An Ecological Survey of the proposed Volcano Baru National Park, Republic of Panama

by

Anne LaBastille

Report

of an investigation carried out between 9 February and 9 March 1972

on behalf of

the International Union for Conservation of Nature and Natural Resources

and

The World Wildlife Fund

for the

Departamento de Servicio Forestal y de 'RENARE'
Ministerio de Agricultura y Ganaderia, Panama

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FOREWORD

Everyone in Panama and outside this country will readily agree, that by far the most prestigious area that qualifies for a national park, is situated around Volcan Baru in Chiriqui Province, where the highest mountain of Panama, 3473 m, is located.

Although national pride in having the highest peak of a country set aside and protected for the benefit of future generations, is by itself a very strong motivation, the area has many other unique assets. It is the home of several animals of great scientific, cultural and aesthetic value, including the rare quetzal bird. On its slopes grow some of the most fascinating cloud forests with giant oaks and other noteworthy trees; various plants can still be found in their original condition, Its role in regulating the watersheds that are the basis for prosperous agricultural developments in Chiriqui Province, is beyond any doubt.

Volcan Baru National Park, if decreed according to the project, would cover 14,322.5 hectares (about 35,400 acres) and would truly become a heritage to mankind. Properly managed, it could become a powerful instrument of development where scientific, cultural, educational, recreational and aesthetic objectives, once achieved, can in turn be converted to true economic development as well.

Dr. Anne LaBastille is a well-known ecologist, who has been associated with IUCN and WWF for many years. Her work was greatly facilitated through the assistance and cooperation of the Panamanian authorities and of FAO.

If Volcan Baru National Park comes officially into existence, and if properly used by thousands of Panamanians and others interested in admiring, studying and "feeling" this magnificent place, no doubt it will serve as an example to other developing countries. It will also stand as a magnificent monument to those (particularly the Panamanian authorities) who were able to foresee its importance at a critical moment of the country's history -- and before it was too late.

Gerardo Budowski
Director General, IUCN

c/o Dept. of Natural Resources
Fernow Hall
Cornell University
Itahca, N.Y. USA

8 de Junio de 1972

Ing. Nilson Espino
Ministro de Agricultura
Ministerio de Agricultura y Ganadería
Panama City
Panama

Excelentísimo Señor Ministro Espino,

Me complace en alto grado informarle que una copia de mi informe "Encuesta Ecológica para el Proyecto de un Parque Nacional en Volcán Barú, República de Panamá", ha sido enviada en el día de hoy al despacho del Ing. R. Gutierrez, Jefe del RENARE, y otra copia al Lic. Tovar, Jefe de Parques Nac. y Vida Silvestre.

Esta encuesta fué posible realizarse gracias a la coordinación de esfuerzos entre la Unión Internacional para la Conservación de la Naturaleza y los Recursos Naturales (UICN), el Fondo Mundial para la Vida Silvestre de los E.U. (World Wildlife Fund-USA), la F.A.O. y su propio Ministerio de Agricultura de Panamá, y se llevó a cabo del 9 de Febrero al 9 de Marzo del presente año. El fin de la encuesta ecológica ha sido la investigación de la flora y fauna del Volcán Barú, con énfasis particular en el ave Quetzal y la localización de áreas que sean de valor para estudios científicos y para el desarrollo turístico de Panamá.

Me permito hacer el comentario que el Volcán Barú es un área de belleza escénica espectacular, con buenas poblaciones establecidas de Quetzales en reproducción, que tiene una enorme importancia para la protección y conservación de las aguas de las vertientes de las Montañas Centrales, y con excelentes áreas de bosques primarios cuya protección es de gran valor para el futuro del país. Como un parque nacional deberá de constituir una posesión muy valiosa para Panamá, tanto económica como científicamente.

Muchas gracias por la oportunidad de trabajar en Panamá con su gobierno, y por la excelente cooperación que me brindó el personal de su oficina.

Queda a sus gratas órdenes,

Respetuosamente,

Anne LaBastille, Ph.D.
Wildlife Ecologist

AB:nb

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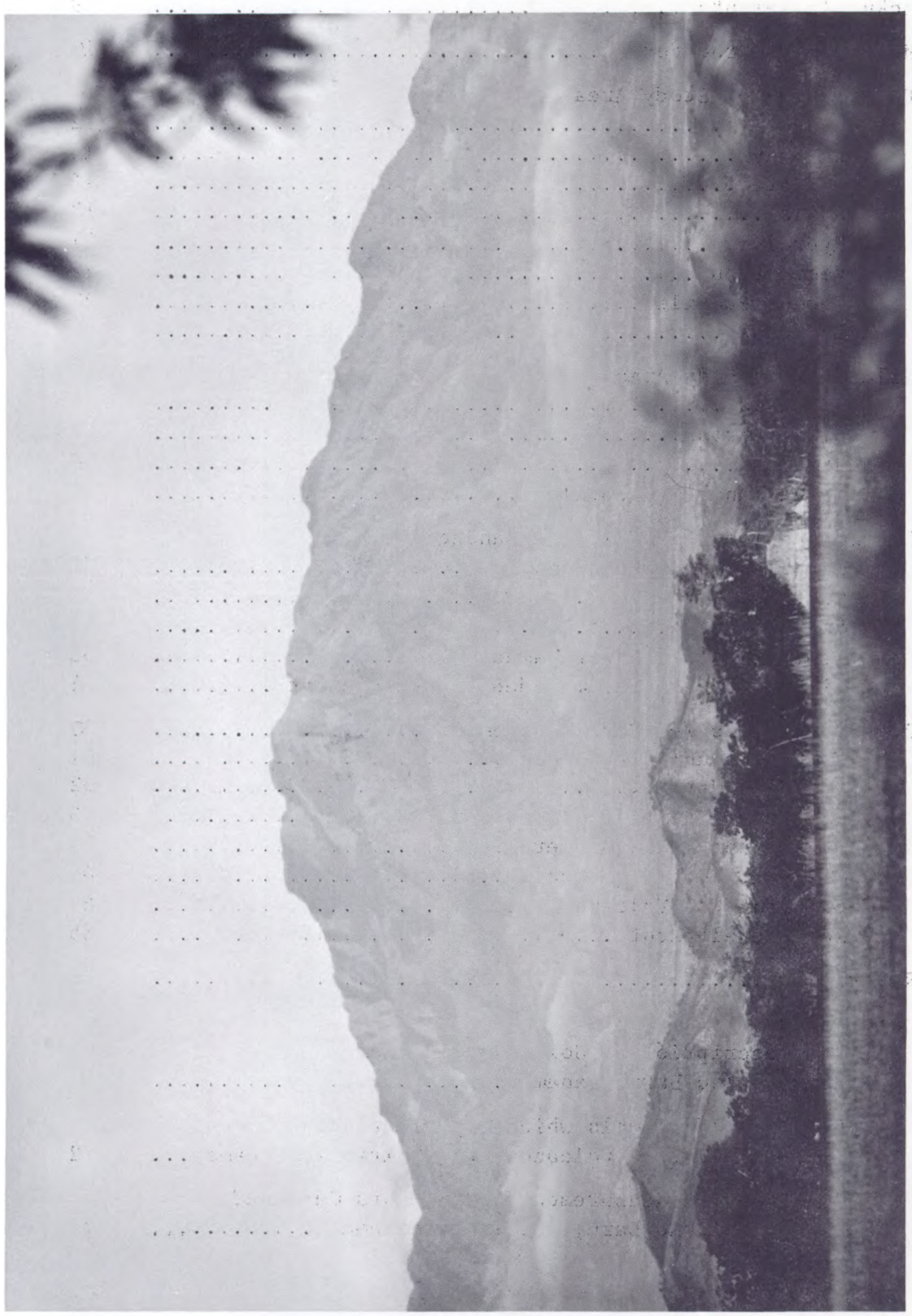


View of Volcano Baru from David, Chiriqui, Panama. Photo by: Clyde H. Smith

INTRODUCTION

This conservation project began during a visit of Dr. Gerardo Budowski, Director General of the International Union for Conservation of Nature and Natural Resources in Switzerland, to the former Minister of Agriculture in Panama, Ing. Carlos Landeau, December 1970. At the Minister's request, initial steps were taken by IUCN to arrange for an ecological survey of the proposed Volcano Baru National Park in western Panama. Following a cabinet change that took place early in 1971, a renewed expression of interest was given by the present Minister of Agriculture, Ing. Nilson Espino, in June 1971, and arrangements were continued.

The writer, a wildlife ecologist and Field Collaborator with the Laboratory of Ornithology, Cornell University, Ithaca, New York, agreed to undertake the survey during the dry season of 1972. Collaboration was arranged with the Forest Service and RENARE (Department of Natural Resources) of the Ministry of Agriculture and Animal Husbandry, and with FAO representatives in Panama. One month was spent on Volcano Baru by the writer, a photographer, Clyde H. Smith, and a small team from RENARE and the Forestry Service, February 9 - March 9, 1972.

The main purpose of the investigation was to appraise the wildlife resources of the region, with particular emphasis on the rare and lovely Quetzal, to survey vegetational, ecological and geological areas of interest for their future potential as tourist attractions, to procure the best possible photographic documentation of the area, and to offer suggestions and recommendations for the scientific management of wildlife and other natural resources within the Park boundaries.

These investigations and recommendations should compliment and amplify a survey already completed for the Panamanian Government, i.e. the long-term national plan for national parks, prepared by Richard Ogle and Harold Jones (1972) of the U.S. National Park Service in cooperation with FAO. Their report outlines four potential

national park sites, and suggests Volcano Baru be given priority.

The establishment of a National Park with the magnitude, majesty and variety of Volcano Baru is without doubt the wisest type of land use planning by the Government of the Republic of Panama. Not only will it ensure the preservation and perpetuation of remaining Panamanian primary montane forest and associated wildlife, but it will also provide critical watershed management and protection of fragile mountain soils. The aesthetic and recreational advantages to Panamanians and foreign visitors alike are obvious. So, too, are the economic benefits to be gained by careful use and enjoyment of this natural splendor. Volcano Baru as a national park can become a prime example to neighbouring countries of the many advantages and gains possible through the conservation of natural resources.

In the frantic search by our growing human population for dwindling natural resources, the establishment of this (and other) national parks in Panama is occurring at the last and best moment in time. Last because the years may soon arrive when no untouched natural area or animal remains to be preserved; and best because the years at hand are when human beings need to be calmed, inspired, strengthened and educated by the natural world as never before.

ACKNOWLEDGEMENTS

This ecological survey was made possible by a generous grant from the World Wildlife Fund, US National Appeal and the support of the International Union for Conservation of Nature and Natural Resources (IUCN), and the World Wildlife Fund (WWF), in Switzerland, under joint project No. 42-1.

The writer especially wishes to compliment Dr. Gerardo Budowski, Director General of IUCN, for his statesmanship and support of the Volcano Baru National Park project with the Minister of Agriculture

and Ranching and with FAO representatives in Panama.

Field work in Panama was logistically very well arranged by the Department of Forest Service and Natural Resources (RENARE) under the direction of Ing. Ricardo Gutierrez, and the Division of National Parks and Wildlife under direction of Lic. Dario Tovar. The writer wishes to express sincere appreciation as well to Mr. John Howell, FAO Project Manager of the Forestry Inventory and Demonstrations Project in Panama, for his support and advice.

Many Panamaian officials and government employees were of great assistance to the field team, including Ing. Victoriano Rios, Director of the Forest Service in David, Chiriqui; Alberto Aquilino Sanjur, District Forester in David; Javier Ortega M., forestry technician; and Benjamin Cuevas Montezuma, our superb Guaymi Indian guide.

Other Panamanian people who befriended and assisted us were Sr. Conde Tomás of Concepción and owner of Finca Aguacate; Father Bill Baldwin, overseer of the Florida Audubon Society's cabin at Bambito near Cerro Punta; Mr. Collins, owner of Finca Lerida near Boquete; and Dr. E. Tyson, professor, Florida State University's Center for Tropical Studies at Albrook Air Force Base, Canal Zone.

Mr. Clyde H. Smith was the official photographer for the field survey, and proved to be a fine woodsman and companion. The writer wishes to express her gratitude for his assistance in making the survey more efficient and pleasant.

Appreciation is also expressed to the Cooperative Wildlife Research Unit and to the Laboratory of Ornithology at Cornell University for their assistance with field equipment and to the Wildlife Unit and Department of Natural Resources for providing office space during preparation of this report.

And last of all, thanks are extended to Mrs. Carol Fairbanks and Mrs. Nancy Bowers for their typing services.

METHODS AND PROCEDURES

An ecological survey of the proposed Volcano Baru National Park in the Chiriqui highlands of Panama was made between February 9 to March 9, 1972, during dry season. In general, field reconnaissance was carried out well above the 5600 foot (1700 meter) contour line because most of the proposed National Park will be at higher elevations and because little, if any, natural forest with its associated wildlife now exists at lower elevations. Three weeks, February 12 to March 4, were spent in the field; the remainder of the time, in the city of Panama with government officials and arranging equipment.

Field work was divided into three major parts. The first phase consisted of a week of reconnaissance in the Boquete area (Finca Lerida, Quebrado and Rio Bajo Chiquero, Finca La Oasis, government cabin), the Cerro Punta area (Forestry Station, Quebrado Bajo Grande, Bambito), and El Hato del Volcán area (Finca Aguacate, "llanos" del Volcán, Cerro Aguacate). The second phase was devoted to a more intensive and detailed investiagion of a typical area of Lower Montane Wet Forest (cloud forest) with breeding populations of Quetzals, at an elevation of 7000 feet (2100 m.). This stage occupied 10 days, but was disrupted for three days by a severe wind storm with gusts to 70 mph. The third phase consisted of the volcano's ascent, collection of vegetation and observations of wildlife and geological formations at the summit, and descent, which took six days total.

Phases two and three utilized the following techniques. Early morning and late afternoon observations were made of bird-life, especially Quetzals (see section on Wildlife). Small mammal populations were sampled with trap lines and mist nets. A forest profile (150 x 30 feet) was made during Phase two, and a pressed collection of 72 plant species and eight soil samples were made during Phase three.

