The Southern Tip of the Nicoya Peninsula in Costa Rica

A Report to the International Commission on National Parks of the International Union for Conservation of Nature

Prepared by
Waldemar Albertin

Inter-American Institute of Agricultural Sciences
Tropical Center for Research and Graduate Training
Turrialba, Costa Rica
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INSTITUTO INTERAMERICANO DE CIENCIAS AGRICOLAS

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PREFACE

International attention has been focused on the destruction of the last remnants of virgin dry zone forest and its endemic fauna in the southern tip of the Nicoya Peninsula in Costa Rica through the diligent efforts of a long time resident, Mr. Olof Wessberg. Before the International Union for Conservation of Nature and Natural Resources could recommend a course of action in this area it seemed appropriate that a brief reconnaissance survey should be made. To carry out this assignment the Union's International Commission on National Parks was fortunate in obtaining the help of a volunteer group from the Inter-American Institute of Agricultural Sciences at Turrialba through the Cooperation of Dr. Gerardo Budowski in the Forestry Department of the Institute.

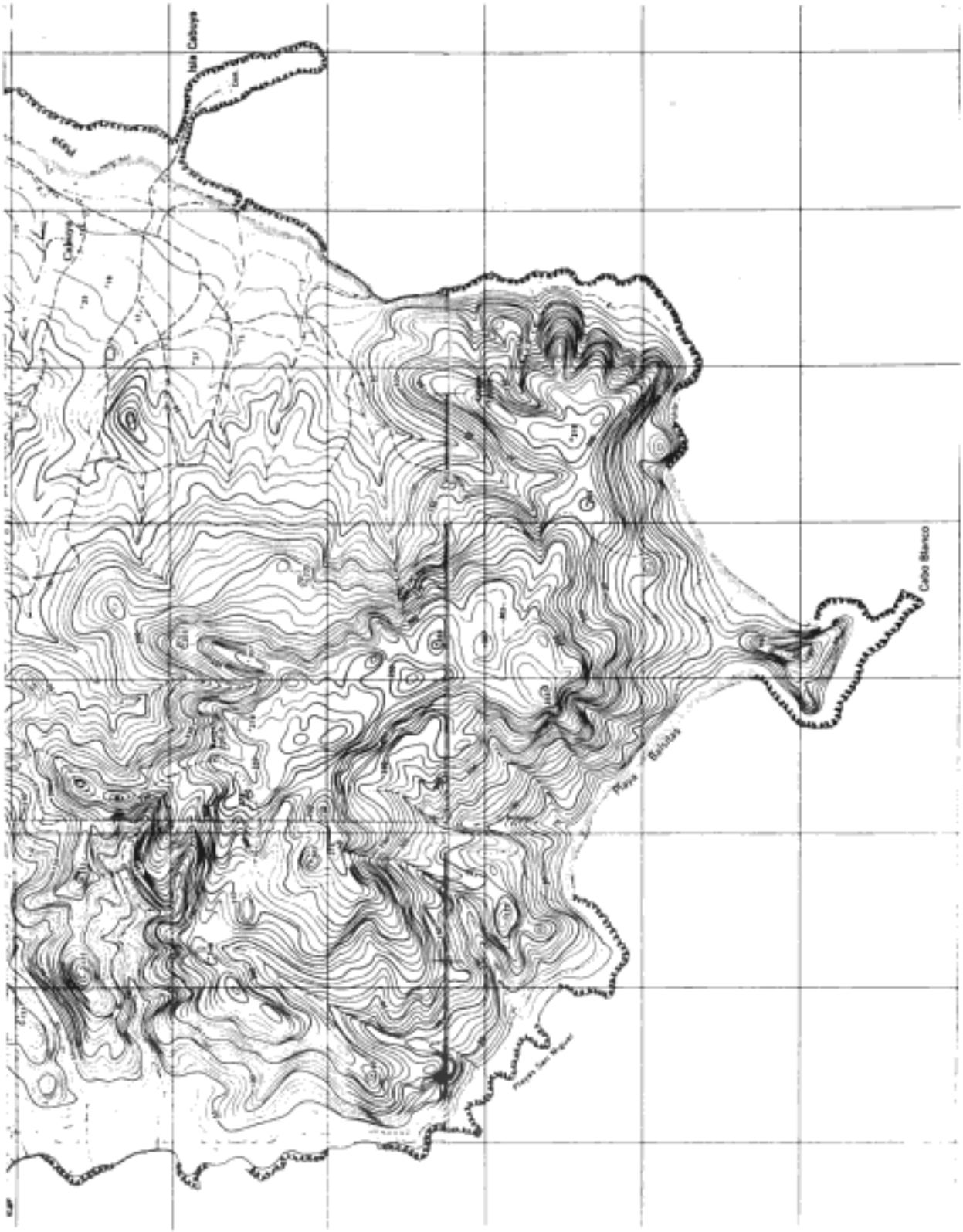
The report of the survey contains a wide range of useful information that is particularly helpful to the organizations that are considering raising funds to help save some of this virgin area for a permanent park or reserve. This is a matter that has concerned the World Wildlife Fund, and for this reason I am pleased to acknowledge a grant that they have made to the Commission to cover the cost of this preliminary survey and the publication of this report.

