation occurs during the months of July and August, it is less abundant.

Figure 9. Graph of mean monthly rainfall at Nandaime (after Incer, 1973).



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During the morning of May 15, 1975, when the dry season had been severely prolonged, cloud cover was observed until about 10:00 A.M. Cloud cover was observed to have two effects on the local climate. (1) Moisture gathering about the forests caused a continual drip from the vegetation until the cloud disappeared. (2) The cloud screened the forest floor from solar radiation which would otherwise raise the temperature of the environment. When the rainy season finally arrived, periods of midday sun were shorter, and by August cloud cover frequently never disappeared. It was observed that on days of slight precipitation near Granada, rain occurred in torrents on the windward side of Mombacho.

Wind Velocity

Wind velocity is expectedly high and gusty at Mombacho's summit, and the frequently blown-down trees of the cloud and elfin forests attest to these high winds. This may be a most critical factor in maintaining the stature of the elfin forest.

Cloud Cover

Although it is characteristic of the cloud and elfin forests to be overcast, clearing almost always occurs in the forenoon lasting until mid to late afternoon during the dry season. During the rainy season clearing occurs less regularly and for shorter periods.

Small clouds on the windward side were observed passing rapidly, parallel with the slope. When nearing essentially vertical cliffs these clouds moved parallel with the cliff face. Vertical air movement must be maximal in areas of greatest incline and a corresponding higher local precipitation is expected.

Rapid Changes of Climatic Factors

One of the most striking characteristics of the weather, especially at the elfin forest level, is the rapid changes of climatic factors. One moment rapidly moving fog disappears revealing the full force of the sun, at which time the relative humidity decreases. Then the pattern is repeated with a sudden fog blanket. These rapid changes in the weather may have a considerable effect on the vegetation.

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VEGETATION

This thesis does not purport to provide a detailed analysis of the vegetation of Volcan Mombacho, but a brief survey is attempted in order to bring the flora into perspective.

Vegetation in tropical areas is much more poorly known than in north temperate zones and it is usually more complex. Beard (1944) indicates that as many as 80 dominants occur in lowland rainforests with successively fewer in dryer or colder forest types. The names of the dominant species in northern areas are used in titling various vegetation types, for example, beech-maple and oak-hickory forests. In choosing terminology for appropriately describing the vegetation of Mombacho physiognomic characters seem to be more useful. The works of Beard (1942, 1944), Holdridge (1967) and Duke and Porter (1970) have been consulted in arriving at a suitable terminology applicable to the vegetation of this mountain.

For the purposes of this study, it seems most natural, as well as convenient, to divide Mombacho into two altitudinal vegetation zones, and to divide the upper zone into three sub-zones. For the lowest zone, which is continuous throughout lowland western Nicaragua, the term "deciduous seasonal forest" of Beard seems most appropriate. This term reflects the deciduous nature of the vegetation as affected by seasonal occurrences in rainfall patterns. Beard indicates that his

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"deciduous seasonal forest" seems to equate with the "savanna forest" of Schimper. The latter term seems inappropriate since the word "savanna" implies a grassland which may not faithfully describe the nature of the total vegetation, yet to use Beard's terminology does not exclude the idea that this forest type may include a substantial savanna element. Shantz and Marbut (1923) proposed the term "dry forest" but the adjective does not adequately describe the forest during the rainy season.

The zone with which this study is most concerned is here termed the "cloud forest." This term indicates exactly the nature of the forest--often beclouded or immersed in fog. The cloud forests of Mombacho are evergreen and are thus physiognomically distinct from the deciduous forest.

Deciduous Seasonal Forest

During the rainy season the deciduous seasonal forest is very similar in appearance to the tropical rain forest. Even the stately emergent Ceiba is common to both forests in Nicaragua, although it usually does not gain its greatest stature in the deciduous forest. Open areas become congested with impenetrable tangles of shrubs and vines if not continually cut back. When the rains cease in December the forest takes on the leafless character reflected in the title, "deciduous seasonal forest," and appears very much as a northern hardwood forest in late fall.

A few species maintain their leaves throughout the otherwise leafless season (for example, Enterolobium) but are not common. Many trees, such as Plumeria, Byrsonima and Cochlospermum, flower during the

dry season, lending color to the otherwise dusty-brown and steel-gray landscape. Besides the above-mentioned genera many others are common including Apeiba, Bursera, Tabebuia, Sterculea and various Leguminosae.

The shrubby layer includes Casearia, Karwinskia, and several vines of the families Convolvulaceae, Bignoniaceae, Solanaceae, Aristolochiaceae, Cucurbitaceae and Vitaceae.

The herbaceous layer is probably most diverse but few samples were taken for this study. Grass species are dominant in some areas, which are maintained for cattle grazing.

The shrubby and herbaceous layers are usually torched by landowners to rid the areas of undesirable weeds and ticks so that their utility as grazing land is restored. Though fire is beneficial in returning nutrients to the soil, it excludes a number of plants from the environment, some of which are seedlings of important forest species.

Because of the great demands made upon the deciduous seasonal forest by man, very little can be found in a natural state. Most of the forests surrounding Mombacho were probably converted to agriculture by native Indians long before the Spanish conquest.

Cloud Forest

Mombacho contains one of perhaps four cloud forests in western Nicaragua. Two occur on Volcan Concepcion and Volcan Maderas in Lake Nicaragua, and one other blankets the Sierra de Managua. The Mombacho cloud forest extends from approximately 400 m altitude on the east north-east flank to the summit. It begins considerably higher on the

south-southwest flank since it benefits less from the moisture-laden easterlies.

Beard (1944) refers to three of several natural vegetation units in New World mountains as "lower montane rainforest," montane rainforest, and elfin woodland. These three units based on physiognomy roughly correspond with three subzones of the cloud forest proposed here. There is little doubt that the vegetation is much more complex than these units indicate, but the terms are useful when delimiting the habitats of various floristic elements. Beard's "lower montane rainforest" describes the lower subzone of Mombacho's cloud forest quite accurately, but the term is cumbersome and the term "rainforest" implies a lack of seasonality of precipitation. Although this zone contains mostly evergreen elements, the occurrence of precipitation is definitely seasonal.

For the next higher altitudinal zone Beard uses the term "montane rain forest." The term "rain forest" is again rejected for reasons noted above. For the vegetation of the highest zone Beard uses the term "elfin woodland" to which a mild objection is raised to the noun "woodland" because of its inferred distinction with "forest." Beard's term "frost woodland" can be excluded from consideration because of the probable absence of frost on Mombacho.

The total cloud forest is characterized by evergreens and also by the general richness of the vegetation in every habitat as manifested by the great precipitation due to orography. The many shades of green of the cloud forest indicate a complex aggregation of dominants, but this diversity diminishes in the elfin forest especially

along exposed ridges where dominance is assumed by one tree species--Clusia salvinii.

The tallest trees are to be found in the lower part of the cloud forest. They become successively shorter with altitude until the dwarfing effect is culminated in the elfin forest.

Characteristic of the cloud forest is the presence of masses of epiphytes representing a variety of plant groups. A number of epiphytic ferns of several families occur as do members of the angiosperm families Gesneriaceae, Piperaceae, Araceae, Utriculariaceae, and Ericaceae. By far the greatest numbers of epiphytic species are found in the families Bromeliaceae and Orchidaceae.

Lianas are abundant especially in the lower cloud forest. These consist mostly of two Monstera species often found enveloping tree trunks. The Monstera drops out at the level of the elfin forest where another very curious liana occurs--Marcgravia brownei. This plant begins its life as a vine with short, blunt leaves and flattened stems closely appressed to the bark of tree trunks. When it reaches a certain height or perhaps light intensity, it changes its growth pattern. The shoot then becomes self-supporting, the leaves elongate and develop acute tips, and lateral branches form, bending downward perhaps from the weight of the umbels. In keeping with the bizarre habit each pedicel is associated with a bucket-shaped nectary. One's first encounter with this species is certain to leave permanent impressions!

The herbaceous flora of the cloud forest is characterized by ferns, but in open disturbed areas grasses are common. One species, Oplismenus hirtellus, was observed to occur in areas of moderate shade

in the upper forest, but never in deep shade. Several composites occur, mostly in disturbed areas, or in habitats of high light intensity. Two species of Dieffenbachia are found, one in the low, the other in the upper cloud forest. These plants have the habit of sending out rhizomes which extend to various lengths before the apex turns upward forming a shoot. Presumably shoot formation is stimulated when the rhizome reaches an open area of sufficient light intensity. Areas with Dieffenbachia are reticulated with these rhizomes, which are sometimes stacked in two or more layers. The severed stems of both species fill the air with a foul odor of skunk. Occasionally terrestrial orchids are found, but their occurrence is very local. Tropidia polystachya, supposedly abundant and widespread in much of the New World tropics was encountered on two occasions. Goodyera cf. bradeorum is more often found in the upper cloud and elfin forests as are two species of Malaxis.

Lower Cloud Forest

The lower cloud forest ranges from approximately 400 to 900 m altitude, varying with exposure to the easterlies, slope, etc. It is characterized by the great height of individual trees, the often very dark understory shaded by the several vegetational strata, and by the appearance of the canopy which contains distinct crowns. It lacks the great emergents found in the rain forests of eastern Nicaragua, but otherwise exhibits a similar physiognomy.

The herbaceous story is usually not dense due to subdued light intensity. Both vascular and non-vascular epiphytes are relatively uncommon on the lower portions of trees, but occur in large numbers in

the crowns of trees. This factor made study of the lower cloud forest difficult, and most epiphytes were collected from trees which had fallen or were felled. Undoubtedly many more species are there which were out of reach. Many bromeliads and orchids in this area, such as Guzmania lingulata, Tillandsia schiediana, Trigonidium egertonianum, Epidendrum boothii and Epidendrum fragrans, are also common to lowland rain forest areas. Two common epiphytic aroid species, Anthurium scandens and A. crassinervum, were most abundant in this zone, the latter occurring in the marginal areas with the deciduous forest.

The shrub layer of the lower cloud forest includes the urticaceous Urera but probably the family best represented here is the Piperaceae. Pothomorphe was observed and collected with various species of Piper in disturbed areas, but other species of Piper were found in the darkest understory. In the lower cloud forest of the east slope, Carica pennata was observed to assume a dominant position in the understory. It is more than possible that this area was at some time severely disturbed, allowing the Carica to dominate.

A number of pioneer and weedy species are found growing in and around coffee plantations. Among the more attractive is Mirabilis jalapa which is common about the coffee plantations of the north-northwest flank. Occasional Marantaceae are encountered in roadsides and coffee plantations, and during the rainy season the ground is carpeted with numerous Urticaceae, Euphorbiaceae, Gramineae and Cyperaceae.

The lower cloud forest is the most disturbed zone above the deciduous forest and the little intact primary forest which remains is threatened. The best examples of extant lower cloud forest seem to

be in the northeast-facing valley above Finca Las Delicias. Agriculture here is causing the demise of the cloud forest at an alarming rate, and measures should be taken to preserve the few remaining examples. It appears that most of the primary lower cloud forests on the northern flanks have either been removed or severely disturbed.