Plant specimens and soil samples taken in field work were left with the RENARE office, Ministry of Agriculture and Ranching, in Panama, for identification and analysis. Microclimate measurements, using maximum-minimum thermometer, sling psychrometer and rain gauge, were made and are presented under the section on Forest Profile.

Elevations were taken with an Airguide altimeter (100 foot graduations) which were read at critical points during ascents and descents of the volcano and on setting up new campsites. It is considered that these altimeter readings were accurate to within a $\pm$ 400-foot range.

The principal map used in field reconnaissance work was the topographic map of Panama (1:50,000), sheets 3642 I, Cerro Punta; 3742 IV, Rio Changuinola; 3742 III, Boquete; and 3642 II, El Hato del Volcán (Dirección de Cartografia, 1964).

As far as could be determined, the field team's stay for five continuous days near Volcano Baru's summit is the longest period of time ever spent there by any scientific group. The problem of back-packing sufficient water, food, camp and field equipment up the steep trails was critical and will be of major importance in organizing any future long-term scientific investigation at the summit. It is strongly recommended that field teams climb the Volcano from the Boquete side, driving up to the Government cabin. This trail has the advantage of being less steep than the Volcán trail, and begins at a higher elevation.

Transportation throughout the survey was generously provided by the Ministry of Agriculture's Department of Natural Resources and Forest Service. A guaymi Indian guide was hired for the period of field work, and his services proved most valuable. Six attempts were made to make an aerial reconnaissance flight over the Volcano Baru region in order to obtain photographs and a more accurate image of ecological zones and geology. Unfortunately, due to mechanical, weather and other difficulties, they were unsuccessful.

A photographic documentation was made by a professional photographer throughout the 30-day survey, culminating in over 1400 35 mm colour transparencies. These include exposures of the Forestry Station, Quetzals, native vegetation, scenery, geological formations, field procedures, waterfalls, and government personnel. A number of "tourist" shots were taken for possible future use by the government and the author for brochures or popular articles about the proposed national park. Of these 1400 photos, an assortment of 175 slides has been selected and duplicated for each of the organizations involved with the project.

In conjunction with the writer's preparation of this report, a review of literature was made at Cornell University libraries. This work included a 35 1/2-year review of Biological Abstracts for ecological and natural history references.

DESCRIPTION OF STUDY AREA

Topography

Volcano Baru is situated in the Talamanca Range of western Panama 15 miles from the Costa Rican border. This range continues as the Cordillera de Talamanca northwest into Costa Rica. It has eight peaks above 10,000 feet on the continental divide plus four near the crest line. Volcano Baru is actually somewhat offset, being situated eight miles south of the continental divide with its southern slopes falling away to the Pacific coast and ocean.

The general area covered by the volcano massif stretches south and east towards the Pacific coastal plain, west beyond El Hato del Volcán and the plains ("llanos") of Volcán, and north to the valley of the Rio Chiriqui Veijo, Cerro Punta, and the continental divide. Northwards the range is largely unpopulated, broken, rugged and

heavily forested, providing the only good access route for wildlife to the Caribbean coast. Panama City and the Canal are located about 275 miles (455 km) from the mountain itself.

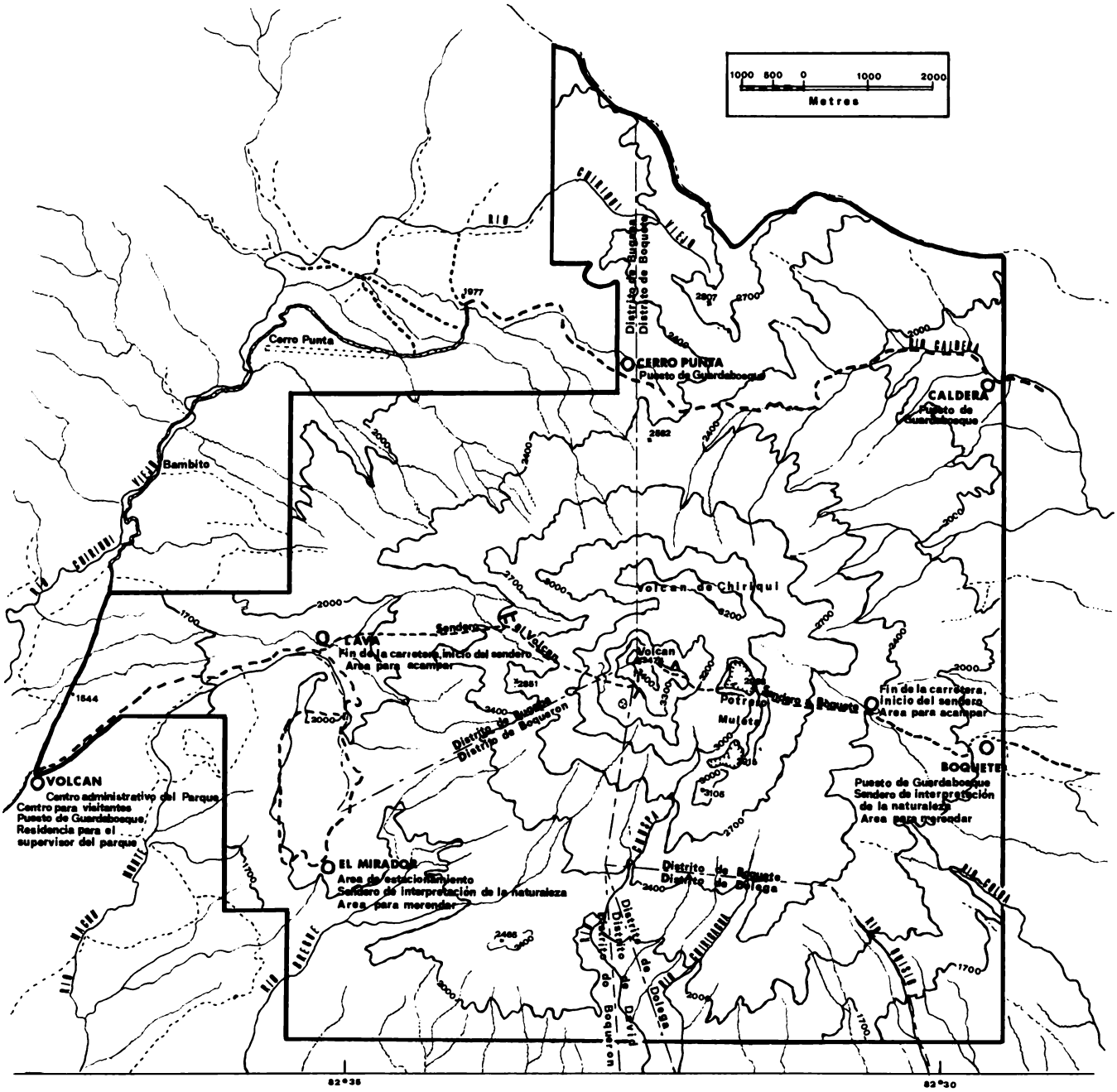
Two main paved roads provide access to Volcano Baru. One runs from David, Panama's second largest city, on the Pan American Highway to Boquete (25 miles, 40 km); the other from Concepción, also on the main Highway, to El Hato del Volcán, approximately the same distance. Thus, there are two towns which may be considered "jumping-off" sites for the main massif and the trail which crosses the Volcano. No roads exist between Boquete and Cerro Punta, a town seven miles (11 km) northeast of Volcán, but a foot trail does cross this uninhabited and broken section of the volcano.

Various altitudes have been given to Volcano Baru, also called Volcan de Chiriqui, the highest point in Panama. These range from 11,100 to 11,900 but the most accurate measurement appears on the 1964 topographic map of Chiriqui Province -- 11,410 feet (3474 m). From the summit, views can be had of the Atlantic (Caribbean Sea) and the Pacific Oceans on clear mornings.

The area delineated for the proposed Volcano Baru National Park (Fig. 1) will cover 14,322.5 hectares (about 35,800 acres). Of this, 5,122.5 hectares (about 12,700 acres) are presently national lands. Of the remaining private lands, much is not legally claimed at present by titles. Part of the continental divide is included in the north-eastern corner.

Maps

The best maps covering the Volcano Baru area, presently known to the author and available to the public, are the topographic series (1:50,000) produced by the U.S. Army Map Service, Washington, D.C., and available from Dirección de Cartografía in Panama. Aerial photography has covered about 85% of Panama, at



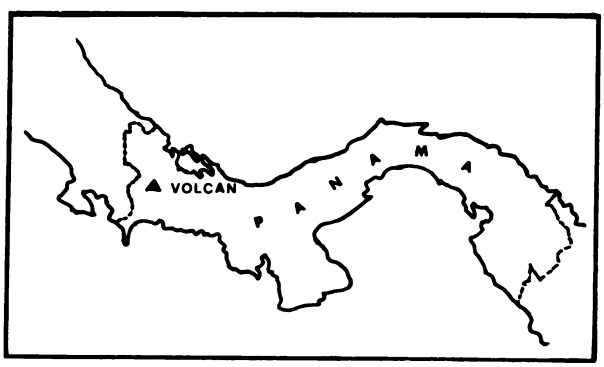


FIGURE I - PROPOSED BOUNDARIES AND PLAN OF DEVELOPMENT FOR VOLCAN BARU NATIONAL PARK

scales of 1:60,000, 1:30,000 and (partially) 1:20,000, but is difficult to procure. Soils, land capability and geological maps do not exist as yet for the Province of Chiriqui; however, the Depto. de Forestal y de Suelos in Panama is working on this aspect of mapping, (Pan American Union, 1965). Ecological maps, other than the Holdridge system (1:1 million) (Holdridge, 1947) are sadly lacking for Panama; however, now that the national resource and cadastral mapping programme is underway (for example, the ERS satellite), current and past land-use maps and non-forest ecological maps undoubtedly will be produced. The reader is referred to the Annotated Index of Aerial Photographic coverage and mapping of Topography and Natural Resources for Panama, produced by the Pan American Union, 1965.

Geology

Volcano Baru, the highest point in Panama, is part of the long Talamanca Range of pre-Tertiary granite and metamorphic rocks. Baru, however, is a Pleistocene volcano whose activity in historic times is questionable. Currently, there are no active volcanoes in Panama.

The main massif of this volcano is ellipsoidal in shape, being nine miles (14 km) long on its main east-west axis and seven miles (11 km) wide on the north-south axis. The overall dimensions of the main Talamanca range at this point, of which it is a part, are 20 miles (33 km) east-west and 30 miles (50 km) north-south.

According to Terry (1956), heavy flows of andesite and less heavy flows of clastic materials compose the cone. The base of this lava cone is not visible but it emerges from the clastics on the mountain's east and west margins at roughly 3000 to 4000 feet (1000 to 1220 m) elevations, and is probably composed of sedimentary rocks of mid-Miocene age. Several craters are found atop Baru, at

about 11,000 feet, south-west and somewhat below the main summit. These are grouped together with their major opening looking out to the south-west and the town of Volcán (Fig. 2).

Through this breach poured the lava flows which formed the plains, or "llanos" of Volcán, an arid, grassy area.

Near the peak on the south-eastern side, at Potrero Muleta, 9,770 feet (2,960 m.) are three more deep depressions which Terry (1956) also describes as craters. These have deep andesite walls, flat floors of pumice (covered with baked mud and grass or shallow water as the season dictates) and narrow notches in the walls. Terry puts these craters at a later date than the other group. He reports a tepid sulphur spring in a larger one. Our guide, Benjamin Cuevas M. told, however, of leading a party of geologists who refuted the idea that these flat-floored depressions are craters. He knows of no sulphur spring in the area, and our group did not see one.

The town of Cerro Punta lies on the site of an old volcanic crater lake with one volcanic plug nearby.

In general, the area of western Panama is subject to great geologic stresses due to transisthmian and offshore faults wedging and squeezing the narrow sigmoid isthmus. Seismic activity, therefore, is strong. A heavy shock was suffered on July 21, 1934, which caused millions of dollars of loss. (The field team experienced four or five minor earth tremors during their stay on the volcano.) As past evidence of great volcanic forces, the ejecta of Volcano Baru are reported to cover 700 square miles in Panama.

Climate

Panama lies entirely within the Northern Tropics; however much of the Talamanca Range of which Volcano Baru is a part is decidedly sub-tropical and temperate in climate. Under the Köppen (1931)

macroclimate classification, the area is Ew = evergreen and semi-evergreen seasonal forests, and C_f = montane and lower montane rain forest.

The yearly climate is roughly divided into a dry season (late December - late April), and a rainy season (late April - late December). During the dry season, the north-east trades blow over the Caribbean coastlands and the Talamanca Range, bringing dry, clear, warm days to the Pacific area. These winds produce two phenomena at certain times. One is the "bajareque", or misty sprinkle (Fig. 3), which drifts down from seemingly cloudless skies, but is in fact pushed over the continental divide from clouds banked up by the strong winds. On Volcano Baru's northern, western, and eastern lower ridges, one can see these clouds curling over the crests. The other phenomenon which has potential hazards for campers and climbers is the strong wind storms which blow periodically during the dry season. Gusts to 65 knots were recorded at the David airport on February 18-19, 1972. At elevation 7000 feet, Finca Aguacate, the author estimated winds at 65-70 mph and close to 100 mph at the summit of Baru.

In general, according to Beard (1955), temperature and humidity increase up to 8250 feet, 2500 m, in tropical America, then decrease, with a critical temperature line at 10,000+ feet, 3000+ m. On Volcano Baru, frost was recorded a number of times at night both at 7000 feet and at the summit in late February (Table 3). Even at 7000 feet, water in a 1-inch plastic pipe was congealed too hard to flow in early morning! Daytime temperature highs ranged in the 70's Fahrenheit (21-26° C.) at 7000 feet and upper 60's F. (18-21° C.) near the summit. 45° F. (7.5° C.) is probably the average mean temperature above 11,000 feet. Ogle and Jones (1972) report a mean annual temperature of 59.5° F. (15.3° C.) with a range of 1.8°C. at Cerro Punta over a 5-year period, elevation 6500± feet (1975 m). Humidity at these elevations was low, probably averaging about 50% during the daytime.