I also wish to express appreciation to those who participated in the survey trip, and extend thanks to Waldemar Albertin for preparing the report, and to John Milton, whose brief ecological survey of the area is covered in an appendix to the report. Thanks are also extended to all the people in Costa Rica, who helped in so many ways to assure the success of the survey.

Let us hope that the recommendations in the report will help Costa Rica and lead to action that could save some of the virgin area for scientific study, for the protection of an unusual biotic environment with its fauna and flora, and for the benefit and enjoyment of all mankind in the years to come.

Harold J. Coolidge, Chairman
International Commission on National Parks
International Union for Conservation of
Nature and Natural Resources

1 March 1963
Washington, D. C.



PERSONNEL MAKING THE SURVEY TRIP

Avelino Aguirre, Ing. Agr.	IICA
Waldemar Albertin, M. F.	IICA
André Challe	Costa Rica
Luís Cañadas, Ing. Agr.	IICA
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John Milton, Student of Conservation	University of Michigan
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CONTENTS

INTRODUCTION

From April 7 to April 11 a group of students and technicians upon invitation by the International Commission on National Parks, made a survey trip to the southern tip of the Nicoya Peninsula to study the possibility and suitability of the area to be set aside as a National Park Wildlife Refuge, Wilderness Area or Forest Reserve.

Each one of the participants studied and reported on specifically assigned subject matter and the following report is a result of the information gathered by all the participants of the group. Special thanks is given to Mr. André Challe, who generously lent his time, good will and his "Papagayo" to land the group at the designated area. Mr. Olof Wessberg, with his complete knowledge of the people and the area around Cabo Blanco was particularly helpful in making local arrangements for the group.

Due to the short period of time spent by the group in the area, this paper should only be considered as a report on a preliminary survey of the southern tip of the Nicoya Peninsula.

CHAPTER I

Geographic Description

The Peninsula of Nicoya forms part of the provinces of Guanacaste and Puntarenas and lies between the latitudes 9°30' and 9°45' North of the Equator and the longitudes 85°15' and 85° West of Greenwich. It is bordered by the Pacific Ocean on its western coast and the Gulf of Nicoya on its eastern coast. Some of its small villages in the southern tip include Mal Pais, Delicias, Corallito, Manzanillo and Moctezuma. Most of the terrain, especially around Cabo Blanco, has steep slopes and elevations ranging from 0 to 350 m.