Upper Cloud Forest

The upper cloud forest ranges from approximately 900 m to the level of the elfin forest, the altitude of which seems to vary with exposure. It is characterized by a low, few-layered canopy lacking distinct crowns. The trees are often conspicuously covered with vascular and non-vascular epiphytes even to the base of their trunks, and the light intensity at the ground level is much higher than that of the lower cloud forest. The herbaceous flora is consequently richer and includes terrestrial orchids, two locally abundant species of Carex, and occasional composites as well as numerous ferns.

Two commonly observed tree species of the upper cloud forest were Clusia salvinii and Senecio arborescens, but the latter never assumes the stature of the higher surrounding trees. Epiphytes appeared to be stratified in the forest according to light intensity. The lowest epiphytes include Xylobium elongatum, but the upper strata contains the greater diversity. Here are locally abundant orchids (Sobralia, Elleanthus, Pleurothallis, Stelis, Masdevallia, among others), and a number of bromeliads.

The upper cloud forest seems to be less threatened by agriculture than the lower cloud forest. However its restricted size renders it vulnerable to complete and rapid destruction. The tell-tale tracks

of wandering cattle were noted above Finca Las Delicias near the crater rim. Though not normally permitted to roam the higher flanks, these cattle had apparently broken their fence, a situation which is likely to be repeated. The upper cloud forest could easily be converted to coffee plantation which poses the greatest threat. Such an attempt was made at Plan del Flores, although this effort apparently failed, and similar attempts seem inevitable in the remaining forests.

Elfin Forest

Elfin forest is a peculiar type of stunted vegetation which occurs at upper elevations of the world's tropics where precipitation is abundant and distributed more evenly throughout the year. Wind velocities tend to be high with frequent gusts and the forest is usually beclouded and dripping wet.

The elfin forest has been studied by a number of investigators. Brown (1919) investigated an elfin forest (mossy forest) on Mount Maquiling on the island of Luzon, Philippines. Beard (1944) studied elfin forests in the Antilles, Van Steenis (1972) notes the elfin forests of Java in The Mountain Flora of Java. Detailed investigations have been conducted at Pico del Oeste, Puerto Rico by Howard (1968, 1969) and collaborators. Alvarez del Castillo (1976) contributed an ecological and floristic work on an elfin forest on Volcan San Martin Tuxtla, Veracruz, Mexico.

Beard (1944) characterizes the elfin forest of the Caribbean area as an

> open woodland about 8 meters high of stunted, gnarled trees, often stilt-rooted and with thick fleshy leaves, with long rambling branches pointing away from the wind. There may be

> an understory of drarf palms and tree ferns. The whole is loaded with moss, lichens and epiphytes and forms a completely impenetrable thicket.

Viewed from the air, the elfin forest appears as an even and dense canopy, as though it had been pruned like a hedge. The upper cloud forest lacks this pruned appearance, and the line delimiting the two forests is usually rather distinct. As one works his way through the forest the canopy is observed to consist of one stratum beneath which are occasional shrubs (especially Psychotria sp. and Clidemia setosa) and a wealth of herbs. Nearly every branch is inhabited by mosses and hepatics and epiphytic vascular plants are everywhere common. The leaves of arborescent elfin forest species with few exceptions tend to be leathery, entire and not particularly large. Prop roots are locally common (especially associated with Clusia salvinii), a feature which probably enables the species to survive severe and gusty winds. A few aerial roots were observed containing a gelatinous sheath, a feature also noted by Gill (1969) on living roots of Hedyosmum arborescens at Pico del Oeste.

Aerial photographs show that the elfin forests extend along all exposed ridges and pinnacles of Mombacho down to an altitude of about 900 to 1,000 m. It blankets even the roughest topography, including nearly vertical cliffs.

The arborescent stratum includes a number of species, and there appears to be two or more communities with different composition. The elfin forest most protected from wind is more diverse and includes Clusia salvinii, Rapanea ferruginea, Freziera friedrichstaliana, Myrcianthes fragrans, Oreopanax xalapense, Viburnum hartwegii, a number of Rubiaceae, and tree ferns of the genera Cyathea and Nephelea. Beard

(1944) notes that "pure stands of Clusia spp. constitute this formation [the elfin forest] in some of the Lesser Antilles between 1,000 and 1,100 meters . . ." Pure stands of Clusia occur on Mombacho but only along the most exposed ridges and pinnacles. The Clusia trees stand out in aerial views because of their darker green appearance. Senecio arborescens barely establishes itself in the elfin forest and its larger leaves are undoubtedly more severely traumatized by wind gusts than are the leaves of more sclerophyllous species.

The elfin forest is especially well endowed with epiphytes. A number of groups are represented. Ferns, bromeliads, and orchids are among the most diverse groups encountered, but an epiphytic Utricularia, two ericaceous shrubs and the gesneriad Columnea tulae are also present. Among the genera of epiphytic ferns represented are Elaphoglossum, Grammitis, Polypodium, Hymenophyllum, and Trichomanes. Bromeliad genera present include Aechmea, Guzmania, Pitcairnia, Tillandsia, and Vriesia. These most common epiphytes are conspicuous for their inverted bell shapes.

Of more than 50 orchid species found on Mombacho, about 30 occur in the elfin forest and most are epiphytes. One of the most common species, as well as attractive, is Sobralia macrantha. This large-flowered, reedy-steemed orchid seems to pioneer in disturbed environments as on faces of cliffs and in deforested areas of Plan del Flores. Its flowers have a wide range of hues from white to dark magenta with white, yellow or brown in the labellum. Hardly any two clones are morphologically alike. Three species of Elleanthus also were observed to invade disturbed habitats. Two of these are difficult to distinguish from the Sobralia when not in flower, although the old

inflorescences are distinctive. Epidendrum lacustre occurs nowhere abundantly but is scattered everywhere through the elfin forest. Two specimens of Mormodes, probably M. buccinator, were discovered in the elfin forest. This comes as a surprise since it is otherwise common only at the base of Mombacho in deciduous forest areas. Jacquiniella teretifolia, usually a deciduous forest to low cloud forest inhabitant, was observed on Heliocarpus, just inside the crater rim. Lycaste aromatica was observed in the elfin forest at Plan del Flores, although it was more often encountered in the upper cloud forest. A number of small epiphytic orchids are often encountered, including Epidendrum miserrimum, Stelis cucullata, Pleurothallis broadwayi, P. blaisdellii, a species of Pleurothallis with large purple and white flowers, Masdevallia chontalensis, and three species of Dichaea, a small leafy viney orchid often creeping over the bark of trees. At least one species of Maxillaria occurs on Mombacho's windswept ridges, but has not been observed in flower. Considering the large plant size it must be spectacular. Trevoria glumacea was found to be locally common, but was observed only once with flower buds. A Stanhopea species, probably S. ecornuta, was found at Plan del Flores. Two specimens of orchids with the habit of Gomeza were found in sterile condition and this generic identification must be considered tentative. Many species encountered in the lower forests of Mombacho undoubtedly find their way to the elfin forest as the Mormodes suggests, but few are likely to establish permanent colonies.

The two species of Ericaceae encountered were the epiphytic Cavendishea crassifolia and Spherospermum majus. The former forms large

masses in crowns of trees and is everywhere common. The latter species is less often seen and may be more common in the upper cloud forest.

The herbaceous stratum is expectedly rich. Species collected in the mature elfin forest are different from species found in open disturbed areas. In the shaded area of the mature elfin forest the terrestrial herbaceous flora consists largely of fern species. An absence of grasses were noted but two species were encountered in less shaded areas. The first, Lasiacis ruscifolia, has rather broad leaves and nearly black fruits at maturity and inhabits the lower levels of the cloud forest. The other species, Oplismenus hirtellus, forms mats in slightly open areas. The grass family as a group cannot be said to be successful in the elfin forest. Three species of Cyperaceae, Carex donnell-smithii, C. polystachya, and Uncinnia hamata, occur frequently in the elfin forest, often along damp and exposed banks. The terrestrial orchid inhabitants include Malaxis maxonii, M. tipuloides, Erythrodes spp., Goodyera bradeorum, and Psilochilus macrophyllus. One terrestrial gesneriad, Kohleria, was found once inside the west crater rim. Composites were occasionally encountered in the elfin forest, especially Eupatorium pycnocephalum, and Spilanthes aff. americana, but they probably occur in areas which have become revegetated after disturbance, and thus their significance in the elfin forest is minimal.

The herbaceous flora of disturbed areas seems to vary with locality. The herbs of the disturbed crater rim consist almost exclusively of Isachne arundinacea with a scattering of the previously mentioned composites. Other grasses are encountered at Plan del Flores, the most common of which is Arundinella deppeana. A few other herbs,

including Castileja arvense, several composites, Hippeastrum and the ferns Phlebodium aureum and Ophioglossum reticulatum occur in open areas.

It was noted that a shrubby layer is often lacking especially in the elfin forests dominated by Clusia. In the more diverse elfin forest are shrubby Psychotria spp. and a bristly melastome, Clidemia setosa. The diversity of shrubs of disturbed areas is much higher, except along the crater rim where Rubus is most abundant. At Plan del Flores the open disturbed area once cleared for coffee growing consists of a large number of shrubs and the above mentioned herbs. Among the shrubby species are Conostegia spp., Monochaetum deppeanum, Ardizia sp., Parathesis sp. and Viburnum hartwegii.

Two species of vines were collected in the disturbed Plan del Flores area, Arthrostema ciliatum and Liabum discolor, whereas Marcgravia brownei was a rather frequently encountered liana of the mature elfin forest.

At least four alien floristic elements were observed at Plan del Flores. Hippeastrum sp. was observed and collected once. A row of Hibiscus rosa-sinensis was observed in the abandoned clearing as were Coffea arabica and occasional clumps of Musa paradisiaca. Occasionally untended coffee plants were observed. Among a large number of pioneer species and weeds found in the disturbed area of the cloud forest above Finca Las Delicias was a cultivated Coccoloba uvifera. None of the alien elements found seemed to be reproducing and no juvenile individuals were observed.

Epiphytes and terrestrials occasionally exchange niches. Normally epiphytic orchids were found growing as terrestrials. The

orchid Trevoria glumacea often becomes established on the ground along the northeast crater rim. Sexual reproduction becomes a problem for these plants with normally pendulous racemes, and none was observed to form an inflorescence. Occasionally terrestrial ferns and orchids become established on trees, especially in crotches where there is an accumulation of detritus. The characteristic terrestrials were rarely found growing with their roots more than a meter above ground level, and were never observed growing in the forest canopy.

ENVIRONMENTAL DISTURBANCES AND THEIR EFFECTS ON THE VEGETATION

Environmental disturbances on Mombacho have been caused by vulcanism, landslides, fire and man. The latter is seen to pose the greatest threat to Mombacho's vegetation, as is true for other cloud forests in Central and South America.