During the rainy season, there are frequent heavy rains, thunderstorms and high humidity, with probably a smaller variation in temperature range. The heaviest annual precipitation occurs in the lower part of the Lower Montane belt and probably approaches 4000 mm per year.

Since Volcano Baru lies slightly south of the main Talamanca Range -- eight miles from the continental divide -- it does not receive the same full impact of oreographic precipitation that the Caribbean slopes do. However, the northern slopes of Baru appear to be much moister, because of a slight overlapping of rainfall, than the south, southeast, and southwest slopes, which probably lie in a slight rain-shadow.

Soils

The soils around Volcano Baru are almost, if not entirely, volcanic in origin. In the lower lands, Boquete and Cerro Punta particularly, soils are highly fertile and will support a number of crops (see Land Use section). At higher elevations, due to edaphic and climatic factors, soils are less fertile and are best left in natural forest cover. Around Volcán, despite lower elevation, soils are less fertile because the lava is more recent and less weathered. The fairly flat stretch from Volcán towards the Volcano's foot-hills (known as the "llanos") was formed from laval discharge of the craters. It averages half a mile or more wide, is grown to grass, low bushes and Agave, and is composed largely of pumice. This area is used for pasture-land. Eight samples of soil were taken from various locations between 7000 and 11,300 feet and given to the Ministry of Agriculture for analysis (see Appendix A).

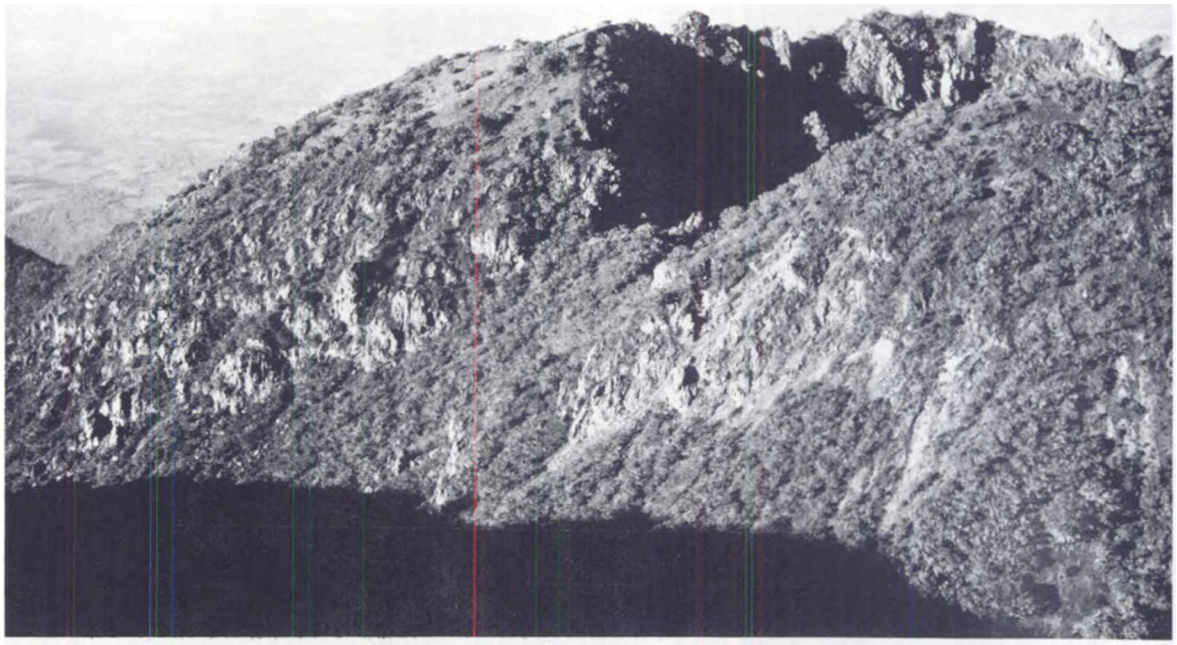


Figure 2 - View of crater complex near summit of Volcano Baru
Photo by: Clyde H. Smith

Figure 3 - "Bajareque", or misty sprinkle, blowing over the northern ridges of Volcano Baru
Photo by: Clyde H. Smith

Figure 4 - Steep slope near Cerro Punta recently denuded of forest cover
Photo by: Clyde H. Smith

Hydrology

Above 6000-7000 feet (1820-2120 m), at least during the dry season, Volcano Baru is almost lacking in standing or running water. Many perennial streams appear to originate below these elevations directly from the Pacific slopes as springs or waterfalls, for example, the Rio Bregue and Rio Bajo Chiquero. Seasonal streams probably flow at higher elevations during the rainy season.

Many of the larger rivers of Panama head up on the Volcano, but all flow out on the Pacific side. They include the Rio Chiriqui Viejo, Macho del Monte, Chirigagua, Caldera, David and Majagua.

Two small perennial ponds occur west of El Hato del Volcán in undrained volcanic depressions, but are not within the Park boundary nor considered in this survey. In Terry's (1956) geological reconnaissance of Panama, he reports a tepid sulphur spring on one of the large craters to the east near Volcano Baru's peak. However, none of the true craters nor the flat depressions at Potrero Muleta held water when examined by the field team. It is considered that any pool found at higher elevations only results from standing rain water or from seepage of underground water. In the dry season, camping out at higher elevations presents a major problem in obtaining sufficient drinking water. Some dew and water from mosses can be collected.

A considerable quantity of water does reach the upper forests and ground in form of fog and cloud condensation. This is evident from the epiphytic vegetation living upon the tree branches and from the mosses, orchids and ferns below. As explained by Holdridge (1961), water from condensation in cloud forests of the Talamanca Range in Panama makes a really significant difference in total rainfall and in run-off. This, in turn, becomes very important in regulation of stream flow, erosion, irrigation projects and potential hydroelectric developments at lower elevations. Working along the

continental divide at 6400 feet (1950 m) beyond Boquete, Holdridge (1961) found that in the absence of natural forest, i.e., removing cloud condensation surfaces and hence the condensation and constant moisture to the ground, there is probably a reduction of 500 mm of run-off per year, mostly during the dry season of the Pacific coast. It is evident that destruction of this delicate water regime through lumbering or burning cloud forest for farm or pasture lands, can lead to decreased stream flow in the dry season, more rapid run-off in the rainy season, excessive leaching of the soil, and damaging erosion over time.

That removal of rain forest on the volcano slopes has already resulted in serious damage to human enterprises at lower elevations, may be surmised from the bad flood of the Rio Caldera, near Boquete in November 1969. This flood, according to Howell and Tovar (personal communication), washed out homes, crop lands, bridges, trees and widened the river channel by several hundred feet in places. Even upstream along Rio Bajo Chiquero, one of Rio Caldera's small tributaries, flood debris and erosion was clearly evident to the field team on February 13, 1972.

Loftin (1967) states that temperatures of Rio Chiriqui Viejo in the Cerra Punta area have increased five degrees in the last thirty years, that the water has silted to the point where rainbow trout have disappeared downstream, and that the river now floods over its banks during the rainy season.

Ogle and Ray (1972) state that agriculture in the Volcano Baru region has destroyed 90% of the original native forest which helped to regulate the hydrological balance of the Rios Macho del Monte, Chiriqui Viejo, and Caldera (see Fig. 4).

Vegetation

Western Panama, because of extensive range in elevations, is an area of rich ecological diversity. A number of scientists have

ascribed names to some or all of the various vegetational groupings on a climatic, edaphic, phyto-physiological and/or other basis. Among these classifications are those of Beard (1955), Bennett (1968), Budowski (1965), Carr (1950), Holdridge and Budowski (1956), Holdridge (1947 and 1964), Martin (1955), Myers (1969) and Tosi (1964). For the purposes of classifying and describing the general dominant vegetational groupings within the proposed Volcano Baru national park, the author follows Budowski (1965) and Beard (1955). Species names are taken in part from Holdridge (1961), Holdridge and Budowski (1956) and Sr. Aquilino Sanjur (personal communication). The author agrees with Myers' (1969, p.9) fitting description of cloud forest as found on Volcano Baru: "habitats .... that are floristically and physiognomically diverse but which have in common cool temperatures and extremely high humidity imposed by enveloping clouds."

A number of experts exist in the Panamanian Forest Service and at Costa Rica's Tropical Science Center who are well qualified to identify the various species of plants on Volcan Baru. It is hoped that they will have opportunity to examine the collection of specimens made during the field survey and to make future field trips to the area. Meanwhile, a few botanical references are included in the list of references (Bailey, 1943; Woodson and Schery, several volumes; Standley and Steyermark, 1940).

For the purposes of this report, only vegetational zones above 5600 feet (1700 m) are described inasmuch as most of the proposed National Park lies above this altitude. For descriptions of general vegetational groupings and plant transects below 5600 feet (between David and Boquete, and Concepción and Volcán) the reader is referred to Bennett (1968), Edwards (1971), Holdridge and Budowski (1956) and Holdridge (1961).

The author noted a small area of what may best be called Subtropical Dry Forest at the start of the western volcano trail. This zone lies between 6000-6200 feet (1820-1880 m) above the "llanos"

or grassy plains of Volcán and below the montane wet forest of the slopes. It probably lies in a miniature rain shadow from the sharp ridges between Cerro Punta and the main volcano massif. Agave was present along with several thorny plants, abundant rocks, and low scrubby trees. The Lower Montane Wet Forest formation begins at approximately 5600 feet, (1700 m) on the eastern (Boquete) side of Volcano Baru and between 6000 to 6400 feet (1800 to 1950 m) on the western (Cerro Punta and Volcán) side. The Lower Montane Wet Forest was found to extend upwards to almost 9800 feet (3000 m) on the east side, 8600 feet (2600 m) on the west side.

Some of the major plant species of the Lower Montane Wet Forest (not listed in botanical order) are:

Catatola costaricensis
Magnolia sororum
Heliocarpus sp.
Sapium - 2 spp.
Clethra lanata
Erythrina sp.
Ilex sp.
Solanum sp.
Lippia sp.
Persea schiedeana
P. americana
Quercus copeyensis
Cornus diseiflora
Fuchsia arborea
Weinmannia pinnata
Cedrela tonduzii
Styrax sp.
F. Lauraceae - several species
F. Rubiaceae, F. Moraceae

Large trees of F. Lauraceae with maximum dbh's of 36 inches were plentiful on both sides; however, oaks on the east slopes below Potrero Muleta had many dead branches from insect attacks and/or forest fires. On the eastern slopes of this vegetational zone, branches and trunks of trees were lightly covered with a type of Usnea lichen three to six inches long, dentate lichens and some epiphytes. Several temperate zone flowering plants were noted in the understory -- "black-eyed susan", "daisies" (F. Compositae), purple lupins (Lupinus), a type of red "fireweed" -- plus many ferns, such as maidenhair (Adiantum), bracken (Pteridium) and polypody

(Polypodium). On the east side, bamboo was very low and sparse in the undergrowth until about 10,000 feet (3030 m), where a narrow brake of thick, 20-foot, bamboo was found near the water-hole above Potrero Muleta.

The western slope (along the main trail) differed in that fairly lush bamboo growth began at 7500 feet (2270 m) and extended downwards in a belt about 500 feet wide. Small trees of the genus Alnus, strap-like ferns, a gorgeous orange-flowering, parasitic vine growing in the tree tops, and short yellow-knobbed ground saprophytes were quite noticeable. Less Usnea and epiphytes were seen, and the forest had a somewhat drier aspect than that of the eastern side.

The Lower Montane Wet Forest extends to about 8600 feet (2600 m) on the western slopes at which point it becomes Montane Wet Forest. Trees become dwarfed and very limited in density and species numbers up to 11,000^{+} feet (3636 m). This appears caused in part by edaphic factors -- the very steep slopes, thinness and stoniness of soils and leaching of moisture in the permeable volcanic substrate. A very few dwarfed trees covered with moss can be seen almost to the summit, 11,410 feet (3474 m).

The Lower Montane Wet Forest extends to about 9800 feet (3000 m) on the eastern side of Volcano Baru. The Montane Wet Forest belt above this point becomes an elfin woodland of twisted gnarled, short (10-15 feet) trees, heavily laden with Usnea. This extends to about 10,400 feet (3150 m), where vegetation changes to a somewhat taller, more dense woodland, with Quercus and Arcto cephalus probably the dominant species. Trees here are laden with epiphytes, ferns, mosses, Lycopodium and lichens. Low bamboo or cane grass is present in the understory plus many of the temperate flowering plants mentioned above. This woodland appears confined to just below and along the ridges of the eastern slope at about 10,800 feet (3300 m). In a small canyon a heavy growth of 2-foot

cane-grass or bamboo, plus stunted and flattened bushes 12 feet high, probably Escallonia sp., was noted.

The major species in the Montane Wet Forest belt were most probably the silvery-leafed Butalea sp. of F. Loganaceae, Arctostaphylos of F. Ericaceae and Quercus sp. of F. Lauraceae.

It is believed that a Lower Montane Rain Forest belt may occur on the northern slope of Baru where orographic precipitation is greater.

Subalpine plants are common around the peak of Volcano Baru, but this area is not considered true Subalpine Moist Paramo zone such as is found in Costa Rica, Mexico and the Andes (Budowski 1965). Dwarfed and isolated trees and tree clumps grow almost to the summit. Because of the condensation which forms on their branches and leaves and drips to the ground, a mat of mosses, lichens, orchids, etc. is usually present below and in the same shape and circumference as the tree crown.

Of further interest are the unusual microenvironments for subalpine and small Montane Wet Forest plants found within the shelter of larger bushes and clumps of trees near the summit. By pushing aside the outer branches, a tiny damp environment with grasses, ferns, orchids and mosses was often discovered. Larger microenvironments supporting a greater variety and size of plants were located within narrow belts of trees along shallow gullies or at the bottom of little valleys. One such "microwoodland" from 11,000 feet is diagramed in cross-section in Fig. 5. In one small valley, 500 feet below the summit near the eastern crater lip, a bed of sphagnum moss was discovered which measured 18 inches (45 cm) thick and which, when squeezed, gave up several drops of water.