Ecological Description of the Forest

According to Holdridge's Classification of Plant Formations, the southern tip of the peninsula lies within the tropical moist forest formation. About 65 per cent of the original forest cover has been removed. Twenty per cent of the remaining forest cover is secondary or brush and only 15 per cent can be regarded as virgin and undisturbed until May 1962. Of these 15 per cent about 80 per cent are evergreen and 20 per cent deciduous. It is almost certain that the virgin forest will be cleared completely within the next five years at the present rate of settlement and land clearing. The evergreen broadleaf forest is generally found on the higher slopes. Three strata in the high forest were easily distinguished at elevations of 5-10, 15-20 and 30-35 meters. There are some lianas. The ground vegetation consists of small palms, ferns and biscoyol. In some parts of the forest the ground cover by vegetation is almost nonexistent. Instead, a thick cover of dried leaves on the forest floor give one the impression of being in a northern European hardwood forest during the fall instead of being in a tropical moist forest formation. (For a detailed ecological description, see appendix by John Milton.)

Geological Description

During the Pennsylvanian and middle Cretaceous period the Peninsula of Nicoya was covered by the sea. In the Eocene most of Costa Rica including the Nicoya area rose out of the sea. Most of the Cabo Blanco area was laid down during the Miocene Tertiary. The Pleistocene was marked by water erosion. Large amounts of sediment were washed down the short, steep canyons into the sea. In the area of Cabuya around Mal Pais and Cabo Blanco some alluvial fans were formed through the action of water erosion. Near Mal Pais some caves are found in the limestone rock, all having typical stalagtite flows. Some of these massive limestone rock formations have vertical walls extending up to 150 ft.

Soils

The soils can be classified into three major groups:

1. Black Clay Soil
2. Grey Clay Loam
3. Grey Alluvial Clay

1. The Black Clay Soils are generally present on high, flat plateaus where up to now little erosion has taken place. In the layer of 0-5 cm the color of the silty clay loam is dark black. An angular block structure is very characteristic. The layer of 5-37 cm consists of a dark, silty clay in which the angular blocks are less well developed. It is quite sticky when wet and develops cracks when it is dry. Below 37 cm the soil is a compact clay and of dark brown color.

2. The Grey Clay Loams are generally located on the steeper slopes mixed with great numbers of rocks. Most of the still undisturbed forest grows on these soils. Most of the layer 0-3 cm consists of undecomposed leaves and small branchlets. The layer 3-5 cm consists of fine, sandy loam and is grey to brown in color. Below 5 cm coarse, gravelly clay loam makes up the soil layer.

3. Most of the Grey Alluvial Clay is deposited on the gentle slopes and the lower plains reaching a depth of over one m. It seems that the fertility of these soils is good. Most of the agricultural crops of the area are produced in these lowlands.

Archaeological Description

Many centuries before the Spaniards discovered the Peninsula of Nicoya between 1519-1522, the Indians of the Chorotega tribe had a thriving culture in the peninsula growing maize, yucca, beans and fruits. Later cotton and cacao were introduced. Other tribes which at one time or another have invaded the area were the Arawakas and the Chibchas moving in from the Caribbean. Evidence of these Indian cultures is still present in forms of pottery, carved stones, pipes, goldwork and shell mounds occasionally found in the area. On the finca of Mr. Martínez we were shown a carved stone in the shape of a turtle with dimensions of 2 x 1.5 meters.

Climate

According to data taken by the Meteorological Service of Costa Rica and considering the peninsula as a whole, there is a great variation in the amount of rainfall per year in different areas. The northern zone receives the least rainfall ranging between one to two meters per year. Two meters of rainfall are registered for the central zone and two to three meters of rain are received by the southernmost area. There is a higher amount of precipitation on the west coast than on the east coast of the peninsula. Average temperatures are around 80°F and the average relative humidity is around 85 per cent. Prevailing winds from the west, south and southwest carry most of the moisture from the Pacific and generally bring with them short, turbulent rainstorms. North and northeast winds are generally dry winds. The months of December, January, February and March are regarded as dry. April is the month of transition. The rainy season extends from May through November, with the heaviest period of rain in October.

CHAPTER II

Forest Description

In the undisturbed forest, the dominant species are made up of Brosimum costaricanum (Ojoche), Achras zapota (Níspero), Bombacopsis quinatum (Pochote) and Anacardium excelsum (Espavel). These species in mature age reach a height of over 30 m. Epiphytes and some tree orchids are moderately abundant. Leaves of the trees are generally thin and shiny. Buttressing on the dominant old trees is common. The crowns of larger trees generally are of umbrella-shape. Bombacopsis quinatum (Pochote) grows almost in pure open stands in rocky soils of the lower plains close to the ocean. In total over 35 different species were identified.