Volcanic eruptions on Mombacho are infrequent, but when they occur they can play a decisive role in molding the flora. Total destruction of the flora would require the most severe eruption, and would need to result from either an extremely violent explosion of the mountain or from complete burial by ash and lava. Van Steenis (1972, Figure 65) includes a photograph of Vaccinium twigs sprouting after inundation by an ash scree and another depicting the effects of an avalanche of dry ash and lapilli on the vegetation. After the dry ash and lapilli had stripped the vegetation of its branches individual tree trunks exhibited new sprouts at the nodes. These depictions attest to the perseverance which mountain forest species must exhibit to endure severe volcanic events. In light of this I believe that the last violent eruption which took place in the sixteenth century probably did not destroy the vegetation to the point that all the present floristic elements would need to have developed from introduced propagules. The vegetation on much of the mountain may not have been

much affected, although the eruption may have caused total destruction of the southwest flank.

Landslides apparently occur rather commonly along the inside crater wall and along precipitous banks on the northeast slope. Apparently the loose volcanic substrate crumbles easily in areas of steep incline and several fresh slides were observed. Frequent slides on the crater rim and the more exposed environment seem to favor the growth of Clusia salvinii. Such slides may also favor the establishment of Sobralia macrantha on nearly vertical cliffs.

The charred upper branches of some elfin forest trees suggest that lightning may play a minor part in disturbing the elfin forest. It is conceivable that lightning could start fires during an exceptionally dry season as it sometimes does in Java (Van Steenis).

By far the most frequent and widespread disturbances are caused by man. Large areas of cloud forest have been removed from coffee agriculture, cattle raising, and subsistence farming. Two deforested areas have apparently been abandoned, but the effects will be evident for many years. A large expanse of former cloud forest on the south slope has been recently cut and burned. The heat on this charred mountainside during midday is most uncomfortable. Not only is the immediate area affected but also the cloud forests above the destruction show severe signs of desiccation. It seems that the air parcel, heated as it passes over the burned area and developing a lower relative humidity, passes through the intact higher altitude cloud forest, severely drying the habitats in which plants with high moisture requirements grow.

Such practices of deforestation can diminish the water supply of any natural springs which otherwise supply the needs of those causing the devastation. It was observed that water was carried by horseback for a distance up the mountain to supply the needs of one coffee finca, above which the mountainside was deforested.

Due to effects of disturbance, it would be difficult to determine which forests represent climax vegetation types. The frequent stressful environmental disturbances probably cause such great disruption that the forest can attain only a limited degree of maturity, rarely if ever reaching the climax stage before another disturbing event ensues. It is presently undetermined whether the Clusia ridges represent a climax or a successional stage. When viewing the elfin forest we are probably observing mostly various stages of succession which rarely culminate in well developed climax forests.

NOTES ON PHENOLOGY

Van Steenis groups the flowering plants of the Java mountains according to three categories: those which flower during the rainy season, those which flower in the dry season and those whose flowering patterns are seasonally indifferent. Since my field experience on Mombacho was limited to the months of May to August and December, many flowering patterns were not observed. Many seasonal elements were not found in flowering or fruiting condition, consequently I am only able to surmize the identity of a number of sterile species. One sterile Heliocarpus sp. was observed occurring barely within the northeast crater rim. Among the sterile orchids collected was Stanhopea cf. ecornuta, a large Maxillaria, Mormodes cf. buccinator and a presumed Gomeza sp.

Sobralia macrantha was observed in flower during the dry season, until the rains came in June. Three conspicuous species of Elleanthus were found to flower toward the end of the dry season in May, a response which may have resulted from greater precipitation as the rainy reason approached. With the beginning of the rainy season, species of Pleurothallis and Masdevallia were observed to come into flower. One orchid, Epidendrum lacustre, was found in flower whenever we visited the elfin forest and it probably flowers continually throughout the year after the completion of each vegetative growth.

Viburnum hartwegii was collected in flower and fruit during the same day, indicating that it may not be particularly seasonal. Several bromeliads, especially Guzmania spp., were flowering profusely early in the rainy season, but appear not to flower continuously.

EPIPHYTE-HOST INTERACTIONS

Epiphytes are usually regarded as benign inhabitants of trees, but the observation of Went (1931) in Southeast Asia and my observations on Mombacho indicate a need for reconsideration. Went noted that the roots of a fern, Pyrrhosia sp., contribute to the decay of twigs, and that the fungus associated with orchid roots may contribute to death of the host branch. One specimen of Ceiba in the lower cloud forest was observed to be so covered with epiphytes, particularly orchids, that it is difficult not to regard their sheer extra weight as hazardous to the host. A particular burden must be born by the host branch after a storm since the epiphytes hold large amounts of water in the root mass and the Bromeliaceae are notorious for storing quantities of water in their crowns. Thus the combined effects of the sheer extra weight plus the secondary effects of fungi and bacteria living in a moist habitat provided by the epiphytic root system must have detrimental effects on the host.

The death of the host branch may be an advantage to some epiphyte species as is indicated by the following observations. One large tree in the upper cloud forest felled by the elements contained in its crown a large quantity of the orchid Masdevallia chontalensis, all plants of which were flowering profusely. It has been often noted by orchid growers that a maximum light intensity short of burning the

foliage results in the largest number of flowers. If the increased light intensity due to the defoliated host caused a greater-than-normal flowering response in the Masdevallia, then there is a high probability that a larger number of seeds were produced to colonize other hosts. The decaying twigs probably also provide a source of nutrients to the epiphytes. It remains to be seen what active roles epiphytes play, but the passive effects of the increased weight plus decay of the host as a result of detritus accumulation and associated fungi are probably significant factors in causing the demise of the host.

PHYTOGEOGRAPHY

It is unwise to speculate about the phytogeographic significance of most floristic elements of Mombacho at this time for two reasons. (1) The species are for the most part poorly known and numerous generic revisions will have to be undertaken before their ranges can accurately be determined. (2) Since much of Central America is poorly collected, phytogeographic conclusions based on presently known plant distributions may be misleading. Nevertheless several observations concerning phytogeography seem justified. Neighboring cloud forests to the south at Zapatera and Volcan Maderas should be explored botanically since many rare elements collected from Mombacho probably also occur in these areas.

Four epiphytic orchids find their northernmost limits on Mombacho. Epidendrum lacustre occurs to the south into South America and its occurrence on Mombacho as a significant range extension was noted by Ames (1923). Trevoria glumacea is otherwise known only from Volcan Maderas and Costa Rica. Epidendrum miserrimum is known from Costa Rica, Haiti and Venezuela (Garay and Sweet, 1974). With more thorough investigation of tropical highlands, the known range of this inconspicuous orchid will probably be extended. Lycaste macrophylla has a southern distribution and may not occur north of Volcan Mombacho. Goodyera bradeorum, described from Costa Rica, is present on Mombacho,

and its range has subsequently been expanded to the north by its discovery in the mountains near Matagalpa. With future exploration this easily-overlooked orchid may be found over a greater range.

The only endemic element noted from Mombacho is Freziera friedrichstaliana. This species, although distinguishable from others by its long petiole, may prove to be no more than a geographical variant of another species of relatively wide range.

The flora of Mombacho is notable for the absence of certain species. Myrica cerifera, a common shrub or small tree found in the mountains near Matagalpa, seems to be absent from Mombacho. Van Steenis (1972, p. 19) noted that high altitude species often descend to specific altitudes in Java, but that they do not occur on mountains of which the summit is lower than a certain critical altitude, even though the same species may be found at lower altitudes on higher mountains. This may also be the case with Myrica and other genera found in northern Nicaragua. Apparently the genera Pinus, Liquidambar and Carpinus, found in northern Nicaragua, have not succeeded in colonizing the quaternary volcanic chain, with the exception of Pinus on El Viejo. The southern range limits of these genera in northern Nicaragua correspond to the southernmost extension of North America during the Tertiary. Mombacho may have contained more temperate elements when it was less eroded, and it probably has played a role as a stepping stone for species passing northward and southward.

HISTORICAL SKETCH OF BOTANICAL EXPLORATION ON VOLCAN MOMBACHO

The first pioneer traveler and naturalist who made collections on Volcan Mombacho was Emanuel Ritter Friedrichstal. His travels included the Antilles, Nicaragua, Guatemala and the Yucatan, beginning in 1837 and ending with his return to Europe in 1841 (Duncker & Humblot, 1878). Unfortunately his field notes became somewhat confused and it is entirely possible that several Friedrichstal specimens attributed to Guatemala actually had their origin in Nicaragua. Such is probably the case with Freziera friedrichstaliana which was supposedly collected by him and described as a Guatemalan species. Since the above species has not subsequently been discovered in Guatemala and it is established that Friedrichstal had traveled in Nicaragua (Standley & Williams, 1961), it is likely that the Freziera specimens are Nicaraguan. Freziera friedrichstaliana is known only from Volcan Mombacho (Kobuski, 1941).

Anders Sande Oersted visited Mombacho in December of 1847 (fide Seymour, personal communication). It is reported by Ko Ko Lay (1949) that he collected Heliocarpus nodiflorus and it is probable that he collected many more specimens.

Kobuski (1941) noted that G. Wright collected Freziera friedrichstaliana on Volcan Mombacho.

Paul Levy, a French engineer, resided in Granada for some time and collected specimens of Nicaraguan plants between 1869 and 1885 (Hemsley, 1887 and Chaudhri et al., 1972). None of his specimens have been discovered from Mombacho, but considering its proximity to Granada, it seems likely that he would have collected there.

Charles Fuller Baker, graduate of Michigan Agricultural College in 1891 (Cattell, 1906), made collections on Mombacho in February of 1903 (from herbarium sheet, Baker 2488, MSC).

In 1909 the first of two volumes of Flora Nicaraguense by Miguel Ramirez Goyena was published, and to this day it remains the sole flora of the area. Goyena doubtless knew the plants of Mombacho, but nothing is known of his botanizing there. Unfortunately his work cites neither specimens, their localities, nor their known ranges, so its utility is limited.

W. R. Maxon, A. D. Harvey and A. T. Valentine visited Mombacho in July, 1923. Maxon, a noted fern specialist, was particularly interested in the pteridophytes of Mombacho. During his visit he collected a new species of Malaxis which Oakes Ames named M. maxonii.

Verne Grant collected on Mombacho in 1940 and 1941 (fide Seymour and Frank Almeda, personal communication).

In January 1967 L. O. Williams, Antonio Molina R. and A. H. Heller collected there during a three-day period.

A. D. Moore, D. A. Dudey and Charles Nichols collected on the southeastern slope on January 9, 1969. Much of the material for this work comes from their collections.

On January 27 of the following year Edwardo Narvaez S. and I collected in the disturbed area around the vacation house above Finca Las Delicias.

On April 9, 1971 I collected about 30 numbers from the elfin forest on the northwest crater rim.