Two localized areas of interest vegetationally are the true craters of Volcano Baru, and the deep holes among lava rocks piled on the northern outer lip of craters. The former area, although strewn chiefly with dark gray lava rubble, does support a limited amount

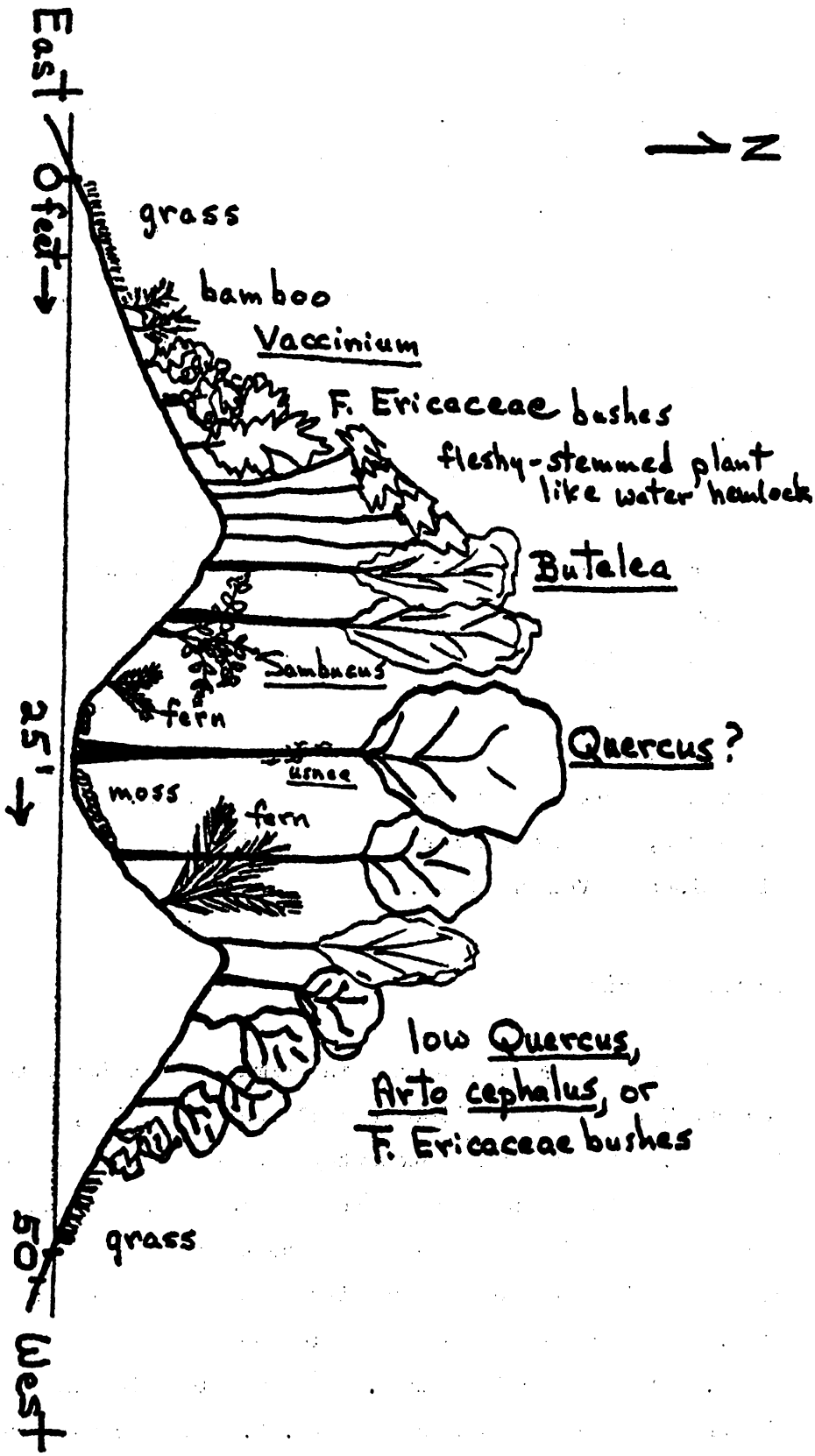


Figure 5 : Cross-section of Montane Thicket growing in shallow gully surrounded by open subalpine plants, at 11,000 feet, 3,333 meters, Volcano Baru, Panama. (Overall dimensions = 100 feet, 33 m. long x 40 feet, 13 m. wide)

of plant life. Most specimens seem to be smaller versions of species found outside and near the summit. Perhaps edaphic factors account for the size differences. Inside the rock holes (10 feet down to 30+ feet, 3-10 m depths), were found four species of plants growing in very dim light. One was a 12-to-20 inch plant whose bright green leaves and stems were covered with very fine long whitish hairs, Another specimen covered with hairs consisted of a leafy clump shaped like a violet plant 6 inches tall. Two other specimens were sphagnum-like and fern-like mosses which covered the rocks of the hole.

It will be clear from the above that considerable differences in the elevation of vegetational zones, especially of Lower Montane Wet Forest, exist on Volcano Baru. This adjustment of zonation is known as the "massenerhebung" effect, and has been described on other mountains in Panama by Myers (1969).

Seventy-two species of plants -- Subalpine and Montane Wet Forest -- were collected, pressed and left with the Department of Natural Resources in Panama for identification. To the author's knowledge, this is the first plant collection made from the higher elevations of Volcano Baru.

Forest Profile

A forest profile was made in primary, or climax, Lower Montane Wet Forest, at 7100 to 7250 feet elevation, near Finca Aguacate. The area was noteworthy for its good population of breeding Quetzals and because it appeared to the writer to be an excellent site for possible development as a Quetzal sanctuary or natural history tourist facility under the proposed national park plan. The section of forest sampled measured 150 x 30 feet (50 x 10 m). Slope direction was N. 40°E and slope incline about 45%. The profile diagram is found in Fig. 6. Stand consistency and averages are presented in Table 1.

Figure 6 : Profile of lower montane wet forest at 7,200 feet, 2180 m. elevation above Finca Aguacate, Volcano Baru, Panama.

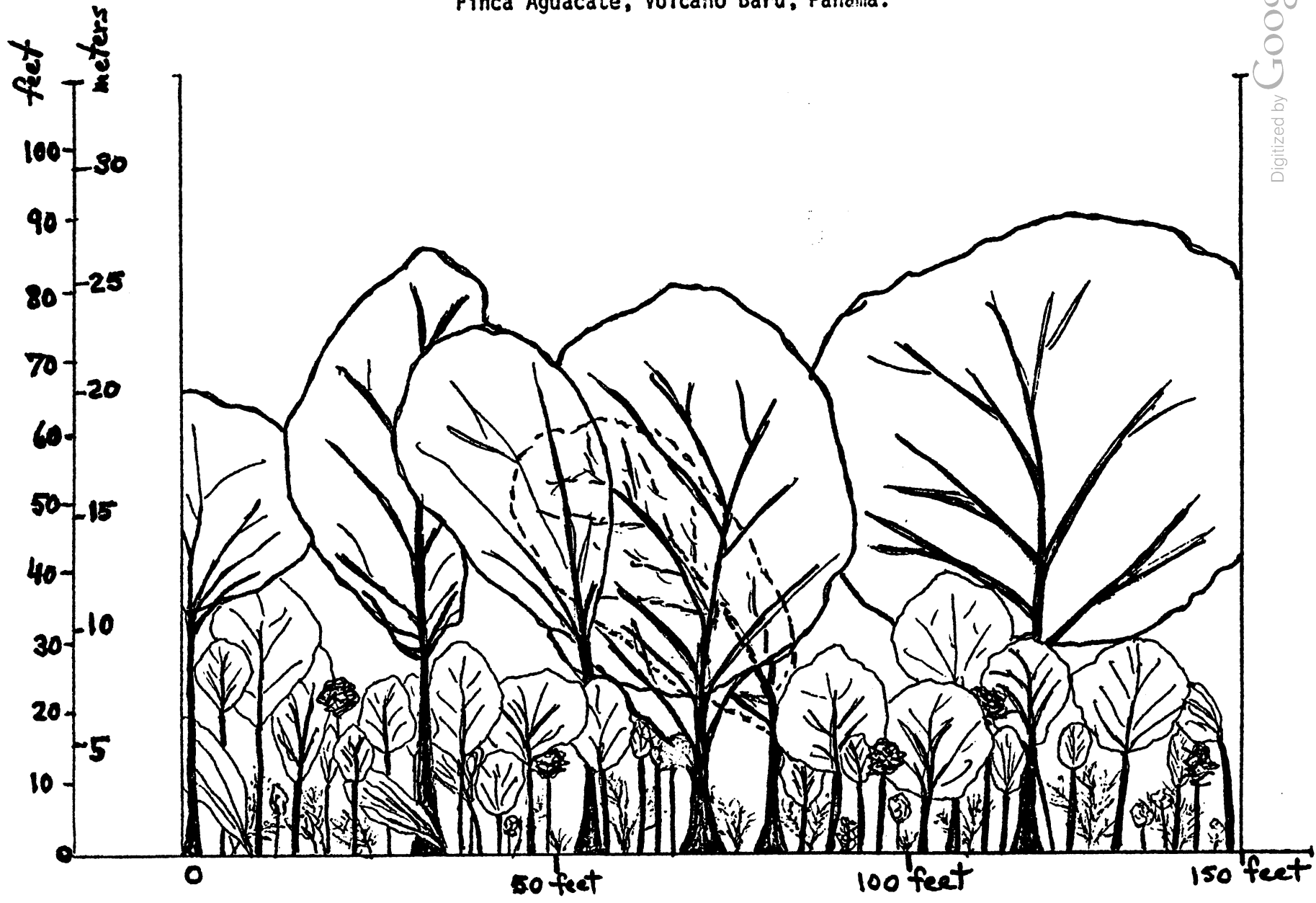


TABLE 1: Forest Profile:

Stand Consistency and Averages

Species	Total Number of Trees (in forest profile under 15')	Average dbh (in inches)	Average Height (in feet)	Relative Density %
"palo colorado"	12	5.8"	26'	29.3%
Quercus	6	28.6"	76'	14.6%
"sierrito"	5	4.7"	21'	12.2%
Cecropia	4	3.4"	18'	9.7%
"guabo"	3	7.8"	33'	7.3%
"canillo"	2	3.7"	24'	4.9%
"uvita"	2	3.0"	16'	4.9%
unknown species	7	-	-	-
	41			

TABLE 2. Forest Profile Data, Finca Aguacate, Volcan Baru, Panama

Species (or common name)	dbh (in inches)	Height (in feet)	Commercial Height (to first branches in feet)	Crown Radius (in feet)	Major Characteristics
			Trees between 7100-7150 feet		
Quercus, "roble"	24	65	35	15-25	
"guabo"	5	30	20	5	
"palo colorado"	9	25	0	15	crown bent out in one direction
"palo colorado"	10.5	35	10	8	crown bent out in one direction
"palo colorado"	6.5	35	12	10	
"palo colorado"	3.5	25	20	5	very thin tree
"palo colorado"	3.5	18	10	6	bushy top
?	4.0	18	12	6	
?	6.0	25	15	6	
?	10.0	25	15	5	broken top but main branch taken lead
Quercus, "roble"	26.0	95	30	20	branches bent almost horizontal
?	5.0	12	1	0	
"canillo"	3.5	30	14	8	small green fruits, leaves parallel veined, large, opposite, petioles at right angles to main stem
"palo colorado"	3.7	20	10	8	crown only in one direction
?	1.0	15	5	4	
"sierrito"	7.0	25	15	15	tiny leaves, smooth dark reddish bark, few single small green fruits at ends of branches
			Trees between 7150-7200 feet		
Cecropia, "pava"	1.5	15	12	3	
Quercus, "roble"	19.0	75	18	30	crown bent out in one direction
Quercus, "roble"	41.0	80	12	50	crown mostly one big branch; buttressed roots to 3' high on lower slope side
"sierrito"	5.5	25	12	10	

Table 2 (cont'd.)

Species (or common name)	dbh (in inches)	Height (in feet)	Commercial Height (to first branches in feet)	Crown Radius (in feet)	Major Characteristics
Quercus, "roble"	19.0	60	18	25	crown only one direction
"sierrito"	3.0	18	9	5	
?	3.0	18	8	4	
"canillo"	4.0	18	0	3	thick green leaves, pink inner bark
"uvita"	3.0	16	0	6	
"palo colorado"	7.5	30	12	6	
?	4.5	18	10	8	leaves slightly notched, alternate
?	5.5	25	6	10	leaves very lustrous, new leaves lighter color, inner bark maroon red, several leaves infected
			Trees between 7200-7250 feet		
Cecropia, "pava"	5.75	22	8	7	
"palo colorado"	5.5	20	6	4	
"uvita"	3.0	16	12	5	
?	4.7	25	12	6	several leaves infected
"guabo"	10.0	40	0	15	
"sierrito"	3.5	18	12	5	
"palo colorado"	5.0	30	15	6	
Quercus, "roble"	42.0	90	25	35	some buttressing to 3', lower slope side
Cecropia, "pava"	3.3	19	12	3	
"guabo"	8.3	30	15	10	
"palo colorado"	4.0	18	10	6	
Cecropia, "pava"	3.0	15	10	2	
?	4.0	18	0	6	crown only in one direction, nine branches from ground level.

It is a three-storied forest with the canopy (story A) largely closed between 35 to 80 feet (10 to 25 m). Dominant species are Quercus sp. and "palo colorado". The B story reaches to between 12 to 25 feet (4 to 8 m). The C story is restricted to low bamboo, a few palms and ferns, and small trees or bushes mostly under 15 feet (5 m). Under-story coverage of all classes of shrubs and small trees under 15 feet on the profile was estimated at Class 2, or 6-25% coverage, by the Braun-Blanquet (1951) system. Buttresses appear on the very large oaks, but other trees have thin straight trunks. Some of the smaller trees lean markedly out towards the light on this steep slope. Epiphytes are fairly common on the large branches of the A story trees, but few lianas or vines were noted. Detailed data of the forest profile is given in Table 2.