Forest Inventory

A strip cruise of the southern tip of the peninsula beginning at the beach of the Playa Balsitas in an Azimuth of 330° was run up to the beach near Cabuya. The strip run was 5 m wide and 3720 m long, corresponding to a surface area of 18,600 m^2 or 1,86 ha. A 30-m chain tape was used and an Abney level to measure slopes and corrections for distances on slopes. The following observations were recorded:

1. Vegetation
    a. Forests: comprising stands which were judged virgin.
    b. Brush: areas where all forest had been eliminated but the area actually not used for agricultural purposes.
    c. Young secondary forest: areas which have been in brush about five years with some natural tree regeneration.
    d. Areas used for agriculture: burned over areas, maize plantations, rice, pastures.
2. Trees of 4" and more at Dbh
    a. Dbh in inches
    b. Total height in feet
    c. Scientific name
3. Elevations: at intervals.
4. Soils, rivers, streams, wildlife

Results

The area surveyed consisted of:

35% forest
40% land used for agriculture
20% brush
5% secondary forest

The forest was generally located on the steep and very steep slopes, agriculture on the plain areas but also on some steep slopes. Brush and young secondary forest extended over sloping and plain areas but mostly over very stony soils. On these soils the original forest had been cut and burned. Later the sites became unsuitable for agriculture and were abandoned.

In total 35 different species were encountered: Madroño (Calycophyllum candidissimum) and Níspero (Achras zapota) are the two most frequent species, covering about 25 per cent of the total stand. Other often occurring species are Azulillo (Hamelia patens), Pochote (Bombacopsis quinatum), Capulin (Muntingia calabura), Roble (Tabebuia pentaphylla) and Ojoche (Brosimum costaricanum). These seven species comprise more than 66 per cent of the stand.

The distribution of the trees over the Dbh classes gives a graph characteristic for an all-aged forest (see appendix). The forest area was little touched. Only occasionally some big trees of commercial timber value had been cut. These stems are squared in the forest and transported by oxen to either Cabuya or Mal Pais.

Roads were not encountered in the area but numerous trails. A poor jeep road from Nicoya to Cabuya already exists.

The general impression of the inventory group was that the area may be saved for a National Park or Forest Reserve, but quick action is necessary (See list of species in appendix).

Accessibility

The southern tip of the peninsula is presently not very accessible. The best means of communication are small boats which serve the small villages along the coast regularly 2-3 times per week. The only pier presently suited for larger boats is located in Bahia Ballena. From this point several roads passable by oxcarts lead inwards. South of Bahia Ballena the open sea prohibits boat landings. Cabuya can be reached by a small motorboat as well as Mal Pais at high tide. A trip by boat from Puntarenas takes about five hours to Cabuya and seven hours to Mal Pais. The only all-weather road in the peninsula runs south from Liberia on the Pan American Highway down the middle upper half of the peninsula through Nicoya to end at Puerto Jesús. South of Nicoya there are several ox and jeep trails and a great number of trails passable by foot. There is an airfield south of the Bockett Pyramid where single-engine aircraft can land. From the airport it takes about five hours by horseback to reach Cabo Blanco. The only airport which permits landings of two and more engine planes is located in Nicoya. On the west coast of the peninsula extensive sandy beaches near villages permit single-engine airplanes to land.

Estimation of the Area Suitable as Forest Reserve

Under the present situation and following the marked line on the map, approximately 22 sq km of land could be set aside for this purpose. However, this does not have to be the limit. The area north of the proposed line is somewhat more densely populated than the southern tip, but villages are scarce. Particularly along the west coast, some large tracts of forests north of Mal Pais may be included in the Forest Reserve.