In May 1972 R. L. Wilbur, D. E. Stone and F. Almeda made collections near the crater (Frank Almeda, personal communication).

Frank C. Seymour made collections on July 25, 1972, and also on August 1 of the same year with Stuart B. Robbins.

David A. Neill, Stephan A. Marshall and I collected around the north and northwest crater rim in December, 1973 and January, 1974.

Julius von Warscewicz and Hermann Wendland may have visited Mombacho, but available information is too scanty to confirm this. Reichenbach (1866, p. 43) reports that Warscewicz collected an Arpophyllum which probably did not come from Mombacho since it is not known to occur there. Hemsley (1887, p. 134) indicates that Wendland "went out to Central America towards the end of 1856, and spent eight months in Costa Rica and Nicaragua," but Granada was burned in that year by the Tennessee-born pirate, William Walker, and was thus an undesirable place to visit. Nonetheless Wendland may have ventured there out of curiosity.

For purposes of this study, David A. Neill and I made collections on Volcan Mombacho between April 26 and August 1, 1975 (Figure 10).

Figure 10. Dates of collections in 1975 and collection numbers by J. T. Atwood and D. A. Neill.

Dates	Collection Numbers
26 April	Neill N21-N27
27 April	Atwood A1-A4
"	Neill N28-N30
29-30 April	Atwood A6-A59
"	Neill N31-N60
14-15 May	Atwood A154-A208
18 May	Atwood A209-A212b
5 June	Atwood A291-A311
7 June	Neill N222-N227
1-2 July	Atwood & Neill AN48-AN94
10 July	Atwood A344-A364
16 July	Atwood & Neill AN184-AN216a
30 July	Atwood & Neill AN301-AN308

FLORA

Many of the identifications in the following checklist are necessarily tentative due to lack of revisionary work. As monographic treatments are produced for various genera, many names included here will be found to be incorrect. Specimens of large or difficult groups collected in 1975 were sent to specialists. D. B. Lellinger identified the pteridophytes. W. C. Burger identified the Piperaceae. J. J. Wurdack identified the Melastomataceae. L. B. Smith determined the Bromeliaceae. T. B. Croat identified the Araceae. H. Kennedy determined the Marantaceae. R. McVaugh identified the Myrtaceae. J. H. Beaman identified the Compositae and helped place many difficult species to family and genus. F. C. Seymour was very helpful in determining a number of species. W. D. Stevens identified the Apocynaceae and Asclepiadaceae, and M. J. Donoghue determined the Rubiaceae and Caprifoliaceae. The remaining identifications of the 1975 collections were made by me.

Various parts of the Flora of Guatemala published by the Field Museum of Natural History were found to be useful for making determinations, as were several available parts of the Flora of Panama published by the Missouri Botanical Garden. My collections were compared with previously collected herbarium specimens whenever possible. When some doubt is cast upon the identification of a specimen, it is indicated

with "cf." If a specimen has affinities with another species, but specific identification is not possible, the species is indicated by the specific epithet of the related species preceded by "aff."

A set of specimens collected in 1975 was left at Universidad Centroamericana at Managua which can serve as references for subsequent work, but the principal set of 1975 collections is contained in the Beal-Darlington Herbarium of Michigan State University. These collection numbers are preceded by A (Atwood), N (Neill) or AN (Atwood & Neill). Most the specimens collected before 1975 by F. Seymour, D. Dudey, D. Moore, C. Nichols, S. Robbins, E. Narvaez S., D. Neill, A. Marshall and me are housed by Mr. Frank Seymour, who kindly provided me with his list of species from Mombacho. An asterisk (*) precedes all specimens not examined by me.

The classification of the fern families adopted here is that of J. A. Crabbe, A. C. Jermy and J. T. Mickel (1975). The classification of the angiosperm families is basically that of A. Cronquist (1968).

A total of 353 species are represented in the checklist, 68 of which are pteridophytes distributed among 16 families and 29 genera. The remaining 285 species are angiosperms representing 78 families and 200 genera. No gymnosperms are known from Mombacho. The largest fern families are the Aspleniaceae and Polypodiaceae with 23 and 16 species respectively. The largest angiosperm families are the Orchidaceae and Compositae with 58 and 27 species respectively.

More collections during the months of September through January should be made, and many more species will doubtless be found. Vegetational measurements should be taken to determine the limits of various associations of plants.

LIST OF SPECIES

FERNS AND FERN ALLIES

ADIANTACEAE

Adiantum concinnum Willd. Robbins 6254, 1 August 1972 (Seymour). Lower cloud forest.

A. macrophyllum Swartz. A48. Common in lower cloud forest.

Pityrogramma calomelanos L. *Seymour 6099, 25 July 1972 (Seymour).

P. ferruginea (Kunze) Maxon. *Atwood 3899, 27 January 1970 (Seymour). Fern of cloud and deciduous forests.

ASPLENIACEAE

Asplenium abscissum Willd. N40, A170. Local on crater rim and Plan del Flores. Atwood 3094 (Seymour) is probably also the same species.

A. auritum Swartz. AN119. Uncommon in deciduous forest near margin of lower cloud forest.

A. cristatum Lam. AN197. Lower and upper cloud forests.

A. fragrans Sw. Dudey & Moore 1966a, 9 January 1969 (Seymour). Robbins 6253, 1 August 1972 (Seymour). Lower cloud forest.

A. formosum Willd. Dudey & Moore 1966, 9 January 1969 (Seymour); AN93. In deciduous forest on border with lower cloud forest near Finca Las Delicias. Rare.

A. hoffmanii Hieron. AN57. Lower cloud forest.

A. myriophyllum (Sw.) Pr. Atwood 3901, 27 January 1970 (Seymour).

A. obtusifolium L. *Dudey & Moore 1966b, 9 January 1969 (Seymour). Probably in cloud forest areas above Finca Las Delicias.

A. praemorsum Swartz. AN117. In deciduous forest near margin with lower cloud forest.

A. pteropus Kaulf. A13. Near northeast crater rim in elfin forest. Growing as an epiphyte.

A. pulchellum Raddi. Atwood 3811, 27 January 1970 (Seymour). Lower cloud forest.

A. pumilum Sw. *Dudey & Moore 1966a, 9 January 1969 (Seymour). Lower cloud forest.

Ctenitis subincisa (Willd.) Ching. AN190. Upper cloud forest. Uncommon.

Diplazium cristatum (Desv.) Alson. A304. Common in elfin forests at Plan del Flores.

D. stratstrum Lellinger. *Atwood, Marshall & Neill 6727, 16 December 1973 (Seymour). Cloud forests, and probably also in elfin forests.

D. shepherdii (Spr.) Link. *Atwood 3907, 27 January 1969 (VT). Lower cloud forest.

Elaphoglossum furfuraceum Christ. *Atwood 5451, 9 April 1971 (VT). Elfin forest.

E. palmense Christ. N41, A308, AN196. Upper cloud and elfin forest inhabitant. Local and not abundant. Epiphyte.

E. tectum (H. B. ex Willd.) Moore (?). *Atwood, Marshall & Neill 6724, 16 December 1973 (Seymour). Epiphytic fern of upper cloud and elfin forests. Not common.

E. sp. A30, A302. Elfin forest epiphyte at Plan del Flores. Much larger plant than E. palmense.

Peltapteris peltata (Swartz) Morton. Atwood 3913, 27 January 1970 (Seymour); Atwood, Marshall & Neill 6707, 15 December 1973 (Seymour).

Polybotrya cervina (L.) Kaulf. AN200. Upper cloud forest above Finca Las Delicias.

Polystichopsis pubescens (L.) Morton. Atwood 3908, 27 January 1970 (Seymour).

BLECHNACEAE

Blechnum divergens (Kunze) Mett. A42. Upper cloud forest terrestrial.

B. ensiforme (Liebm.) C. Chr. *Atwood, Marshall & Neill 6731, 16 December 1973 (Seymour); N39. Upper cloud and elfin forest.

B. fragile (Liebm.) Morton & Lellinger. *Atwood, Marshall & Neill 6730, 16 December 1973 (Seymour). Upper cloud and elfin forest.

B. lehmannii Hieron. A292. Common terrestrial at Plan del Flores in cover of elfin forest.

B. occidentale L. Dudey & Moore 1965, 9 January 1969 (Seymour); Atwood, Marshall & Neill 6729, 16 December 1973 (Seymour). Not uncommon in elfin forest.

B. pyramidatum (Lam.) Urb. *Nichols 2005, 9 January 1969 (Seymour). "In lush growth on mountain."

CYATHEACEAE

Cyathea sp. A298a. Tree fern common at Plan del Flores.

Nephelea mexicana (Schlecht. & Cham.). A344. Tree ferm at Plan del Flores. Common locally.

DAVALLIACEAE

Nephrolepis pectinata (Willd.) Schott. A14. Common fern of upper cloud forest about 900 m alt. above Finca Las Delicias. Undoubtedly in elfin forest.

GLEICHENIACEAE

Gleichenia bifida (Willd.) Spreng. A17. Common fern of disturbed areas of crater rim and elfin forest. Often produces entanglements which are nearly impenetrable.

HYMENOPHYLLACEAE

Hymenophyllum polyanthos (Swartz) Swartz. *Atwood, Marshall & Neill 6723, 15 December 1973 (Seymour); *Atwood, Marshall & Neill 6708, 15 December 1973 (Seymour). Mostly elfin forest inhabitant.

Trichomanes capillaceum L. Atwood 3902, 27 January 1970 (Seymour). Cloud forest, probably occurring in elfin forest.

T. radicans Swartz. Atwood 3900, 27 January 1970 (Seymour); N45. Common in elfin forest.

T. rigidum Swartz. *Atwood, Marshall & Neill 6722, 16 January 1972 (Seymour). Cloud forest and elfin forest.

LOMARIOPSIDACEAE

Bolbitis clandorhizans (Sprengel) Ching. Dudey & Moore 1968, 9 January 1969 (Seymour). Lower cloud forest above Finca Las Delicias.

LOPHOSORIACEAE

Lophosoria quadripinnata (Gmel.) C. Chr. A297. Plan del Flores.

LYCOPODIACEAE

Lycopodium dichotomum Jacq. AN65. Epiphytic in lower cloud forest.

L. taxifolium Sw. *Atwood 5454, 9 April 1972 (Seymour). Perhaps identical with AN65.

MARATTIACEAE

Marattia interposita Christ. AN188. Upper cloud and elfin forest.

OPHIOGLOSSACEAE

Ophioglossum reticulatum L. A353. Very abundant at disturbed area of Plan del Flores.

POLYPODIACEAE

Grammitis blepharodes (Maxon) Seymour. Atwood 5453, 9 April 1971 (Seymour); Atwood, Marshall & Neill 6728, 16 December 1973 (Seymour); A27. Common epiphyte in upper cloud and elfin forests.

G. serrulata (Swartz) Swartz. A25. Upper cloud and elfin forest. Common.

Microgramma lycopodioides (L.) Copel. N27. Lower cloud forest epiphyte.