Light intensity on the forest floor was low. Readings were made with a photo light meter, but because of the shifting light and dark soils, light readings are highly variable and probably useless in obtaining an average.

The abundance and coverage of most species in the forest community was estimated at a scale of 4, or plant species covering 50 to 75% of the area, as suggested by Braun-Blanquet (1951). Based on a total of 41 trees over 15 feet high on the forest profile, the standing density is roughly 410 trees/acre, or 1,025/ hectare, in Lower Montane Wet Forest.

A weather station was set up at the base of the forest transect, utilizing three maximum-minimum thermometers (at ground level, 4 1/2 feet and 12 feet), a rain gauge, and sling psychrometer. Wind velocities were estimated by the observer. Microclimate and light intensity data are given in Table 3.

TABLE 3

Forest Profile: Microclimate and Light Intensity Data
Finca Aguacate, Volcano Baru, Panama

Dates	Maximum/Minimum Temperatures			Precipitation	Humidity	Wind	Light Intensity
1972	ground	dbh*	12 feet	Cubic Inches	% of 100	MPH	in seconds
Feb. 17	70/-	67/-	70/-	.10	100	5	Gossen Polysix meter (ASA 25, Din 15; f8)
Feb. 18	63/50	65/49	65/49	-	58	35	10 readings:
Feb. 19	59/56	60/55	58/54	-	low (psychrometer broken)	50	2 sec .15 .4 .4 .3 / 2 sec 1.0 .3 .6 .15
Feb. 20	-/52	-/51	-/51	-	very low	65**	average = .73 seconds
Averages	64/53	64/52	64/51				

*dbh = diameter breast height (4½ feet)
**Station readings discontinued due to high winds.

Land Use

The Volcano Baru has sustained very little land use until recent years, according to Bennett (1968). Man, despite his presence in Panama for 15,000 to 20,000 years, has had little significant ecological impact on the western highland montane forests until modern times. The arithmetic population density in these highlands during the pre-agricultural period is calculated (Bennett 1968) at about 0.2 persons/square mile. More data, however, on the paleoecology and primitive land use patterns of this area should be available following the archeological investigations of Dr. Olga F. Linares (personal communication) who is working in the Cerro Punta-Volcán basins at present.

Following the Spanish conquest, 1501 A.D. up to 1903, density rose to an estimated three to six persons/square mile. An important feature during this period was the introduction of livestock which was to have potential ecological repercussions. Since 1903, the human population has risen abruptly, doubling or tripling in western Panama. Chiriqui province now holds an estimated 50 to 150 persons/square mile, according to the 1960 census, which has resulted in extensive ecological changes.

According to Holdridge (1961), modern agricultural land use of Boquete and surrounding lands began about 1910. The Cerro Punta region was first cultivated around 1930 (Loftin 1967). In the past 10 to 20 years, greatly increased clearing has occurred, some on fertile, gently-graded agricultural soils, but much on steep slopes at higher elevations in zones of abundant rainfall. Agriculture, cattle ranching and dairy farming are prominant in Chiriqui province, with an estimated 34% of the area under cultivation and 42% under grazing. Bennett (1968) states that <u>below</u> 4000 feet in the Boquete area there is practically no natural forest left, while <u>above</u> 5500

feet forest disturbance is slight. Land in the sub-tropical/temperate zone is, however, becoming increasingly valuable. It is the only region in Panama where certain temperate food, fiber and flower crops can be grown -- for example, potatoes, carnations, cauliflower and sheep. Howell (personal communication) estimated that land is selling for 400^{+}/hectare, $610/acre, above Boquete. The author saw plots of vegetables and flowers as high as 7700 feet (2350 m) on the Boquete side, while on both the Boquete and Volcan sides, especially around Cerro Punta, land is being cleared for pastures to above 7000 (2150 m). As Holdridge (1961) points out so clearly, the removal of large areas of Lower Montane Wet (cloud forest) or Rain Forest cannot be profitable to agriculture or grazing. By destroying the greenhouse effect of the canopy and condensation, it can seriously disturb the water balance, stream flow and irrigation systems at lower elevations. This leads, inevitably, to undesirable socio-economic problems and to lowered values of timer, recreational and scenic lands (Holdridge and Budowski, 1956).

The 1970 census estimate for Panama was 1,385,000 persons, excluding Canal zone inhabitants and tribal Indians; the year 2001 estimate is 3.1 to 4.1 million (Yandle and Stone, 1970). Therefore, unless some form of conservation takes place, one can expect that Bennett's surmise (1968) is accurate in that only two more decades will pass before natural or primary forest will be left solely at the highest elevations in the Chiriqui highlands and many animal taxa will have decreased or been exterminated.

In the Baru region, some logging is being done at elevations up to 7500 feet with resultant destruction to fine old stands of Quercus, Magnolia and other tropical timber trees. Hunting, of course, is pursued in the montane forests around Volcano Baru for such species as tapir, brocket, agouti, mountain lion, jaguar, guans and pigeons. Fishing above 6000 to 7000 feet is largely ruled out by lack of running or standing water.

Human impact is becoming apparent in direct use of the Volcano for recreation. A growing number of people are climbing, hiking, camping -- and littering. An estimated 8000 outsiders come to Chiriqui province each year (half of them foreigners) and most undoubtedly visit Volcán, Boquete, and Cerro Punta at the base of Volcano Baru (Ogle and Jones, 1972). They estimate that there are currently 5,000 visitor days/year on Volcano Baru, while Cuevas (personal communication) judged that 800 persons actually climbed to the summit during 1970-71. Numbers are expected to increase drastically if the National Park is established and developed.

One unfortunate sequel to this increased and varied land use by humans is fire. Due to the still-prevalent primitive system of shifting cultivation ("roza"), the clearing of new pasture lands, logging practices, and increased recreational use of the countryside, the incidence of fire is probably much greater than in former decades during dry season. Strong evidence of a severe forest fire is still visible along the trail from Government cabin (Boquete side) to the summit (Fig. 7). This conflagration began approximately March 19, 1964 near Palmira (at roughly 3000 feet, 900 m) and burned for one month up to about 10,700+ feet (3280 m) elevation. Evidence of other much smaller fires is also visible around campsites high on the Volcano. During the field survey, at least three ground fires of considerable size were noted on the flanks of lower foot-hills around the Volcán-Cerro Punta area, and one had to be extinguished at Finca Aguacate in order to prevent serious damage to our campsite.

WILDLIFE OF STUDY AREA

Quetzals

The majority of information on this magnificent trogon, Family Trogonidae, Pharomachrus mocinno, subspecies mocinno and costaricensis,

is found in Skutch (1944), Wetmore (1968) Bowes and Allen (1969), and LaBastille, Allen and Durrell, (1972).

Pharomachrus mocinno costaricensis is the subspecies found in western Panama (Figs. 8 and 9). Around Volcano Baru the field team found Quetzals between elevations of 5600-7500 feet (1700-2270 m) on the eastern (Boquete) side in the vicinity of Finca Lerida and Quebrado Bajo Chiquero, and 6500-7800 feet (2000-2360 m) on the western (Volcan) side around Finca Aguacate, Cerro Aguacate and Quebrado Bajo Grande above Cerro Punta. Howell (personal communication) had a report of one bird at 9000 feet. These elevations correspond with the Lower Montane Wet Forest (cloud forest) zone on Volcano Baru. It is probable that Quetzals are found almost around the entire Volcano circumference where edaphic and geological factors permit and where land and human use are not limiting.

Unfortunately, agricultural, lumbering and human developments have made extensive inroads on Baru's forests. According to Wetmore (1968), "Because of large size and the attractive plumage of the male, the Quetzal comes under heavy hunting pressure as human settlement and activities increase near its haunts. It is threatened further as forests are destroyed." Between 1856 and 1902 Quetzals appear to have been quite abundant on the slopes of Volcano Baru in the Boquete area and Caribbean side. In modern times the distribution has become restricted to the mid and upper slopes of the volcano, chiefly above Boquete, Cerro Punta and Bambito. Wetmore (1968) states that: "Some of the birds persist under these adverse conditions where forest remains, but the species is one that definitely needs protection."

This alarming situation is present throughout the Quetzal's range -- southern Mexico to western Panama (its southernmost limit) -- and shows little sign of improving with the current human population explosion. The Quetzal is not listed in the IUCN Red Data Book. The author has made attempts to have it classified as a rare and endangered species, but apparently too little is known of its total population

Figure 7 - Damage from forest fire in primary oak forest, March 1964 burning, 9000 feet, east side of Volcano Baru. Photo by: Clyde H. Smith

Figure 8 - Male Quetzal, Pharomachrus mocino costricensis, from Volcano Baru, 7000 feet. Photo by: Clyde H. Smith

Figure 9 - Quetzal nest tree, Volcano Baru, 7500 feet
Photo by: Clyde H. Smith

numbers to justify inclusion. An interesting addition to our observations and photographs was a glimpse of the Guaymi Indians' usage of Quetzal feathers (Fig. 10). The field team made a brief visit to the Guaymi Indian Reservation of "Acutuco" north of San Lorenzo, when a severe wind storm prevented field work on Volcano Baru. Through the excellent connections of our Guaymi guide, Benjamin Cuevas M., we were privileged to meet a chief and photograph his festival hat, decorated with 35 long Quetzal tail plumes and one of their dances in which the Quetzal feather hat is worn (Fig. 11). Judging from this visit, the more isolated and primitive of Panama's tribal Indians may still utilize Quetzal plumes for ceremonial head-dresses, and possibly dried or stuffed birds as fetishes. Since use of the plumes appears limited to personages of high rank in the tribe and since the feathers are treasured for years, the author doubts that hunting by Indians constitutes any serious decimation to the Quetzal population in Panama.

Based on field observations on Volcano Baru, there exists an estimated population of 10 to 15 Quetzals in the Quebrado Bajo Chiquero/Mirador de la Toma area of Finca Lerida; about eight to 12 in the Quebrado Bajo Grande area above Cerro Punta; and 12 to 18 in the Finca Aguacate/Cerro Aguacate area. A total estimate of the entire population of Volcano Baru, other than saying "100 or more", would be difficult to make due to insufficient knowledge of the amount of habitat still available. During the actual field survey (February 12 to March 4) most birds seen were in early stages of courtship. Male Quetzals gave their territorial two-note whistle, especially between 6:30 and 7:30 am, the "cŏuee" courtship whistle with females, the "ŭwac" call in courtship chasing (LaBastille et al. 1972), and often performed the flight-display as described by Skutch (1944). On three occasions, groups of males and females were seen close together -- in numbers of 12, 8 and 5. On these occasions, courtship chasing, courtship displays and vocalization were frequent.

Males all had long tail coverts of varying lengths and were very beautiful. The birds were generally quite unwary in behaviour. It was possible to approach to within 10+ yards of them. At other times of the year, however, they are probably far more cautious.

Specific recommendations for scientific management of Quetzals are made under: Wildlife Areas Worthy of Development.

Other Birds

Over 850 species of birds have been recorded in the Republic of Panama; and over 425 in the western Chiriqui highlands at elevations above 3000 feet (910 m). A total of 55 species of birds was seen between 5600 feet (1740 m) and 11,410 feet (3474 m) on Volcano Baru during the field survey. All sightings were by observation; no birds were caught by mist nets. Species and locations recorded are given in Table 4. A more complete list of species has been prepared by the Florida Audubon Society (Loftin 1971). According to the International Council for Bird Preservation, Florida State University and the Florida Audubon Society, 40 species of birds are endemic and exclusive to the Chiriqui highlands. Certain species, namely the Great Curassow (Crax rubra), the Crested Guan (Penelope purpurascens) and Rufous-tailed Jacamar (Galbula ruficauda), have been exterminated from the area.

Flocks of Band-tailed Pigeons, Columba fasciata crissalis, known locally as "torcaza", were seen at elevations of 7000 to 10,500 feet. The species is a game bird in Panama, and a $5.00 license is issued which permits one hunter a bag limit of 20 birds/day. In March, according to Wetmore (1965), the birds are in small bands, not wild, and often perched at the tops of dead trees. This was often observed during the field survey. Although the birds are common locally around Volcan Baru mainly above 5200 feet (1600 m) elevation, there is no record of these pigeons breeding in Panama.