Forest Industry

Before the Spaniards reached Nicoya there was little exploitation of the abundant forest species. It seems evident that the Indian population was never concentrated in larger villages due to the extremely difficult climatic and topographic conditions prevailing in that area. With the arrival of the Spaniards the type of forest exploitation changed drastically. Mostly Palo de Brasil (Chlorophora tinctoria), used for dyes, was then intensively utilized. Within the last 50 years, some other species have been increasingly exploited following the settlement of more people along the shores of the Gulf of Nicoya. After the high-quality timbers, exploited under the selection system, became scarce and with the increase of population, some forest areas were clear-cut for agricultural crop production, especially close to population centers.

With the help of fire, the destruction of the forests progressed very rapidly. At present fire is being used not only to burn forest land but also to clear the dry vegetation after each harvest of crops and to clear pastures. The selective cutting of a few species is actually very typical of the whole of Costa Rica.

The method of exploitation consists of a survey of the forest for desired species, an estimation of volume and at the same time a study of the possibilities of extraction and the place to which to skid the logs. Standard size of the logs is 12 ft. All logs are squared by ax at the place where they are felled and then transported either on the ground by oxcart or with two-wheeled wagons to the beach.

Within the Cabo Blanco area there is no lumber industry. The whole forest operation consists of preparing the logs for shipment to Puntarenas, the nearest commercial harbor from which the logs are exported to other countries, or utilizing them locally.

The most common species in order of their highest value previously and presently exploited in the area are:

"Palo de Brasil" (Chlorophora tinctoria)

> Previously used for the production of dyes. Now almost extinct in the area.

"Cedro amargo" (Cedrela mexicana)

> Fine lumber, easy to work and insect resistant. Previously exploited. Now scarce.

"Pochote" (Bombacopsis quinatum)

High quality lumber. Difficult to dry. Very similar to "cedro amargo."

"Espavel" (Anacardium excelsum)

Light and soft wood, not durable in contact with the ground. Easy to work. Used for canoes, rough lumber, general carpentry, construction.

"Roble de sabana" (Tabebuia pentaphylla)

Fine and durable wood. Used for furniture and construction.

"Guapinol" (Hymenaea Courbaril)

Various uses. Hard wood. Seed is used as food.

"Cenicero" (Pithecolobium saman)

Durable wood. Highly appreciated for construction.

"Guanacaste" (Enterolobium cyclocarpum)

Tall, beautiful tree with umbrella-shaped crown. Heavy, durable-wood. Used in construction and furniture.

"Alconoque" (possibly Licania arborea)

Durable and handy wood.

"Cristobal" or "Cachimbo" (Platymiscium pinnatum)

Highly appreciated wood for furniture and construction.

"Caoba" (Swietenia humilis)

Most highly valued tree for the quality and beauty of its wood. Used for furniture, ship interiors and cabinet work.

"María" (Calophyllum brasiliense)

High-priced timber. Used in carpentry, flooring, and furniture.

"Camibar" (Prioria copaifera)

Highly valued wood for plywood and veneer.

Other species utilized in the area are:

"Panamá"	- Sterculia apetala
"Madera negra"	- Gliricidia sepium
"Jiñocuave"	- Bursera simaruba
"Jícaro"	- Crescentia cujete
"Balsa"	- Ochroma lagopus
"Carao"	- Cassia grandis
"Ceiba"	- Ceiba pentandra
"Arbol de pan"	- Artocarpus communis
"Coyol"	- Acrocomia vinifera
"Palma real"	- Scheelea gomphococca

A census taken by the Ministry of Agriculture during the years 1949-1952 reveals the following amounts of lumber extracted from approximately the area studied:

Pochote	1,356.5	cúbicas*
Espavel	4,894.5	"
Guanacaste	509.5	"
Cristóbal	432.5	"
Cedro	140.5	"
Caoba	23.5	"
Cenicero	36.5	"
Alcornoque	1.0	"
Roble	39.5	"
María	13.0	"
Camibar	8.0	"
TOTAL	7,455.0	cúbicas or 2,415,420 bd ft

Actually, the figures are higher because only the quantities are given for which the logging operators paid forest tax to the Government. Timbers used for private consumption by the fincas are not included.