Phlebodium aureum (L.) J. Smith. A163. Common at Plan del Flores.

Pleopeltis macrocarpa (Bory ex Willd.) Kaulf. var. macrocarpa. AN119. Epiphytic fern of deciduous forest near margin of cloud forest.

P. percussa (Cav.) Hook & Grev. AN63. Epiphytic in lower cloud forest.

Polypodium dissimile L. Atwood 3906, 27 January 1970 (Seymour); N43. Lower cloud forest on east side of Mombacho. Ca 800 m.

P. fructuosum Maxon & Weath. Robbins 6251, 1 August 1972 (Seymour). Probably also Seymour 6098, 25 July 1972 (Seymour). Lower cloud forest.

P. kuhnii Fourn. Robbins 6252, 1 August 1972 (Seymour). "On the ground . . . Rainforest."

P. loriceum L. Atwood, Marshall & Neill 6725, 16 December 1973 (Seymour). Northwest crater rim. A167. Plan del Flores.

P. plebejum C. & S. Atwood 3905, 27 January 1970 (Seymour). Cloud forest inhabitant. The upper surface of this species is speckled with white, a unique character among other similar Polypodium species from Mombacho.

P. aff. plesiosorum Kze. Determined by Atwood. Seymour 6097, 25 July 1972 (Seymour). Lower cloud forest.

P. polypodioides (L.) Watt var. polypolioides. AN92. In deciduous forest near margin of lower cloud forest.

P. plumula Humb. & Bonpl. ex Willd. AN91. Margin of deciduous seasonal forest and lower cloud forest on a boulder near Finca Las Delicias.

P. wiesbaueri Sod. *Atwood 5452, 9 April 1971 (VT). Upper cloud and elfin forest.

PTERIDACEAE

Pteris altissima Poiret. *Atwood 3909, 27 January 1970 (VT). Lower cloud forest.

SCHIZEACEAE

Lygodium venustrum Swartz. Seymour 6096, 25 July 1972 (Seymour); AN86. In lower cloud forests, also in deciduous seasonal forest.

THELYPTERIDACEAE

Thelypteris (subg. Amauropelta). A304a. Also Atwood, Marshall & Neill 6726, 16 December 1973 (Seymour)? Elfin forest at Plan del Flores.

T. balbisii (Sprengel) Ching. *C. F. Baker 2449 (GH).

T. columbiana (C. Chr.) Morton. A26. Upper cloud and elfin forests.

T. dentata (Forsk.) E. St. John. AA44. Upper cloud forest.

ANGIOSPERMS

ACANTHACEAE

Aphelandra deppeana C. & S. *Dudey & Moore 1959, 9 January 1969 (Seymour). "In lush growth." Probably lower cloud forest.

Blechum brownei Juss. A156, A178. Weed of disturbed elfin forest at Plan del Flores. Usually found at lower altitudes. These and the following may be the same.

B. pyramidatum (Lam.) Urb. *Nichols 2005, 9 January 1969 (Seymour).

Dyschoriste skutchii Leonard. *Narvaez 3888, 27 January 1970 (Seymour).

Ruellia inundata HBK. *Dudey & Moore 1960, 9 January 1969 (Seymour). In lower cloud forest.

AMARANTHACEAE

Achyranthes aspera L. A55. In disturbed area by vacation house.

Alternanthera williamsonii Standl. *Narvaez 3881, 27 January 1970 (MO).

Chamissoa altissima (Jacq.) HBK. Dudey & Moore 1977, 9 January 1969 (Seymour). Disturbed cloud forest area above Finca Las Delicias.

Cyathula achyranthoides (HBK.) Moquin. *Dudey & Moore 1979, 9 January 1969 (Seymour).

Gomphrena decumbens Jacq. AN89. In pastures and roadsides at Finca Las Delicias. Bracts are longer than the flowers.

Iresine celosia L. Dudey & Moore 1977, 9 January 1969 (Seymour). Lower cloud forest areas. Locally abundant and often sold in market places for decoration.

I. sp. A47. In disturbed area at 800 m on northeast flank. Viney plant with deltoid coarsely dentate leaves.

ANACARDIACEAE

Mangifera indica L. *Atwood 3921, 27 January 1970 (Seymour). Probably cultivated but often escapes. Common in deciduous forest areas from Granada to base of Mombacho.

APOCYNACEAE

Echites cf. turrigera Woodson. AN71. Deciduous forest areas.

Plumeria rubra L. Not collected but often observed as a conspicuous element of the deciduous forest. This is the national flower of Nicaragua. The Mombacho plants have white flowers.

Rauvolfia littoralis Rusby. AN84. Herb in deciduous forest area near Finca Las Delicias. Rather common.

Stemmodenia donnell-smithii (Rose) Woodson. AN69. In deciduous forest.

AQUIFOLIACEAE

Ilex aff. carpenterae Standl. Al92. Collected at Plan del Flores. The above identification is uncertain in this difficult group, and several specific epithets seem equally well applied.

ARACEAE

Anthurium crassinervum (Jacq.) Schott. AN82. Common epiphyte in trees of upper deciduous forest areas around Finca Las Delicias. This species forms very large rosettes.

A. scandens (Aubl.) Engl. A50, N56. Lower cloud forest epiphyte common in coffee plantations at Finca Cutirre and Finca Las Delicias.

Dieffenbachia auranticca Engler. AN206. Upper cloud forest ravine above Finca Las Delicias ca. 99 m alt. Very local.

D. seguine L. A212. Common terrestrial in deep shade, at about 600 m.

Monstera adansonii Schott. AA2, A172, N28, A363. Common liana just about everywhere except the elfin forest.

M. acuminata C. Koch. AN66. Common vine flanking tall trees of lower cloud forest.

Syngonium polophyllum Schott. AN90. Common in deciduous forest areas.

ARALIACEAE

Oreopanax xalapense (HBK.) Dcne. & Planch. A361, A299. Frequent but not abundant in upper cloud and elfin forests.

ARECACEAE

Chamaedorea sp. A171. In cloud and elfin forests, probably in areas recently disturbed.

Undetermined. AN50. In lower cloud forest near Finca Cutirre. Occasional.

ARISTOLOCHIACEAE

Aristolochia anguicida Jacq. AN81. In deciduous forest near Finca Las Delicias, growing near the following species. Collection in fruit only.

A. cf. maxima Jacq. AN77. In deciduous forest near Finca Las Delicias.

ASCLEPIADACEAE

Asclepias curassavica L. Robbins 6260, 1 August 1972 (Seymour). Lower cloud and deciduous forests.

BEGONIACEAE

Begonia filipes Benth. Dudey & Moore 2004, 9 January 1969 (Seymour). Cloud forest.

B. plebeja Liebm. Dudey & Moore 1985, 9 January 1969 (Seymour). Lower cloud forest.

BIGNONIACEAE

Arrabidaea mollissima Bur. & K. Schum. *Dudey & Moore 1957, 9 January 1969 (Seymour). Probably collected in deciduous forest.

Cydista diversifolia (HBK.) Miers. AN207. In deciduous forests around Finca Las Delicias.

BIXACEAE

Bixa orellana L. AN67. Common in low cloud forest above Finca Cutirre.

BOMBACACEAE

Ceiba sp. No collection made. Forms immense crowns often supporting a variety of epiphytes. Throughout deciduous forest.

BORAGINACEAE

Cordia dentata Poir. AN75. Finca Las Delicias in deciduous forest.

C. stelifera I. M. Johnston. *Atwood, Marshall & Neill 6715, 15 December 1973 (Seymour).

Heliotropium indicum L. AN74. Deciduous forest near Finca Las Delicias.

BROMELIACEAE

Catopsis sp. AN205. Probably common in cloud forest, but not found in good condition for determination.

Guzmania lingulata (L.) Mez var. minor (Mez) L. B. Smith. AN203. Common epiphyte of cloud forests. Very attractive species with brilliant red bracts.

G. monostachia (L.) Rusby ex Mez. AN204. Common epiphyte of cloud forests. The contrasting black-veined lower bracts and red upper bracts distinguish this from other species of Guzmania on Mombacho.

G. nicaraguensis Mez & C. F. Baker. AN306. Uncommon at crater rim. Elfin forest epiphyte.

Pitcairnia sp. A187. Common in the elfin forest at Plan del Flores.

Tillandsia bulbosa Hook. AN58. In lower cloud forest at Finca Cutirre.

T. fasciculata Sw. *Atwood 5459, 9 April 1971. Cloud and elfin forest epiphyte.

T. festucoides Brongn. ex Mez. AN56. Collected in the lower cloud forest at Finca Cutirre where it is probably common.

T. monadelpha (E. Morr.) Baker. AN52. Lower cloud forest.

T. schiediana Steud. AN80. Most abundant in dry deciduous forest, but occasionally encountered in upper cloud forest areas.

T. usneoides L. Atwood 3916, 27 January 1970 (Seymour). Common cloud forest epiphyte.

Vriesea pedicellata (Mez & Werckle) Sm. & Pitt. A16, A198. Epiphyte of elfin forest.

V. sp. A15. Found above vacation house above Finca Las Delicias.

BURSERACEAE

Bursera simaruba (L.) Sarg. AN214. Common tree of deciduous forest.

CAMPANULACEAE

Lobelia laxiflora HBK. *Atwood 5477, 9 April 1971 (VT). Elfin forest.

CAPRIFOLIACEAE

Viburnum hartwegii Benth. A200. In disturbed sites of elfin forest at Plan del Flores.

CARICACEAE

Carica pennata Heilbron. Not collected but observed in lower cloud forest. Plants are dioecious and occur in rather deep shade.

COCHLOSPERMACEAE

Cochlospermum vitifolium Willd. A78. Common deciduous forest component, but found as high as 800 m.

COMBRETACEAE

Combretum fruticosum (Loeff.) Stuntz. Dudey & Moore 1951, 9 January 1969 (Seymour). Probably lower cloud forest.

COMMELINACEAE

Campelia hirsuta Standl. *Dudey & Moore 1974a, 9 January 1969 (Seymour).

C. zanonia (L.) HBK. N50. Common in cloud forest.

Commelina erecta L. *Narvaez 3884, 27 January 1970 (Seymour). Cloud and elfin forest inhabitant.

Dichorisandra hexandra (Aubl.) Standl. AN186, A49. Common in cloud forests.

Phaeosphaerion persicariaefolium (D. C.) C. B. Clarke. A168. Found on disturbed sites at Plan del Flores.

Tripogandra cf. cumanensis (Kunth) Woodson. A44. Disturbed sites of cloud and elfin forest.

COMPOSITAE

Baccharis trinervis (Lam.) Persoon. A7, A43, A189, A201. Disturbed area at vacation house.

Bidens pilosa L. Reported by F. C. Seymour (personal communication).

B. riparia HBK. *Narvaez 3891, 27 January 1970 (Seymour).

B. squarrosa HBK. *Atwood 3924, 27 January 1970 (Seymour).

Chaptalia nutans (L.) Hemsl. Seymour 6105, 25 July 1972 (VT). Common in disturbed areas.