Figure 10 - Guaymi Indian hat decorated with 35 Quetzal tail feathers
Photo by: Dr. Anne LaBastille

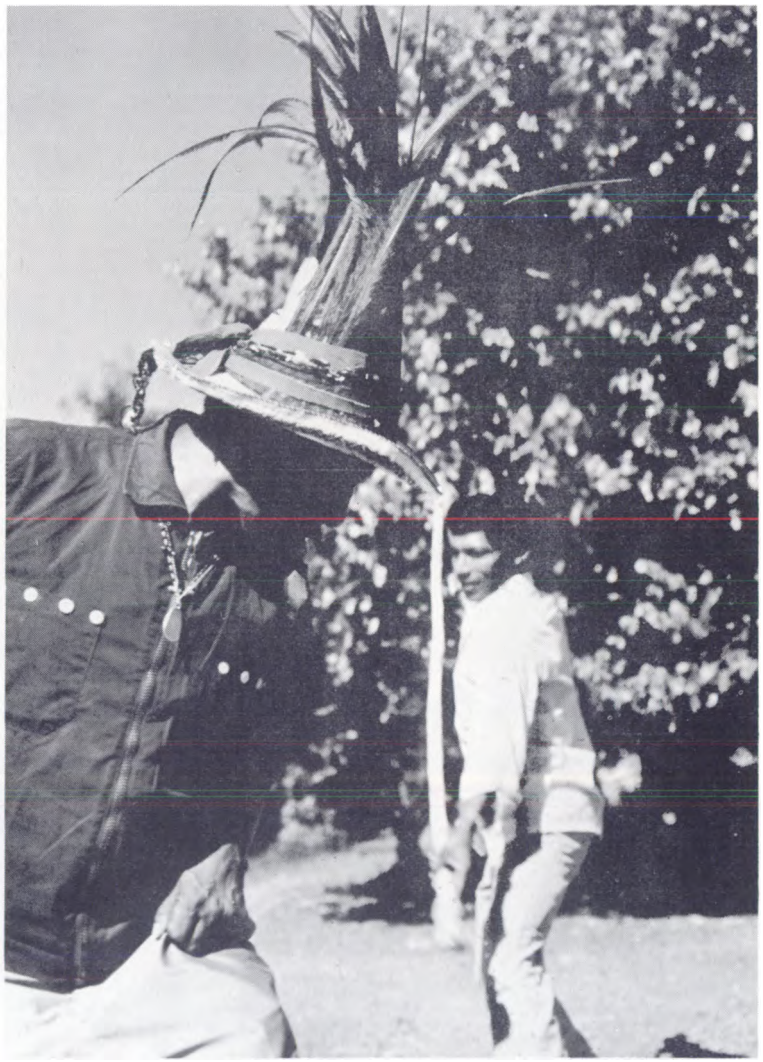


Figure 11 - Guaymi Indian chieftain wearing Quetzal feather hat to perform ritual "la balsa" dance
Photo by: Dr. Anne LaBastille

Figure 12 - Dr. A. LaBastille retrieving mouse caught on small mammal trapline at 7000 feet in cloud forest. Note agouti hole in right background. Photo by: Clyde H. Smith

ABLE 4: Species and Locations of Birds seen on Volcano Baru, Panama during ecological survey, February 12 - March 4, 1972

	Species	Scientific Name	Elevation	Location
1.	Highland Tinamou	Nothocercus bonapartei	7000'	Cerro Aguacate near top
2.	Black Vulture	Coragyps atratus	7000'	Finca Oasis above Boqute
3.	Turkey Vulture	Cathartes aura	5000'	Near Boquete
4.	Swallow-tailed Kite	Elanoides forficatus	5000'	Near Volcan
5.	Red-tailed Hawk	Buteo jamaicensis	7000'	Finca Oasis above Boquete, Quebrado Baja
6.	American Kestrel	Falco sparverius	6000'	Near Volcan
7.	Black Guan	Chamaepetes unicolor	7000', 10,500'	Finca Aguacate, near Summit, eastern side
8.	Spotted Wood-Quail	Odontophorus guttatus	7000'	Finca Aguacate
9.	Band-tailed Pigeon	Columba fasciata	7000' - 10,500'	Finca Aguacate to eastern Summit
0.	Sulphur-winged Parakeet	Phyrrhura hoffmani	7000' - 11,000'	Rio Bajo Chiquero to Summit
1.	Mottled Owl	Ciccaba virgata	10,500'	Calling at night, near Summit
2.	Dusky Nightjar	Caprimulgus saturatus	10,500'	Calling at night, near Summit
3.	Vaux's Swift	Chaetura vauxi richmondi	7000'	Bajo Chiquero
4.	Green Hermit	Phaethornis guy	7000'	Quebrado Bajo Chiquero, Bajo Grande
5.	Violet Sabrewing	Campylopterus hemileucuris	7000'	Quebrado Bajo Grande
6.	Green Violet-ear	Colibri thallassinus	6000'	Beginning of volcano trail
7.	Variable Mountaingem	Lampornis castaneoventris	10,500'	Near Summit, east side
8.	Volcano Hummingbird	Selasphorus flammula torridus	10,500'	Near Summit, east side
9.	Quetzal	Pharomachrus moccino costaricensis	6500' - 7500' 6500' 7000' 7000'	Quebrado Bajo Chiquero Finca Lerida Finca Aguacate Quebrado Bajo Grande

TABLE 4 (Cont'd)

20.	Collared Trogon	Trogon collaris	7000'	Finca Aguacate
21.	Emerald Toucanet	Aulacorhynchus prasinus caeruleogularis	7000'	Finca Aguacate
22.	Acorn Woodpecker	Melanerpes formicivorus	7500'	Finca La Oasis
23.	Smokey-brown Woodpecker	Veniliornis fumigatus	7000'	Finca Aguacate
24.	Hairy Woodpecker	Dendrocopos villosus	7000'	Finca Aguacate
25.	Flint-billed Woodpecker (or Pale-billed Woodpecker)	Campephilus (Phloepceastes) guatemalensis	6000'	Finca Lerida
26.	Spotted Woodcrepper	Xiphorhynchus erythropygius	6000'	Rio Bajo Chiquero
27.	Buff-throated Foliage-gleaner	Automolus ochrolaemus	5500'	Rio Bajo Chiquero
28.	Black Phoebe	Sayornis nigricans	6000'	Rio Bajo Chiquero
29.	Boat-billed Flycatcher	Megarhynchus pitangua	6000'	On volcano trail, west wide
30.	Yellowish Flycatcher	Empidonax flavescens	9000'	On volcano trail, east side
31.	Torrent Tyrannulet	Serpophaga cinerea	6000'	Rio Bajo Chiquero
32.	Mountain Elaenia	Elaenia frantzii	7000'	Finca Aguacate
33.	Blue-and-white Swallow	Pygochelidon cyanolenca	11,600'	Above Summit
34.	Silvery-throated Jay	Cyanolyca argentigula	7000'	Finca Aguacate
35.	American Dipper	Cinclus mexicanus	5600'	Rio Bajo Chiquero
36.	Plain Wren	Thryothorus modestus	7000'	Finca Aguacate
37.	Timberline Wren	Thryochilus browni	10,500'	Near Summit, east side
38.	Gray-breasted Wood-Wren	Henicorhina leucophrys	7000'	Finca Aguacate
39.	Andean Solitaire	Myadestes malanops	7000'	Finca Aguacate

TABLE 4 (Cont'd)

40.	Clay-coloured Robin	*Turdus grayi*	5600+'	Rio Bajo Chiquero
41.	Mountain Robin	*Turdus plebejus*	7000'	Finca Aguacate
42.	Sooty, or Black Robin	*Turdus nigrescens*	11,000'	Near Summit
43.	Black-billed Nightingale-Thrush	*Catharus gracilirostris*	11,000'	Near Summit
44.	Long-tailed Silky-Flycatcher	*Ptilogonys candatus*	7000'	Finca Aguacate
45.	Flame-throated Warbler	*Vermivora gutturalis*	10,500'	Near Summit, east side
46.	Black-throated Green Warbler	*Dendroica virens*	7000'	Finca Aguacate
47.	Wilson's Warbler	*Wilsonia pusilla*	7000'	Finca Aguacate
48.	Collared Redstart	*Myioborus torquatus*	10,500'	Near Summit, east side
49.	Common Bush-Tanager	*Chlorospingus opthalmicus*	10,500'	Near Summit, east side
50.	Large-footed Finch	*Pezopetes capitalis*	10,500'	At Summit, in craters
51.	Yellow-thighed Finch	*Pselliophorus tibialis*	11,000'	Near Summit, east side
52.	Yellow-throated Brush-Finch	*Atlapetes gutturalis*	10,500'	Near Summit, east side
53.	Volcano Junco	*Junco vulcani*	11,000'	Near Summit, east side
54.	Rufous-collared Sparrow	*Zonotrichia capensis*	7500'	Finca La Oasis

Possible Accidentals

55.	Harris' Hawk	*Parabuteo unicinctus harrisi*	7000'	Finca Aguacate

In general the sighting of birds on Volcano Baru, especially at lower elevations, is easy and enjoyable. The large range of vegetational zones provides numerous habitats and tropical, subtropical and temperate species. For the serious ornithologist, an excellent historical review of work done in this area is given in Blake (1958). A list of ornithological references has been published in the Florida Audubon Society's Field Checklist (Loftin 1971).

It is suggested that bird-watching, especially in a number of different habitats, should be a well-publicized aspect of recreation in the proposed Volcano Baru National Park. Appropriate field checklists, lists of locations and experienced guides should be made available. Edwards and Loftin's Finding Birds in Panama (1971), second edition, is recommended.

Mammals

Mammals were determined on Volcano Baru, above the altitude of 5600 feet (1740 m) by sight observations, tracks, scats, bones, hair, and reports of local inhabitants. Actual sightings were quite limited due to the lack of drinking water, noctural nature of many mammals and dense character of parts of the cloud forest. Eleven species were found to exist on Volcano Baru and these are given in Table 5 with locations.

Traplines for small mammals were run at Finca Aguacate (7100 to 7300 feet: Fig. 12) and also near the summit (11,000 feet). A total of 87 trap nights (69 mouse traps, 18 rat traps) was accumulated at the former location; 39 at the latter. Seven adult mice, Oryzomys alfaroi, Alfaro's Rice Rat, were taken at Finca Aguacate. (One adult Peromyscus nudipes, Naked-footed Deer Mouse, was also caught at a cabin near Bambito, 4,500 feet.) External measurements of these rodents are given in Appendix C. Specimens have been sent to U.S. National Museum, Curator of Mammals, for verification.

TABLE 5: Species of Mammals and Locations Found on Volcano Baru, Chiriqui, Panama
(Names taken from Handley, 1966)

SPECIES	NUMBERS	LOCATION	METHOD OF DETERMINATION
Rabbit *Sylvilagus* sp.	Few	Near Summit 11,000'	droppings and clippings of vegetation
Squirrel *Sciurus granatensis*	5	Mirador de la Toma at Finca Lerida - 7000', Finca Aguacate - 7000'	sighting sighting
Naked-footed Deer Mouse *Peromyscus nudipes*	1	Florida Audubon Society cabin at Bambito - 4500'	caught in trap
Alfaro's Rice Rat *Oryzomys alfaroi*	7	Finca Aguacate - 7000'	caught in traps
Agouti *Agouti paca*	Few	Mirador of Cerro Aguacate - 7200'	tracks, holes
Coati mundi *Nasua nasua*	Several	Near Summit - 10,800'	rooting in ground
Kinkajou *Potus flavus*	1	Finca Aguacate	night-lighting-eyes
Longtailed Weasel *Mustela frenata*	1	Finca La Oasis above Boquete, 7000'	local inhabitant trapping weasels
Puma *Felis concolor*	single individuals	Above Boquete	local inhabitants reeall recent sightings
Tapir *Tapirus bairdii*	single individuals	Cerro Aguacate and in hills behind Rio Macho del Monte; Potrero Muleta - 9200'	old trail; accounts of local inhabitants who hunt tapirs
Brocket Deer *Mazama americana*	2	Waterhole above Potrero Muleta - 9800'	tracks
Peccary *Tayassu tajacu*	Several	Finca La Oasis - 7500', Rio Bajo Chiquero by waterfall - 6300', Cerro Aguacate - 7200'	tracks, odor, rootings

Mist nets were employed to catch bats. A total of six net nights was accumulated at Finca Aguacate, but nothing was captured. A few small bats, however, were observed flying about at dusk.

Large game mammals, for instance the larger cats -- puma and jaguar -- probably make only local and sporadic appearances on the upper slopes of Volcano Baru. Possibly the margay, ocelot and jaguarundi (Felis wiedi, pardalis, and yagouaroundi) are somewhat more common around the volcano in undisturbed areas. The Central American tapir is very rare or absent from the Pacific coast of Western Panama (Handley, 1966). Judging from local reports, it only appears occasionally on Volcano Baru during rainy season. The species is known to range from sea level to the summits of the highest ridges in the eastern and western mountains of Panama; however, due to excessive hunting and habitat destruction, it is now rare. It is listed as a rare and endangered mammal (White sheet, Code 4 (a) **P) in the IUCN Red Data Book (1966). A discussion of those larger mammals considered rare and endangered is found under: Recommendations for Wildlife Management.

A discussion of the fascinating exchange of fauna between the North and South American land masses via the Panamanian land bridge in Pleistocene times is found in Simpson (1950) and Hershkovitz (1966). Bennett (1968) states that the mammalian fauna of Central America and Panama is mainly Neotropical in origin -- a northern extension of the Brazilian sub-region -- with little Neartic representation. He also discusses the effects of human influences and modifications upon the zoogeography and ecology of Panama.

For an up-to-date checklist of Panamanian mammals, the reader is referred to Handley (1966) and Mendez (1970). A list of mammals which probably could occur in Volcano Baru above 5600 feet is presented in Appendix B.

In general, mammals are not readily observed on Volcano Baru, particularly during dry season. It is suggested that visitors be

informed of this fact so as not to be disappointed. Also that special feeding and water stations be established to attract wild animals to specific points, (see Section on Wildlife Management)..

Amphibians and Reptiles

No particular effort was made to find amphibians or reptiles in the field. Only one observation was made -- a single blackish lizard at 11,200 feet elevation within a crater bowl. Walters (1953) records a lizard, Barisia monticola, from one of the craters, plus a total of seven spp. of reptiles and amphibians found on Volcano Baru. Myers (1969) has a discussion of amphibians found in Panamanian cloud forests. Dunn (1947) reports on 32 spp. of snakes collected at elevation 5300 feet above Boquete, mostly upland forms from Costa Rica, 16 spp. of which are not present elsewhere in Panama or are represented by other races. Slevin (1942) also reports on a collection of reptiles from this area.

RECOMMENDATIONS FOR WILDLIFE MANAGEMENT

Water and Food Stations

The chief limiting factor to wildlife during the dry season (probably the time of heaviest tourist visitation) is water shortage. Standing or running water above 7000 feet is practically non-existent, except for two small springs (see Section on Recommendations for Park Management). Larger mammals and birds are forced to concentrate at these water-holes or move towards the moister Caribbean (northern) slopes of Volcano Baru. Smaller species of birds and possibly some mammals can manage to survive on dew which is fairly heavy at higher elevations and occasional cloud condensation in the vegetation near

the summit. The writer found wildlife to be quite scarce during the survey, and usually could only be determined by tracks, scats and bones.

It is therefore recommended: 1) that existing springs be deepened and managed as wildlife water holes; 2) that water impoundments and catch-basins be established at the Government cabin, at Potrero Muleta, along the main Volcano trail at about 8000 feet elevation and around the summit; 3) that various water catchment devices be installed similar to the wildlife rain trap and the Gallinaceous Guzzler described by Giles and Toschik (1971). These have been used with great effectiveness in arid U.S. southwestern quail habitat, and could easily be installed and maintained by park wardens on Volcano Baru. Visitors could be directed to these areas and hidden in blinds and photo shelters so as to observe wildlife without alarming it.