Sawmills

In the past there has never been a sawmill installed in that area. During the last six years an 8 h p driven, 12" circular saw with a manually-operated carriage has been utilized. This saw is only capable of sawing small logs for local lumber consumption in Mal Pais.

Mining Conditions

There is no knowledge of a mine in operation in that area. It is very unlikely that there are mining possibilities at the present. A more intensive geological survey of the peninsula, however, may reveal some mineral deposits in the "Geological Complex of Nicoya."

*A "cúbica" is equivalent to 27 cubic ft or 324 board feet and measures 18" x 18" x 12'.

Farming Conditions

The area studied is situated in the 5th district called Paquera of the Central Region of the Province of Puntarenas. This district consists of 17 villages, of which Cabuya and Mal Pais are included.

A census taken in 1955 revealed the following uses of land in the Paquera area:

Number of farms	793	
Farm land	16,154.4	manzanas*
Trees, brush, shrubs	1,724.3	"
Permanent pastures	14,848.0	"
Forests	7,890.3	"
Other lands	521.6	"
TOTAL	65,045.0	"
Average size of farms	49	manzanas

Agriculture

The principal crops of the area are beans, corn, rice, bananas and a banana variety used as human and animal food. Most of the agricultural farms are located around Cabo Blanco, Cabuya and Mal Pais in areas extending up to two km inland from the beaches. Cultivated areas are generally small.

The rough topography does not generally permit the farmers to keep the soils in good condition. The use of fire, lack of soil conservation practices and absence of fertilizers speed up the soil degeneration considerably. Most of the agricultural patches are on slopes ranging from 16 per cent to 65 per cent which also accelerates the process of soil erosion.

Around some farm houses small fruit tree orchards may be found but they are not well taken care of. Only with good climatic conditions, and relatively small insect and disease attacks are the farmers able to market some of the fruits.

Most of the agricultural crops, especially rice and corn, are annually heavily attacked by land crabs.

Livestock

In the area of Cabuya and Cabo Blanco numerous pastures are present. Dominant grasses are Hypharrhenia rufa, Panicum maximum, Panicum purpurascens, Melinis minutiflora and Paspalmum notatum. Especially during the dry season, when the grasses are dry, cattle are being driven into secondary brushlands for grazing.

*1 manzana = 6988.96 m^2

Other Commercial Activities

Besides living off the forest and agricultural crop production, people near the sea have developed certain skills in maritime fishing. Fish are very abundant in the shallow waters of the beaches. There is, however, no commercial fishing operation other than that for local consumption. Fishing is done from small dugout canoes and with simple fishing lines. No nets are used.

Agricultural Production Possibilities

In general, the production possibilities of agricultural crops are quite limited for a number of reasons. Primarily they are: (1) poor conditions of the soils, (2) very rough terrain, (3) thin layers of top soils which are quite easily eroded, (4) absolutely no technical assistance of the farmers in regard to soil conservation and agriculture, (5) lack of communication, (6) difficulties in obtaining private financial aid or loans from the banks.

CHAPTER III

Rivers, Annual Fluctuation of Water Levels

In the whole area surveyed not a single permanent river was observed. There are a number of intermittent streams which carry considerable amounts of water after each rainstorm during the rainy season but they dry out quickly after a short dry period. When the forest was still well preserved, some 15 years ago, certain brooks were reported to have had water all year round.

Fresh Water Availability

Throughout the area there are a great number of springs which never dry out. The water is clear, tasty and without any disease carriers close to the source. Springs are particularly numerous along the beaches.

Lakes

For a hilly, tropical terrain with good drainage facilities it was astonishing to find a small lake close to Playa Balsitas at about 50 m elevation. During the dry season the "laguna" measures about 150 x 150 ft. In the rainy season it increases to approximately 300 x 300 ft. The fluctuation was considerably small while forest surrounded the lake. A great number of waterfowl is reported to stay at the lake during the migratory period from September to January, but there are some waterfowl during the whole year. A large number of birds was observed around the lake.