Cirsium mexicanum DC. *Atwood 5478 (Seymour); Atwood 5479, 9 April 1971 (Seymour); A46, N60. Disturbed areas of cloud forest.

Clibadium arboreum Donn.-Sm. A161. Small tree in elfin forest.

Conyza chilensis Spreng. A183. In disturbed site at Plan del Flores.

Elvira biflora (L.) DC. *Atwood 3923, 27 January 1970 (Seymour). Cloud forest.

Erectites hieracifolia (L.) R. *Nichols 2014, 9 January 1969 (Seymour). Disturbed area above Finca Las Delicias.

Erigeron bonariensis L. *Narvaez 3895, 27 January 1970 (Seymour). Disturbed area above Finca Las Delicias.

Eupatorium odoratum L. A54. Disturbed site at vacation house.

E. pycnocephalum Less. A155. Weed at Plan del Flores.

E. sinclairii Bth? *Narvaez 3894, 27 January 1970 (Seymour). In disturbed area of cloud forest at vacation house.

Galinsoga ciliata (Raf.) Blake. *Narvaez 3893, 27 January 1970 (Seymour). In disturbed area of cloud forest.

Liabum discolor (Hook. & Arn.) Benth. & Hook. ex Hemsl. A188a, A196. Rare in disturbed elfin forest at Plan del Flores.

Melampodium divaricatum (L. Rich. ex Pers.) DC. AN85. In deciduous forest.

Melanthera nivea (L.) Small. *Dudey & Moore 1961, 9 January 1969 (Seymour). Leaves not typical. Cloud forests.

Perymenium nicaraguense Blake. *Dudey & Moore 1991, 9 January 1969 (Seymour).

Pseudelephantopus spicatus (Juss.) Rohr. *Nichols 2011, 9 January 1969 (Seymour). Weed of disturbed area of cloud forest above Finca Las Delicias.

Senecio arborescens Steetz in Seem. N38, A21. Common in upper cloud forest, less so in elfin forest.

Spilanthes aff. americana (Mutis) Hiern. ex Sodiro. A19, A175. On crater rim and at vacation house.

S. ocymifolia (Lam.) A. H. Moore. *Narvaez 3892, 27 January 1970 (Seymour).

Verbesina fraseri Hemsley. *Dudey & Moore 1963, 9 January 1969 (Seymour).

Vernonia canescens HBK. A181. Common in disturbed elfin forest.

CONVOLVULACEAE

Ipomoea coccinea L. *Dudey & Moore 1956, 9 January 1969 (Seymour). Roadside around Finca Las Delicias.

COSTACEAE

Costus cf. sanguineus Donn.-Sm. Nichols 1998, 9 January 1969 (Seymour). Sterile.

CRUCIFERAE

Rorippa indica (L.) Hieron. *Narvaez 3886, 27 January 1970 (Seymour). In disturbed areas of cloud forest.

CHRYSOBALANACEAE

Chrysobalanus icaco L. *Robbins 6261, 1 August 1972 (Seymour). Probably lower cloud forest.

CUCURBITACEAE

Elaterium ciliatum Cogn. *Robbins 6269, 1 August 1972 (Seymour). Disturbed forest areas.

CYPERACEAE

Carex cf. donnell-smithii L. H. Bailey. A162. Common herb of elfin and cloud forests. Spikes seem a bit short for the above species.

C. polystachya Swartz ex Wahl. *Atwood, Marshall & Neill 6733, 16 January 1973 (Seymour); A197. Not uncommon in elfin forest.

Cyperus mutisii (HBK.) Griseb. *Robbins 6256, 1 August 1972 (Seymour).

C. tenuis Sw. Dudey & Moore 1973, 9 January 1969 (Seymour). Common in disturbed areas at low and high altitudes.

C. sp. A182. In grassy areas at Plan del Flores.

Rhynchospora polyphylla Vahl. A179. Common in disturbed areas of elfin forest.

Uncinnia hamata (Swartz) Urban. Atwood 5457, 9 April 1971 (Seymour). Common in elfin and cloud forests.

ELAEOCARPACEAE

Muntingia calabrura L. Seymour 6103, 25 July 1972 (Seymour). Common tree of deciduous forest area.

ERICACEAE

Cavendishia crassifolia (Benth.) Hemsley. A35, N24, N46. Abundant epiphyte of upper cloud and elfin forests.

Sphyrospermum majus Griseb. A11. Common epiphyte of upper cloud and elfin forests.

EUPHORBIACEAE

Acalypha setosa A. Rich. AN48. Common weed of coffee plantations.

Euphorbia cf. graminea Jacq. Narvaez 3883, 27 January 1970 (Seymour). Common in disturbed cloud forest area.

Jatropha podagrica Hooker. *Dudey & Moore 1952, 9 January 1969 (Seymour). Lower cloud forest?

Ricinus communis L. Dudey & Moore 1952, 9 January 1969 (Seymour). Below upper cloud forest level.

FLACOURTIACEAE

Casearia nitida Jacq. AN213. Common shrub in deciduous forest near Finca Las Delicias. Not expected to occur in cloud or elfin forests.

GESNERIACEAE

Columnea cf. tulae Urban. Atwood 5476, 9 April 1971 (Seymour). The following numbers are probably also the same species; A29, A31a, A195 and N59.

Kohleria sp. Atwood, Marshall & Neill 6716, 15 December 1973 (Seymour). Inside west crater rim, uncommon terrestrial herb. The whorled leaves, the uppermost of which are not reduced, and the lack of a conspicuous peduncle are noteworthy.

GRAMINEAE

Arundinella deppeana Nees. A40. Common in disturbed areas at Plan del Flores, but not occuring in elfin forest.

Eleusine indica (L.) Gaertner. Dudey & Moore 1970, 9 January 1969 (Seymour). Common weed of lower cloud forest.

Isachne arundinacea (Sw.) Griseb. A10. Common grass of disturbed elfin forest areas. Its mat-like viney growth seriously impedes one's progress when traversing the rough terrain.

Lasiacis ruscifolia (HBK.) Hitchc. Dudey & Moore 1948, 9 January 1969 (Seymour). Common where disturbance has occurred in the cloud forests.

Oplismenus burmannii (Retz.) Beauv. *Dudey & Moore 1972, 9 January 1969 (VT); A158. Locally common in upper cloud and elfin forests.

O. hirtellus (L.) Beauv. A10a. Common in elfin forest.

Panicum trichoides Sw. *Dudey & Moore 1971, 9 January 1969 (VT). Probably from lower cloud forest or deciduous forests.

Setaria paniculifera (Steudel) Fourn. A360. Common in disturbed area of elfin forest with Arundinella and Epidendrum radicans.

Sporobolus poiretii (Roem & Schltr.) Hitchc. A199. 14 May 1975. Common in disturbed elfin forest.

GUTTIFERAE

Clusia salvinii Donn.-Sm. A311, A24, N222. Very common especially in forest where nearly solid stands are to be found along the most windswept ridges.

HELICONIACEAE

Heliconia cf. collinsiana Griggs. Observed near Finca Cutirre. Inflorescences pendulous from a tall plant of banana proportions.

H. latispatha Benth. *Williams & Molina 200027 (F).

LABIATAE

Hyptis cf. mociniana Benth. A185. Weed in open disturbed area of elfin forests.

Salvia occidentalis Sw. *Nichols 2006, 9 January 1969 (Seymour). In disturbed areas of cloud forest.

LAURACEAE

Ocotea veraguensis (Meisnn.) Mez. Baker 2493, 20 February 1903 (MSC). "Small tree, 20-30 ft. high, with rather thick top. New foliage strikingly contrasted in color to old. Flowers with strong and pleasant odor. Used by natives as tonic medicine. Occasional in high forests."--from Baker herbarium sheet.

LEGUMINOSAE

Desmodium affine Schl. *Nichols 2001, 9 January 1969 (VT).

Mimosa pudica L. Not collected. Common weed of open disturbed areas.

Inga sp. Weedy tree of upper coffee plantations near Plan del Flores.

LENTIBULARIACEAE

Utricularia cf. montana Jacq. A351, AN307. Locally common epiphyte of cloud and elfin forest.

LILIACEAE

Hippeastrum cf. solandriflorum Herb. A364. Probably once cultivated. Plan del Flores.

Hypoxis decumbens. L. N226. Disturbed areas of cloud forest. Probably common. No seeds were observed, but only the above species is known from this area.

Xiphidium caeruleum Aubl. Dudey & Moore 1974, 9 January 1969 (Seymour). Abundant locally in cloud forest.

MALPIGHIACEAE

Byrsonima crassifolia (L.) HBK. Small tree of deciduous forest.

MALVACEAE

Hibiscus rosa-sinensis L. A191. Once cultivated at Plan del Flores but now abandoned.

Sida acuta Burm. *Robbins 6273, 1 August 1972 (Seymour). Common weed of deciduous forest.

MARANTACEAE

Calathea macrosepala var. macrosepala K. Schum. AN192. Common beside paths of lower cloud forest.

Maranta arundinacea L. A357. Common if coffee plantations on north flanks, but probably more widespread in lower cloud forest.

MARCGRAVIACEAE

Marcgravia brownei (Tr. & Planch.) Krug & Urban. A22, N223. Common vine of elfin forest. The pedicels seem a bit short for the above species which seems consistent with other Nicaraguan populations.

MELASTOMATACEAE

Arthrostema ciliatum R. & P. A188. Uncommon vine of disturbed areas. The above specimen collected at Plan del Flores.

Centradenia cf. inaequilateralis (C. & S.) C. Don. *Narvaez 3926, 27 January 1970 (Seymour). Disturbed area of cloud forest above Finca Las Delicias.

Clidemia setosa (Triana) Gleason. A350. Common understory shrub of elfin forest. Very distinctive for its fine dense bristles distributed throughout the plant.

Conostegia oerstediana Berg ex Triana. N34, A174. Small tree occasional at vacation house and Plan del Flores.

C. subcrustulata (Beurl.) Triana. AN209. In deciduous forest area below Finca Las Delicias.

Miconia laevigata (L.) DC. AN53. Near Finca Cutirre in lower cloud forest.

M. minutiflora DC. Atwood 3922, 27 January 1970 (VT).

M. cf. theazans (Bonpl.) Cogn. N35. Above Finca Las Delicias in disturbed areas of cloud forest.

Monochaetum deppeanum (Schlect. & Cham.) Naud. A173. Common in open areas of elfin forest. This species ranges north to Mexico and southward to the island of Omotepe in Lake Nicaragua.

MOLLUGINACEAE

Mollugo verticillata L. AN88. Weed in open areas and roadsides at Finca Las Delicias, and probably widespread in deciduous forest.

MORACEAE

Cecropia peltata L. AN70. Common tree nearly everywhere in disturbed areas.

MUSACEAE

Musa paradisiaca L. Not collected but observed at Plan del Flores. Undoubtedly planted.