A similar technique to attract ground birds and squirrels with feeding stations is recommended. Areas or platforms baited with corn, rice, fruits and nuts should be established and maintained by park wardens. Again, bird-watchers and photographers can be directed here for observation and hidden in blinds. Generally, it takes most wildlife species about three weeks to adjust to drinking and feeding at artificially-built water and food stations.

Quetzal Management

The management of the Quetzal -- one of the prime attractions of the Park -- has been discussed elsewhere (LaBastille 1969), but certain specific recommendations may be made for Volcano Baru National Park. The chief areas for Quetzals are: Finca Aguacate of Sr. Conde Tomás and the Mirador of Cerro Aguacate, both accessible by jeep road and trail from Volcán; Quebrado Bajo Chiquero and the Mirador de la Toma of Finca Lerida, both accessible by jeep road and

trail from Boquete. Areas of 100 to 300 acres should be specifically designated in these two sectors as public Quetzal Sanctuaries, within or bordering the National Park and managed as such. Management techniques would include girdling soft-wooded tree species in order to allow them to decay to the point where Quetzals could excavate nest holes; the placement of artificial Quetzal nests at choice locations in primary forest; the placement of metal flashing around existing or potential nest tree stubs to discourage climbing predators; stiffening fines and enforcing laws to protect the Quetzal from exploitation (zoo trade, skin and feather trade, poaching, egg collecting); planting species of wild native trees whose fruits are edible to Quetzals; eliminating lumbering (except on highly selective basis) from areas of primary Lower Montane Wet Forest.

Fire Control

In general, fires should be eliminated or controlled within the entire National Park in order to avoid wildlife mortality, loss of nest and den sites, and destruction of vegetation. In an area with so little water, the best method would seem to lie in a strong "crash" programme to educate and control the public, especially those remaining itinerant farmers and ranchers who wish to clear and burn land for more pasture and cropland on the volcano.

Protection of Larger Mammals

The most attractive and unique large mammals in the park area are the Central American tapir (Tapirus bairdii) also known as "macho del monte", and the larger cats -- puma (Felis concolor) and the jaguar (Felis onca). The two latter species have been persecuted to the point where Mendez (1970) states they are drastically diminished

and very uncommon. Unfortunately, hunting for these species still occurs. Tapirs seem to be almost non-existent on the Pacific coast side of Volcano Baru (from Cerro Punto around to Boquete). There is still an old gouged-out trail of tapirs on the Cerro Aguacate side, but the writer was told that tapirs no longer occur in that area. Mendez (1970) states that excessive hunting and elimination of forest land are major factors pushing the tapir towards extinction. A strong recommendation is made that the further hunting of tapir and large cats anywhere in western Panama be completely prohibited in the hopes that remnant populations along the Caribbean slopes might repopulate Volcano Baru National Park. Large mammals are well known, from experience in Africa, to excite particular interest and enjoyment among tourists, and can therefore be a source of considerable economic income and publicity for a national park. Another good reason for making a special effort in this matter, is that the gradual rehabilitation of such native species in their original habitats should ensure greater diversity and better balance in the whole ecological situation of the region.

Wildlife Areas Recommended for Management

Areas deemed worthy of management and light development for tourist and conservation purposes, and which could then be suitably publicized, are as follows:

1. Mirador de la Toma above Rio Bajo Chiquero
2. Quebrado and Rio Bajo Chiquero
3. Finca Aguacate, Volcán side
4. Mirador of Cerro Aguacate
5. Government cabin above Boquete
6. Potrero Muleta
7. Forestry Station at Cerro Punta
8. Quebrado Bajo Grande, Cerro Punta

9. Elfin woodland on east ridge near summit
10. Craters and rockholes near summit
11. Summit of Volcano Baru and tropical Sub-alpine Paramo

(1) Mirador de la Toma, and (2) Quebrado and Rio Bajo Chiquero

From Boquete, driving to and above Finca Lerida, a jeep road leads to the Mirador (lookout) de la Toma which commands a view of the Quebrado (canyon) and Rio (river) Bajo Chiquero. The latter flows eastward into the Rio Caldera and is presently tapped for potable water for the town of Boquete. The lookout is at approximately 6500 feet elevation or about 900 feet above the canyon. The very beautiful primary forest of magnolia (Magnolia sororum) and oak (Quercus) growing around the lookout has trees up to five feet dbh and almost 100 feet high. Quetzals are present both in this forest and below in the Bajo Chiquero canyon. The area is definitely desirable as a Quetzal Sanctuary and as a nature lookout with signs describing the trees and birds.

The canyon and river themselves are most picturesque. The water is clean and cold (about 60° F), with a moderate current - 49.8 gallons/second or 188.8 cubic decimeters/second at the time of the survey. An average depth of one foot and width of 10 feet were recorded, but several small cascades and deep pools invite swimming or wading. Notable birds of the stream itself are the American Dipper (Cinclus mexicanus) and the Torrent Tyrannulet (Serpophaga cinerea). The canyon walls are covered with thick growth of forest and harbour several Quetzals, the close proximity of the temperate Dipper and the tropical Quetzal being an interesting and unusual feature of the locality. At the head of the canyon, a waterfall cuts through a cliff-face about halfway down and falls roughly 100 feet to a small pool, from which the river, which is easily crossed on foot by boulders and logs, can be followed downstream about 1 1/2 miles (3 km) to the jeep road ford.

Because Rio Bajo Chiquero is one of the very few, clean, perrenial, potable, and accessible mountain rivers in the Volcano Baru region, it is highly recommended that a walking trail be made along its banks to the canyon head and waterfall with small rustic bridges or stepping stones to accommodate bird-watchers, bathers, photographers and hikers. This would make a round trip of about four miles (7 km). As part of the canyon and stream and lookout would be outside the planned park boundary, negotiations are urged with Mr. Collins, owner of Finca Lerida, to make this area into a special Quetzal Sanctuary and nature area.

(3) Finca Aguacate and (4) Mirador of Cerro Aguacate

On the western side of Volcano Baru, at 7500 and 7000 feet respectively, are two excellent examples of primary (or at least very old) oak forest with populations of breeding Quetzals. Cerro Aguacate is already under consideration for a scenic lookout and nature trail area within the national park so recommendations will be confined to its wildlife potential. This would include locating and managing the Quetzals, pointing out the deep trail of tapirs which crosses and parallels the present trail for a short distance, and drawing attention to the roving bands of peccaries.

Lower down and about 3 miles (5 km) up the jeep track is the fairly flat pasture land of Finca Aguacate. During the winter (January-March) of 1972, the surrounding hills were being clear-cut half-way up the slopes and the fallen timber left as slash. This represented (at that time) a severe fire hazard. Nevertheless, populations of breeding Quetzals still occur in the remaining woodlands, one strip of excellent primary forest being only a 1/4 of a mile directly west of the farm's main work shed. It is hoped that this will be saved from cutting and that the upper halves of the slopes will not be cut.

The flat farm pastures form an ideal base for bird-watchers and campers when searching for Quetzals. During courtship, the birds are quite tame and may be easily observed and photographed in and about the clearings and adjoining standing timber. It is urged that an agreement be negotiated with Mr. Conde Tomás, owner of Finca Aguacate, to maintain the area as a Quetzal Sanctuary within the official national park boundaries and jurisdiction, where specific management techniques for Quetzals would be applied.

(5) Government Cabin above Boquete

The cabin and adjacent woodland belonging to the Forest Service above Finca La Oasis, 7,700 feet (2,333 m), Boquete side, is recommended as a small nature rest stop. The oak forest here is tall (to 60 feet) and attractive despite presence of domestic animals. Running water (piped) and shelter from inclement weather may be obtained. Although Quetzals were not found here, other birds are common, as well as squirrels, weasels, and peccaries. Our guide, Benjamin Cuevas M. stated that an hour's walk from there, southwest to Bajo Frio above La Ruana hill, wildlife was more abundant and some water might be available during dry season. It is recommended that a small trail be cleared to Bajo Frio for the more adventurous hiker and nature enthusiast. Views along the jeep track to the Government cabin are quite spectacular, and in late afternoon one often can enjoy a rainbow in and above the "bajareque" blowing over Boquete.

(6) Potrero Muleta

This most interesting flat enclosed by extremely steep hills lies at an elevation of 9,761 feet (2,958 m). Two more flats are adjacent, southwards, at 9,619 feet (2,915 m). According to Terry (1956), these are three craters with a tepid sulphur spring in the largest one, but this was not found by the field team. Judging from cracks in the mud floor of the crater basin, the Potrero Muleta

flats become water-filled or water-soaked during rainy season. Tracks and bones of tapirs were found plus evidence of coati-mundi, peccary and brocket deer.

The particular attraction of Potrero Muleta not only in its peculiar scenery and its wildlife concentrations, but also in the enormous relief it provides the hiker and back-packer after climbing the steep trail up from the Government cabin. It is a natural and convenient spot to eat lunch or camp. The only existing natural water -- a small spring above a narrow ravine 1/3 of a mile north-northeast -- is found here. Since numerous species of birds and mammals come here to drink, bathe and wallow in the damp soil of this bamboo pocket and spring, wildlife observations can be made more easily here than at other sites. Blinds and photographic hides should be established for visitors both on the flats and near the spring.

(7) Forestry Station at Cerro Punta

No lengthy description is needed in this case and it goes without saying that this beautifully maintained demonstration forestry and weather station should be well-publicized and interpreted to Park visitors. With over 150,000 young trees and 80,000 seedlings [1], it is a most education exhibit of modern forestry methods.

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[1] Species

Cypress or yew	--	Cupressus lusitanica Cupressus benthamii
Pine	--	Pinus patula Pinus montezumae Pinus oocarpa
Eucalyptus	--	Eucalyptus globulus
Fir	--	Abies religiosa

(8) Quebrado Bajo Grande, Cerro Punta

The canyon lying east and slightly south of the Forestry Station above Cerro Punta at 7,200 feet (2,200 m) is a good place to observe Quetzals. Specific management methods should be carried out here for the species. It is also recommended that a short trail be tied into the Forestry Station road, enabling visitors to walk up and bird-watch or photograph. One or two blinds might also be built. Care should be taken to avoid stinging nettles in the forest.

(9) Elfin Woodland on East Ridge, near Summit

At about 10,800 feet (3,300 m) and along part of the little-used east trail to the water hole above Potrero Muleta, is a narrow band of hauntingly lovely elfin woodland (maximum height 15 feet) heavily hung with mosses and orchids. Protection from fire and woodchopping is essential here, and signs should inform the visitor of this unique ecological area.

(10) Craters and Rockholes, Volcano Baru

A complex of at least three craters is found south-southwest of, and somewhat below, the main summit, with an opening west towards the "llanos" of Volcán (Fig. 2). This eerie, bleak landscape contains little vegetation, one species of lizard, the Large-footed Finch (Pezopetes capitalis), and much of geological interest. There are opportunities for rock climbing and 'pot-holing' or exploring the rock-holes which exist among the tumbled piles of lava boulders on the north-northeast lip of the crater complex. Lava flows, deposits of sulphur, and odd rock formations should be fully covered by the National Park's interpretive programme. Care should be taken that they are not defaced by tourists.

The entire crater complex would make a striking display and educational center for studies of volcanism, geology and regional geography.

(11) Summit of Volcano Baru and tropical Sub-alpine Paramo

The views of two oceans and Costa Rican mountains on clear mornings, as well as magnificent sunsets in evenings, make the climb to the summit well worthwhile, especially for photographers. Additionally, the open area at roughly 10,800 - 11,400 feet (3,300 - 3,470 m) is extremely interesting because of its unique tropical Sub-alpine Paramo-type flora and birdlife. A number of temperate plant species such as Vaccinium, Cladonia, Lycopodium can be found. Every effort should be made to restrict campsites and trails to specific areas and to protect the delicate ecological balance and soil structure of this region.

RECOMMENDATIONS FOR PARK MANAGEMENT

While not strictly in the realm of wildlife management, certain recommendations are offered for the overall management of Volcano Baru National Park in the best interest of both people and the ecology. These are based on observations made by the author and photographer during their field survey, and on predictions made by the U.S. Department of Commerce for the population of Panama in the period 1961-2001. Chief points were discussed with A. Alquilino Sanjur, District Forester, before the survey team left Panama.

The estimated population of Panama in 1970 was 1,385,000, excluding tribal Indians and Canal Zone inhabitants, and is expected to reach between 3.1 - 4.1 million by the year 2001 (Yandle and Stone, 1970). Most rapid growth will occur among secondary school age (13 to 18 years) and working age (15 to 64 years) classes. These

segments of the populace are the most mobile and most apt to seek interesting pastimes for their leisure hours.

It should also be noted that Panama is the most prosperous country in Central America, contains the smallest percentage of active males in agriculture (57% in 1960), has the highest per capita G.N.P., a low illiteracy rate (25% in 1960), the second lowest mortality rate in Central America, a high life expectancy (60 years males; 63 years females), and an urban population of about 42% (1960) (Yandle and Stone, 1970).

For these above reasons, it is fairly certain that a large number of Panamanian people, not to mention tourists from abroad, will be able to avail themselves of the future national parks of the country. However, the adverse reactions arising from having too many people for the national parks, such as is now causing problems in the U.S.A., must also be anticipated as a future possibility and methods of off-setting them need consideration.

Campsites and Fireplaces

On Volcano Baru, it is recommended that a carefully calculated number of campsites and fireplaces be established. Special attention should be given to garbage and human waste disposal and its physical impact on mountain soils and vegetation. At present, crude campsites are scattered randomly about the summit of Volcano Baru, above 10,500 feet (3,180 m), with unsightly piles of garbage, broken glass, rusty cans, plastic wares, and toilet paper scattered about. Even those persons who make attempts to bury their trash are thwarted by the keen-nosed Coati-Mundis (Nasua nasua) or "gato solo", which in their search for food dig up the buried refuse. Specially deep trash holes need to be dug or, alternatively, free plastic garbage bags should be given to campers in which their trash can be carried down again at the end of the climb.