MYRSINACEAE

Ardizia cf. rarescens Standl. *Atwood 5475, 9 April 1971 (Seymour). Elfin forest.

Parathesis sp. A295. At Plan del Flores.

Rapanea cf. ferruginea Mez. A159. Common elfin forest component. The above name seems best applied here at this time although a generic revision will undoubtedly necessitate a nomenclatural change.

MYRTACEAE

Myrcianthes fragrans (Sw.) McVaugh. N225. Probably a dominant of the elfin forest.

Psidium X hypoglaucum Standl. A160. In disturbed area of elfin forest and possibly cultivated.

Syzygium jambos (L.) Alston. N21, AA43. Near Finca Las Delicias. Probably cultivated.

NYCTAGINACEAE

Cryptocarpus globosus HBK. *Dudey & Moore 1978, 9 January 1969 (Seymour).

Mirabalis jalapa L. Robbins 6528, 1 August 1972 (Seymour); A358. In shaded areas about coffee plantations above El Progreso.

M. nyctaginea MacMillan. AN87. In deciduous forest area at Finca Las Delicias.

ORCHIDACEAE

Brassavola nodosa (L.) Lindl. Not collected but not uncommon in deciduous forest.

Catasetum oerstedii Rchb. F. A32. In dry deciduous forests. Very common in trees around Finca Las Delicias.

Cyrtopodium sp. Local plants around Finca Las Delicias. Living collection presently is being grown for determination.

Dichaea graminoides (Sw.) Lindl. A296. Occasional in elfin forest. The linear callus plus the cordate base of the lip indicates the above species. Also distinctive are the cilia on the margins of the leaf apices.

D. cf. muricata (Sw.) Lindl. A28. Upper cloud and elfin forests.

D. aff. rendlei Gleason. A347. Very much like D. panamensis but ovary is muricate. Elfin forest.

D. cf. tuerckheimii Schltr. A207. The above collection is sterile, but the small size indicates this species. Rather common in elfin forest.

Elleanthus df. aurantiacus Rchb. f. N42, A184. Very common epiphyte of the elfin forest.

E. capitatus (R. Br.) Rchb. f. A301, Atwood, Marshall & Neill 6742, 17 December 1973 (Seymour). Common in elfin and upper cloud forest areas. Also common in disturbed elfin forest and seems rather aggressive. Specimens collected contain a mucilaginous substance in the floral bracts.

E. hymenophorus Rchb. f. N32, A186. Common in upper cloud and elfin forests. The foliage of this species is nearly like that of Sobralia macrantha and E. capitatus, but it differs in its spicate inflorescence.

E. poiformis Schltr. Atwood, Marshall & Neill 6743, 17 December 1973 (Seymour); A165. Very common in elfin forest. This orchid is unique for its grass-like appearance and fractiflex raceme.

Encyclia chacaoensis (Rchb. f.) Dressl. & Pollard. Common in lower cloud and deciduous forests.

E. cochleata (L.) Dressl. Not collected, but common in lower cloud and upper deciduous forests.

E. fragrans (Sw.) Dressl. A3. In deciduous and lower cloud forests, but to be expected in elfin forest.

E. gravida (Lindl.) Schltr. A1. Deciduous forest on southeast flank. Uncommon.

Epidendrum boothii (Lindl.) L. O. Wms. AN55. Locally abundant epiphyte in deciduous forest around Finca Las Delicias where it is found with Catasetum and other orchids.

E. difforme Jacq. Plants observed in sterile condition, but their umbellate floral seats and small size separate them from other similar species.

E. lacustre Lindl. Atwood, Marshall & Neill 6738, 16 December 1973 (Seymour). Nowhere abundant, but evenly scattered throughout the elfin forest.

E. cf. laucheanum Rolfe. Atwood 5470, 9 April 1971 (Seymour). Elfin forest inhabitant. Specimens seen not in flowering condition.

E. miserrimum Rchb. f. A206. Rather common locally at Plan del Flores.

E. polyanthum Lindl. Atwood g-62 (Culture number). Collected in May, 1975. Specimen flowered in MSC greenhouses in January 1976. Collected at vacation house.

E. pseudoramosum Schltr. Atwood & Neill 7058, 20 January 1974 (Seymour). Common in elfin forest.

E. radicans Pavon. A164. Common in grassy areas of Plan del Flores. A few yellow forms were observed among the normal red-flowered plants.

E. ramosum Jacq. Atwood, Marshall & Neill 6744, 17 December 1973 (Seymour). Common in elfin forest.

Gomeza sp? Two sterile specimens observed, and the inflorescence and habit indicate the above genus. Found only in elfin forest.

Goodyera bradeorum Schltr. Atwood, Neill & Marshall 6741, 16 December 1973 (Seymour). Local terrestrial of upper cloud and elfin forests.

Isochilus major C. & S. Atwood & Neill 7045, 15 January 1974 (Seymour). Common in cloud forests. The specimens thus far examined all have lanceolate leaves, often with widths of more than 5mm, thus distinguishing them from I. linearis found commonly in Nicaragua.

Jacquiniella teretifolia (Sw.) Britt. & Wils. Atwood 5460, 9 April 1971 (Seymour). Common epiphyte on lower flanks of mountain in deciduous forests, but found occasionally in protected areas of elfin forest.

Lockhartia pittieri Schltr. Atwood 5468, 9 April 1971 (Seymour). Probably common in cloud forests. The above collection was made in the elfin forest on a northwest ridge.

Lycaste aromatica Lindl. Live collection made. Probably occurs mostly in the upper cloud forest where the above specimen was taken.

L. macrophylla (Poepp. & Endl.) Lindl. Atwood g-65 (Culture Number), 16 December 1973. Upper cloud forest. This may represent a northern extension of range for this species. Not common.

Malaxis maxonii Ames. A6. Common in cloud and elfin forests where it sometimes is encountered as an epiphyte. Mombacho is the type locality of the species.

M. tipuloides (Lindl.) O. Ktze. A345. Upper cloud and elfin forest inhabitant. This may be the northernmost limit of the species.

Masdevallia chontalensis Rchb. f. AN305. Common in cloud and elfin forests.

M. simula Rchb. f. Atwood & Neill 7042, 15 January 1974 (Seymour). Apparently rare in upper cloud and elfin forests.

Maxillaria tenuifolia Lindl. AN59. Lower cloud forest.

M. uncata Lindl. Atwood & Neill 7038, 15 January 1974 (Seymour). Localized in areas of cloud forests.

M. sp. Flowering specimen not seen, but the size of the plant and seed capsules indicate that it must be very attractive. Elfin forest.

Mormodes cf. buccinator Lindl. Live collection made, but not yet flowered. Scattered in deciduous forest around Finca Las Delicias, but one plant was found in elfin forest.

Oncidium ascendens Lindl. Atwood 3917, 27 January 1970 (Seymour). In deciduous forest around Finca Las Delicias.

Platystele compacta Ames. Atwood & Neill 7043, 15 January 1974 (MSC). Not uncommon in upper cloud and elfin forests. Vegetative habit appears very much like Masdevallia simula, but the inflorescence is several-flowered exceeding the foliage.

Pleurothallis blaisdelii S. Wats. Atwood & Neill 7040, 15 January 1974 (Seymour). Uncommon in upper cloud and elfin forests.

P. broadwayi Ames. A12, A300, A307. Locally abundant but inconspicuous epiphyte of cloud and elfin forests. This species has the distinctive habit of forming two or more leaves per stem.

P. ghiesbreghtiana A. Rich. & Gal. Not collected. Common in lower cloud forest where it often forms great masses. Also in deciduous forest.

P. sertularioides (Sw.). Spreng. AN54. Collection made north of Finca Cutirre at about 550 m. This lower cloud forest orchid is the smallest Pleurothallis thus far found on Mombacho.

P. tribuloides (Sw.) Lindl. Atwood, Marshall & Neill 7046, 15 January 1974 (Seymour). Local cloud forest inhabitant. The species is distinctive for its echinate ovary.

P. sp. Atwood, Marshall & Neill 6745, 17 December 1973 (Seymour). Plants very locally abundant in elfin forest. Flowers are white and dark red-purple.

P. sp. AN62. An inconspicuous species with narrow rather fleshy elliptic leaves and long viney secondary stems. Flowers are needed for identification. Lower cloud forest.

Ponera cf. striata Londl. Atwood 5463, 9 April 1971 (Seymour). Upper cloud forest.

Psilochilus macrophyllus (Lindl.) Ames. AN308. Rare along crater rim above vacation house.

Scaphyglottis lindeniana (A. Rich. & Gal.) L. O. Wms. Atwood 5462, 9 April 1971 (MSC); Atwood & Neill 7062, 20 January 1974. Lower cloud forest.

S. micrantha (Lindl.) Ames & Correll. A4. Common in deciduous forests around Mombacho.

Sobralia aff. macrantha Lindl. Atwood & Neill 7059, 20 January 1974 (Seymour). Epiphyte in trees, but also a common terrestrial orchid of nearly vertical cliffs and disturbed sites.

Stelis cucullata Ames. A194. Common in upper cloud and elfin forests. Other species of Stelis undoubtedly occur here.

Trevoria glumacea Garay. A209. One budded plant found on southeast flank near top of highest peak. Known from Costa Rica and Omotepe islands a few kilometers south of Mombacho. Probably common, but rarely seen in flowering condition. Of doubtful occurrence in the lower cloud forest.

Trigonidium egertonianum Batem. AN61. Common epiphyte in upper deciduous and lower cloud forests. The above collection is sterile, but probably represents this species.

Tropidia polystachya (Sw.) Ames. Atwood & Neill 7041, 15 January 1974 (Seymour). Cloud forest on southeast slope. Uncommon terrestrial.

Xylobium elongatum (Lindl.) Hemsley. Atwood & Neill 7061, 20 January 1974 (Seymour). Not uncommon in upper cloud forests. This species is distinct for its elongated pseudobulb with two apical, plicate leaves and lateral inflorescences.

OXALIDACEAE

Oxalis neaei DC. A34. Weed of disturbed area around vacation house. This is probably the same species as the following.

O. yucatensis Knuth. *Nichols 2002, 9 January 1969 (VT).

PASSIFLORACEAE

Passiflora biflora Lam. A33. In disturbed area about vacation house above Finca Las Delicias.

PHYTOLACCACEAE

Petiveria alliacea L. *Dudey & Moore 1980, 9 January 1969 (Seymour). "In lush growth on mountain." Probably in disturbed areas in cloud forest.

Phytolacca rivinoides Kunth & Bouche. N84. At vacation house above Finca Las Delicias.

Rivina humilis L. Dudey & Moore 1981, 9 January 1969 (Seymour). Cloud forest.

PIPERACEAE

Peperomia cyclophylla Miq. AN94. Epiphyte of lower cloud forest on margin with deciduous forest.

P. deppeana C. & S. *Nichols 2207, 9 January 1969 (Seymour).

P. hylophila C. DC. N26, N52. Not uncommon in cloud forests. The above collection made from vacation house.

P. serpens (Sw.) Loud. N36. Cloud forest epiphyte.

Piper aduncum L. N22. (Determined by Atwood.) In upper deciduous or lower cloud forest on southeast side of Mombacho.

P. amalago L. A312. Small tree at Plan del Flores.

P. auritum HBK. AN301. In ravine of lower cloud forest above Finca Las Delicias.

P. pseudofuligineum C. DC. A41, AN211. Disturbed areas of lower cloud forest.

P. cf. umbricola C. DC. A8, N33. Disturbed area of cloud forest, ca. 900 m alt. A39 may represent the same species.

Pothomorphe umbellata (L.) Miq. AN49. (Determined by Atwood.) Weedy and common in disturbed areas of cloud forest.

POLYGALACEAE

Monnina xalapensis HBK. Atwood 5472, 9 April 1971 (Seymour); A352. In disturbed areas at Plan del Flores.

POLYGONACEAE

Coccoloba uvifera (L.) Jacq. A45. Cultivated plant at vacation house above Las Delicias.

PLUMBAGINACEAE

Plumbago scandens L. AN83. Common deciduous forest herb.

PORTULACACEAE

Talinum cf. paniculatum (Jacq.) Gaertn. Not collected, but observed in deciduous forest area.

RHAMNACEAE

Karwinskia humboldtiana (R. & S.) Zucc. AN212. Common shrub in deciduous forest below Finca Las Delicias.

ROSACEAE

Rubus aff. hadrocarpus Standl. & Steyerm. A9, A36. Common shrub of disturbed areas of crater rim, elfin forest and cloud forest. The determination is questionable because of the glabrous drupelets.

RUBIACEAE

Borreria laevis (Lam.) Griseb. Robbins 6266, 1 August 1972 (Seymour). Common weed of disturbed area at vacation house above Finca Las Delicias.

Coccocypselum hirsutum var. glabrum (Bartling ex DC.) L. O. Wms. A356. Elfin forest component at Plan del Flores.

Coffea arabica L. Robbins 6267, 1 August 1972 (Seymour). Introduced and cultivated, but expected to escape.

Hamelia patens Jacq. A53. Common and perhaps dominant shrub of disturbed area above Finca Las Delicias.

Hoffmannia oreophila L. O. Wms. N53. Upper cloud forest area.

Palicourea galeottiana Mart. A346. Small tree at Plan del Flores. Rather common.

P. sp. A52, N57. Small tree of upper cloud forest and may venture into elfin forest.

P. sp. A193, A208. At Plan del Flores.

Psychotria graciflora Benth. ex Oerst. A293. Elfin forest component at Plan del Flores.

P. aff. trichotoma Mart. & Gal. A57, A212b. Shrub or small tree of cloud forests.

P. uliginosa Swartz. A23, A291, AN189. Upper cloud and elfin forests, often in disturbed areas.

P. sp. N51, N55, N58a, A169. Upper cloud & elfin forest. Flowers purple. Tree or shrub occurring in elfin forest.

P. sp. AN216. Roadside in deciduous forest area below Finca Las Delicias.

SAPINDACEAE

Paullinia clavigera Schlecht. AN210. Deciduous forest inhabitant.

SCROPHULARIACEAE

Castilleja arvensis Schlecht. & Cham. A154. Common in disturbed area.

Scoparia cf. dulcis L. *Nichols 2007, 9 January 1969 (Seymour).

SOLANACEAE

Cestrum aurantiacum Lindl. A254. Shrub at Plan del Flores; not common. This may be the southernmost limit for the species.

Solanum americanum Miller. *Robbins 6256, 1 August 1972 (Seymour).

S. nigrescens M. & G. *Narvaez 3927, 27 January 1970 (Seymour). Disturbed areas in cloud forest.

S. torvum Sw. A38. In disturbed area around vacation house.

Witheringia cf. meiantha (Donn.-Sm.) A. T. Hunziker. A58. At disturbed area above Finca Las Delicias.

W. solanacea L'Herit. A59. At vacation house.

W. sp. A56. At vacation house. Calyx lobes are distinct.

STERCULIACEAE

Melochia nodiflora Swartz. *Dudey & Moore 1953, 9 January 1969 (VT).

Sterculia apetala (Jacq.) Karst. AN76. In deciduous forest.

THEACEAE

Freziera friedrichstaliana (Szysz.) Kobuski. A166. *G. Wright s. n. (G, US), *Vern Grant 808 (AA). Elfin forest component. The long petiole (4-5 cm) is unique to the above species which is otherwise like F. macrophylla Tulasne with minute papillous appendages on the upper leaf surface near the costa. The hairs are fugaceous with age probably due to the windswept environment. This is the only locality from which F. friedrichstaliana is known.

TILIACEAE

Apeiba tibourou Aubl. AN215. Deciduous forest inhabitant.

Heliocarpus donnell-smithii Rose. C. F. Baker 2490 (MSC) reported by Lay (1949). This is distinguished from the following species

by the unlobed leaves rounded at the base which are not longer than 14 cm or wider than 10 cm. Lay reports that this is abundant at forest edges from 100 to 1,500 m.

H. nodiflorus Donn.-Sm. & Rose. *Oersted 14829 cited by Lay (1949). Lay reports that this species occurs from 1,000 to 2,500 m. Usually in secondary growth or disturbed areas. Probably observed overhanging crater rim.

Luehea sp. C. F. Baker 2311 (MSC). Probably in deciduous forest.

Triumfetta dumetorum Schlecht. *Dudey & Moore 1955, 9 January 1969 (Seymour). Cloud forest.

UMBELLIFERAE

Eryngium foetidum L. Robbins 6259, 1 August 1972 (Seymour). Common in disturbed areas of lower cloud forest.

Spananthe paniculata Jacq. Atwood 5474, 9 April 1971 (Seymour). Lower cloud forest in disturbed areas.

URTICACEAE

Fleurya aestuans (L.) Gaud. Dudey & Moore 1975, 9 January 1969 (Seymour). Common herb in coffee plantations.

Urera sp. Not collected but common in coffee plantations.

VERBENACEAE

Cornutia grandiflora (Schlecht. & Cham.) Schau. AN79. In deciduous forest areas at Finca Las Delicias.

Lantana glandulosissima Heyek. *Dudey & Moore 1958, 9 January 1969 (VT).

L. maxima Hayek. *Seymour 6104, 25 July 1972 (Seymour). Lower cloud forest.

L. trifolia f. hirsuta Moldenke. A355. Roadside in lower cloud forest.

Lippia controversa var. brevipedunculata Moldenke. A202. Collected on north side of Mombacho above Finca Asuncion.

Priva lappulacea (L.) Pers. Dudey & Moore 1983, 9 January 1969 (Seymour). Cloud forest weed.

VIOLACEAE

Hybanthus attenuatus (Humb. & Bonpl.) G. K. Schulze. An73. Common in upper deciduous forest and lower cloud forest. Weedy annual of coffee plantations.

VITACEAE

Vitis tiliifolia Humb. & Bonpl. Sterile specimens observed in lower cloud forest areas, south side of Mombacho.

ZINGIBERACEAE

Renealmia aromatica (Aubl.) Griseb. Atwood, Marshall & Neill 6711, 15 December 1973 (Seymour). Only one plant found in elfin forest.

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APPENDIX

CONSIDERATIONS OF MOMBACHO

AS A NATIONAL PARK

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CONSIDERATIONS OF MOMBACHO AS A NATIONAL PARK

Rapid destruction of natural forests in Central America is everywhere evident. Current agricultural practices include removal of forested areas to the extent that not even local woodlots are preserved to perpetuate the gene pool. Vast areas are being completely deforested by lumbering concessions. Behind the chainsaw closely follow the cattle rancher and subsistence farmer who remove the few remaining trees totalizing the destruction of the original virgin forest.

This man-against-nature attitude is manifested in Nicaragua and there is no end to the current trends in sight. I have personally observed the deforestation effected by American lumbering concessions in otherwise virgin areas of north-central Nicaragua. The Nicaraguan government requires that lumber companies reforest cut-over areas, but has thus far not been able to effectively implement this practice. The pressures of the expanding Nicaraguan population force people of little income to pioneer the deforested areas. These areas are then burned to support maize for a few years until the nutrient resources of the soil are depleted. The land is then used for cattle-raising.

Cerro Quiabu in the department of Esteli supports a cloud forest of but a few hectares and is stocked with cattle, but this remnant cloud forest may not still exist at the time of this writing. As one possible consequence of the deforestation of Quiabu, as well as nearly all the Esteli area, the local streams run dry during the dry season, and become raging torrents during the rainy season.

Between the years 1969 and 1975 the once extensive rainforests of the Zalaya Department along the Rama road have disappeared, and subsequent road building in that department has brought human activity to previously inaccessible areas. The total decimation of Zalaya's rainforests will probably occur not in decades but in a matter of a few years.

One way for the Nicaraguan government to preserve a significant portion of the plant diversity would be by setting aside several tracts of land as refugia for endangered species. Some interest has developed along these lines by a few government officials, but the situation is complicated by a host of economic and political concerns. As desirable as a system of natural areas might be, implementation of such a program must compete with a number of economic and social priorities. To date it has not been possible to set aside a single tract of land in Nicaragua as a wildlife preserve.

Despite the odds against conservation of Nicaragua's forests, there is hope that a park system will be established, perhaps along lines similar to that of Mexico. The first area which should be preserved is Volcan Mombacho. There are at least four reasons why this mountain should be made a national park. (1) It already contains significantly large tracts of virgin cloud and elfin forest, including

one of perhaps three relatively undisturbed cloud forests in western Nicaragua. The cloud forests of the Sierra de Managua are already essentially lost by unrestrained development. (2) The vegetation affords a means of screening passing fog of its partial moisture content, which contributes to the general water supply of local inhabitants. (3) Mombacho should be preserved as a research area located as it is in a critical section of Central America which has been a stepping stone for species passing north and south. (4) Mombacho as a national park could serve as a tourist attraction. The various orchids, bromeliads, ferns, and birds are extremely attractive to foreign tourists. Mombacho as a tourist attraction could serve as a means for educating visitors about a country of which they know little. Furthermore, for Nicaragua to establish Mombacho as the first of a series of national parks would set a good example in an ecologically conscious world. However, development necessary to encourage tourism could destroy the objectives of the first three points. Inclusion of tourist facilities in the park areas would have to be done with extreme care if the natural areas are to be protected from the indirect effects of increased human activity.

Although acquiring Mombacho is the first and most necessary step toward establishing a national park, the problems of maintaining the wildlife refuge would have only begun. Without sufficient guarding of the park boundaries, deforestation will continue. Fire control will be necessary during the dry season, and poaching will undoubtedly need to be prevented. This will necessitate the establishment of a park warden well-staffed with rangers within the park area. Access trails will need to be made for protection along the park boundaries. A

minimum of environmental disturbance would be required for park protection, but overzealous developers could seriously damage that which is supposed to be protected.