At two or three old campsites, the author found evidence of fires which had escaped to nearby woodlands. Since vegetation is quite flammable in the January-March dry season, disastrous forest fires are possible. New campsites should have stone-lined fireplaces available with sufficient space cleared around them. Campers should be asked to carry their own cooking fuel (propane, gas, sterno) or to use firewood sparingly to save the trees.

Drinking Water

The only available natural water sources found by the field team along the major trails to the summit from Boquete (east) and Volcán (west) sides are at 9,800 feet (2,970 m), above Potrero Muleta at the top of a narrow ravine due north of the flats -- and -- at 7,000 feet (2,120 m) under a huge boulder about halfway along the Volcán trail. The basins of both these springs can only accommodate a large water jug or cook pot, and both are open to wildlife and soil runoff. Piped water supplies have been installed at 7,800 feet (2,630 m) at the Government cabin above Finca La Oasis (Boquete side); at 7,000 feet (2,120 m) at the workman's shed and cattle troughs on Sr. Conde Tomás' Finca Aguacate (Volcán side); and at roughly 6,000 feet (1,818 m) near a small shack where the Volcán trail meets the jeep road. Below 6,000 feet water is fairly easy to locate in small streams, waterfalls and springs.

In order that visitors do not have to carry water to the summit of Volcano Baru or use water which could be contaminated, there is a need for more water cisterns, rain traps or impoundments above 8,000 feet, which would depend mainly on rain and dew. Care should be taken to avoid or prevent that contamination of such new supplies by wildlife, human wastes or soil runoff. However, it must always be remembered that the availability and/or scarcity of drinking water can be a critical factor in limiting the number of campers heading

for the summit area and the length of time they spend there. It could be applied for the purpose of protecting the volcano from over-use.

Safety and Comfort of Visitors

All visitors climbing the volcano should be required, for safety's sake, to check in and out at National Park stations and to obtain a registered guide. Any serious accident occurring to a person at or near the summit (broken leg, back, ankle, concussion from fall) would be several hours from medical help and would severely strain rescuers during a rapid descent. A simple field telephone line might be installed for visitor/ranger communication, and self-service first-aid stations maintained near campsites in the summit area. Visitors should be advised to wear stout hiking boots, long pants and a hat and long-sleeved shirt for protection from sun and cold, and to carry adequate rain gear in the rainy season. They should also be required to carry a compass and topographic map since conditions of cloud and mist can totally obscure one's path and sense of direction around the summit and in the craters. Information on the physiological effects of high altitude should be given to visitors and they should also be warned that minor earth tremors do take place occasionally.

Other useful information for visitors' comfort and security, which should be available in printed form, would cover the fact that no aggressively poisonous or dangerous species of wildlife exist above 6000 to 7000 feet, that biting insects other than chiggers are not usually a problem (at least during the dry season), and that stinging nettles which cause very uncomfortable dermal reactions occur in certain sections (the information sheet should have a good drawing of the plant). When visitor use has increased sufficiently to justify it, short talks might be given by Ranger/Naturalists to visitors

before they enter the main Park area, to back up this information and give people a better idea of the fauna and flora.

Trails and Trail Makers

In the writer's opinion, improvement trails is a definite necessity. Both the eastern (above 8000 feet) and western (above 7500 feet) trails need many more switch-backs and more contouring to make the ascent and descent less arduous and dangerous. Contouring is particularly important near the summit in order to minimize erosion and landslides with resultant destruction of the thin soil and fragile vegetation. Recent experiments in the High Peaks region of the Adirondack Mountains of northern New York have shown that the pounding of heavy hiking boots by summer vacationers, combined with frost action, is the chief cause of erosion and destruction of delicate alpine ecology. Eroding trails and peaks may average a loss of one inch of soil per year both vertically and horizontally (Ketchledge and Leonard, 1970). It was found best to make one major trail and to limit visitor traffic to this as much as possible.

Evidence of beginning erosion on Volcano Baru was noted during this survey, principally on the high sections of the summit trail above 9,000 feet. Every effort should be made to arrest this before it becomes serious. Adequate marking of trails is badly needed, especially near the summit. During conditions of heavy cloud and fog, or at night, one can easily lose the way, in the present state of the trails, Marking at the summit may best and most economically be done by erecting large stone cairns (rock piles) at easily visible points and lining sides of the major trail with stones. Signs (at trail beginnings and mid-way points, in craters, on flats, and at the summit) should be erected to inform hikers of the elevations and distances involved from point to point.

Observations of Quetzals

Visitors eager to observe Quetzals should receive a small page of information on the species' habits and locations. This would include the times of day when Quetzals are most vocal and visible, and descriptions of their calls and displays. The fact that it often takes hours of waiting on the part of the bird-watchers should be pointed out; however, this subspecies seems far easier to observe than the northern subspecies studied by the author in Guatemala. Nevertheless, it still needs the kind of approach recommended above if people are not to be disappointed in their hopes of viewing one of Panama's loveliest birds.

Defacing the Volcano

The public has already begun defacing the volcano by painting names and symbols on prominent rocks, smashing bottles on the ground, general littering, carving names or initials on large trees in the forest, and pounding on metal bench marks. It is suggested that an immediate educational programme be started, entreating people to protect the scenic and primitive beauty of Baru. A possible theme might be: "Your Vanishing Volcano".

Road Development

On the possibility of a paved or jeep road to the top of Volcano Baru, it is the writer's opinion that this type of development be eliminated entirely from national park planning. Since Volcan Baru is the highest point in Panama, man cannot afford to violate its still natural and pristine personality. The area above 7500 to 8000 feet (on both east and west sides) should be developed only with foot trails. Its use must be left to the self-propelled

hiker, camper, nature photographer and scientist, who will appreciate and benefit from the wilderness and serenity, to those in fact who will find the climb as the natural prelude or conclusion to an experience as unique and inspiring as can be found in all Central America.

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APPENDIX A

Description of Soil Samples from Volcano Baru, Panama

Location: Finca Aguacate - 7000 feet elevation - primary lower montane wet forest - 45% slope - northeast exposure.

	Sample 1 - SURFACE	Sample 2 - SUB-SURFACE
Texture:	medium-fine, sand silt	medium - sand and silt
Structure:	loose	loose, single grain
Colour:	brown-grey	grey with tan overtone
Stoniness:	slight	slight
Depth:	8 inches	2 feet
Wetness:	dry	dry
Duff:	1 inch	---

Location: Volcano Baru - 11,300 feet elevation - near summit - subalpine-type vegetation - 45% slope - southwest exposure.

Sample 3 - SURFACE		Sample 4 - SUB-SURFACE
Texture:	medium-gritty	medium
Structure:	compacted	compacted
Colour:	grey-yellow	grey
Mottling:	none	none
Stoniness:	moderate	moderate
Depth:	3 inches	not recorded
Wetness:	dryish	damp
Duff:	none	---

Location: East ridge, Volcano Baru - 10,500 feet elevation - Montane Wet Forest.

Sample 5 - SURFACE

Texture: fine

Structure: loose

Colour: dark brown

Mottling: none

Stoniness: slight

Depth: 8 inches

Wetness: dry

Duff: 1/4 inch

Location: Near summit, Volcano Baru - 11,100 feet elevation - open subalpine paramo-type land.

	Sample 6 - SURFACE	Sample 7 - SUB-SURFACE
Texture:	fine	fine, sandy
Structure:	loose	loose
Colour:	grey-brown	grey-yellow
Mottling:	none	none
Stoniness:	none	moderate
Depth:	8 inches	not recorded
Wetness:	dry	dry
Duff:	1/2 inch	---

APPENDIX B

A list of mammals which may occur above 5600 feet (1820 m) on Volcano Baru, Chiriqui, Panama.

(Taken from Handley, Checklist of the mammals of Panama; Mendez, Los Principales mamiferos silvestres de Panama; and Goldman, Mammals of Panama.)

ORDER MARSUPIALIA	Family Didelphidae	Occurrence
South American Mouse-Opossum	Marmosa robinsoni	to 6000'- abundant
ORDER INSECTIVORA	Family Soricidae	
Blackish Small-eared Shrew	Cryptotis nigrescens	6500'- Cerro Punta - rare
ORDER CHIROPTERA	Family Phyllostomidae	
Suapure Naked-backed Bat	Pteronotus suapurensis	to 5300'- Cerro Punta - common
Small-eared Bat	Micronycteris megalotis	to 5300'- Cerro Punta - common

Tail-less bat	Anoura cultrata, Anoura geoffroyi	to 5300'- Cerro Punta - common
Anthony's bat	Sturnira ludovici	5300'- Cerro Punta - abundant
White-lined Bat	Vampyrops vittatus	5300'- Cerro Punta - common
Fruit-eating Bat	Artibeus aztecus	5300'- Cerro Punta - rare
	Artibeus toltecus	5700'- Cerro Punta - common
	Family Desmodidae	
True Vampire	Desmodus rotundus	to 5600'- ubiquitous
	Family Vespertilionidae	
Myotis (Black Bat)	Myotis chiloensis	to 5800' - Cerro Punta - rare
Red Bat	Lasiurus borealis	5300'- Cerro Punta - uncommon
	Family Molassidae	
Brazilian Free-tailed Bat	Tadaria brasiliensis	from 5700'- Cerro Punta-uncommon
ORDER PRIMATES	Family Cebidae	
Howler Monkey	Alouatta villosa	to 5100'+- abundant
White-faced Capuchin	Cebus capucinus	to 6000'+- abundant
ORDER EDENTATA	Family Myrmecophagidae	
Common Anteater	Tamandua tetradactyla	to 5000'+- common
	Family Dasypodidae	
Nine-banded Anteater	Dasypus novemcinctus	to 5500'+- common
ORDER LAGOMORPHA	Family Leporidae	
Forest Rabbit	Sylvilagus brasilensis	to 5300'+- Cerro Punta - common

ORDER RODENTIA	Family Sciuridae	
Tropical Red Squirrel	Sciurus granatensis	all elevations-wide ranging, abundant
Groove-toothed Squirrel	Syntheosciurus brochus	Only north slope Volcano Baru, 7000', above Boquete - rare
Pygmy Squirrel	Microsciurus mimulus	Fog forests above Boquete - rare
	Family Geomyidae	
Chiriqui Pocket Gopher	Macrogeomys cavator	to 7800'- Cerro Punta - common
	Family Heteromyidae	
Desmarest's Spiny Pocket Mouse	Heteromys desmarestianus	to 7800'- Cerro Punta - common
	Family Cricetidae	
White-breasted Rice Rat	Oryzomys albagularis	Fog forest - 7800'- Cerro Punta-rare
Alfaro's Rice Rat	Oryzomys alfaroi	Evergreen forest - 5800' Cerro Punta - rare
Pygmy Rice Rat	Oryzomys fulvescens	7800'- Cerro Punta common
Sumichrast's Vesper Rat	Nyctomys sumichrasti	forest - 5300'- Cerro Punta - rare
Chiriqui Harvest Mouse	Reithrodontomys creper	fog forest - from volcano at 10,400 ft. - abundant
Mexican Harvest Mouse	Reithrodontomys mexicanus	7800'- Cerro Punta - uncommon
Sumichrast's Harvest Mouse	Reithrodontomys sumichrasti	to 10,300' on Volcano - common

Yellow Deer Mouse	Peromyscus flavidus	forest - 3000-5000' Boquete - rare
Naked-footed Mouse	Peromyscus nudipes	forest - to 7800'+ Cerro Punta - abundant
Alston's Brown Mouse	Scotinomys teguina	6000' - Cerro Punta - abundant 7000' - Boquete
Chiriqui Brown Mouse	Scotinomys xerampelinus	to 10,400' fog forest on Volcano - abundant
	Family Erethizontidae	
Mexican porcupine	Coendou mexicanus	to 6200'- Cerro Punta - uncommon
	Family Dasyproctidae	
Paca	Agouti paca	5300'- Cerro Punta common except where hunted
Agouti	Dasyprocta punctata	all elevations - common
ORDER CARNIVORA	Family Procyonidae	
Ring-tailed Cat	Bassariscus sumichrasti	1 specimen from Boquete at 6000'- very rare
Raccoon	Procyon lotor	to 5300'- Cerro Punta - locally common
Coati-mundi	Nasua nasua	all elevations - locally common
Kinkajou	Potus flavus	all elevations - locally common
Bushy-tailed Olingo	Bassaricyon gabbii	to 5300'- Cerro Punta - uncommon

	Family Mustelidae	
Long-tailed Weasel	Mustela frenata	to 5800'- Boquete - mostly rare
	Family Felidae	
Mountain Lion	Felis concolor	6800'- Cerro Punta - rare and local
Jaguar	Felis onca	all elevations - uncommon
Ocelot	Felis pardalis	all elevations - common
Margay Cat	Felis wiedii	possibly at all elevations - uncommon
Jaguarundi	Felis yagouaroundi	possibly at all elevations - uncommon
ORDER PERISSODACTYLA	Family Tapiridae	
Baird's Tapir	Tapirus bairdii	Pacific coast of western Panama - all elevations - rare or absent
ORDER ARTIODACTYLA	Family tayassuidae	
Collard Peccary	Tayassu tajacu	throughout Panama - except where hunted, common

APPENDIX C: External Measurements of Rodents Captured on Volcano Baru, Chiriqui, Panama

Peromyscus nudipes Naked-footed Deer Mouse

Total length = 250 mm	
Tail length = 120 mm	
Hind foot length = 24 mm	1
Ear (ear from crown) = 15 mm	adult

Oryzomys alfaroi Alfaro's Rice Rat

Total length = 232.3 mm	
Tail length = 118.3 mm	
Hind foot length = 25.0 mm	3
Ear (ear from crown) = 20.8 mm	adults

Oryzomys alfaroi

Total length = 229.9 mm	
Tail length = 119.2 mm	
Hind foot length = 24.5 mm	4
Ear (ear from crown) = 20.5 mm	adults