CHAPTER IV

Wildlife

Although the group saw only a small amount of wildlife of which the congos, squirrels and lizards were predominant the following species are reported to be present in the area; but cannot be confirmed by this survey.

Herbivors:

Agouti (Dasyprocta punctata)
Black-browed nuriki (Alteles geoffroy frontatus)
Capuchin monkey (Cebus capucinus)
Chachalaca (Ortalis sp.)
Collared peccary (Tayassu tajacu)
Howler monkey or Congo (Alouatta villosa)
Mexican porcupine (Coendu mexicanus)
Paca (Agouti paca)
Variegated squirrel (Sciurus variegatoides)
White-lipped peccary (Tayassu peccari)
White-tailed deer (Dama virginiana)

Carnivors:

Armadillo (Dasypus novemcynctus)
Basilisk lizards (Basiliscus plumifrons)
Chameleon (Anolis sp.)
Coati (Nasua narica)
Collared anteater (Tamandus tetradactyla)
Fence lizard (Sceloperus sp.)
Hog-nosed skunk (Conepatus semistriatus)
Jaguar (Felis onca)
Jaguarundi (Felis yagnaroundi)
Kinkajou (Potos flavus)
Margay (Felis wiedii)
Ocelot (Felis pardalis)
Opossum (Didelphis marsupialis)
Puma (Felis concolor)
Raccoon (Procyon lotor)
Spotted skunk (Spilogale angustifrons)
Various Salientia
Various Serpents

This list is by no means complete. Some of the listed animals are at the point of becoming extinct due to the largely reduced forest cover, increased human and domesticated animal populations and unrestricted hunting.

Birds

Although a large variety of birds was observed their identification was very difficult for the group and no attempt will be made to list their scientific names. Birdlife, however, is still very abundant and definitely a great asset to the area. During the months of September to December, different varieties of migrating ducks make their home near Cabo Blanco. Mr. Wessberg on his finca near Moctezuma on April 10, 1962 at 5:30 p.m. counted between 15-32 birds per minute near the beach. Over the ocean great numbers of sea gulls and pelicans are always present. One of the outstanding features of the area is the island Cabo Blanco which is about one mile south of the tip of the peninsula and about one sq km area. During the rainy season this rocky island (no vegetation) appears to be grey or almost brown. In the dry season the rock turns white due to the guano of a very large rookery of frigate birds (Fregata magnificens) and pelicans. The bird population of the island may well exceed 1,000.

Insects

At the time of our survey there were very few insects which may irritate campers or hikers. There were a few mosquitos seen but they are not believed to be Malaria carriers. During the wet season, however, there may be more mosquitos seen. Large numbers of beautiful butterflies are present everywhere.

Snakes

North of Moctezumae some poisonous tropical rattlesnakes are frequently observed in brushlands. False Coral snakes, nonpoisonous, have been seen close to Cabuya. Lampropeltis doliata is recorded in the area. The only snake we saw on our survey appeared to be a vinesnake, green merging into brown with a white belly.

Fishing

Since all creeks are intermittent and dry during parts of the year all fishing is restricted to the open sea. On our trip from Puntarenas to Mal Pais by boat, we observed some sharks, dolphins and sea turtles. There is presently no commercial fishing operation in the area. Sports fishermen, however, frequently visit the area during weekends from as far a place as Florida. Most common gamefish are Sailfish and Marlin and sharks. Prospects for establishing a commercial fishing operation are slim because the coast is abrupt and the sea quite deep close to the shore.

Hunting and Fishing Regulations

Although hunting and fishing regulations are in existence in Costa Rica, very little has been done to enforce these regulations. In remote areas such as Cabuya or Mal Pais, law enforcement is extremely difficult. The inhabitants seem to hunt and fish all year round to provide meat for their families.

CHAPTER V

Human Description

The present population consists to the largest extent of a mixture of Spanish, Indian and a little Negro blood. Most families have about 6-8 children of minor age. The women generally tend the homes while the men work in the fields. Children who live away from population centers seldom attend school. Without exception all people are friendly towards strangers. Due to rumors they have heard, however, the local people are fearful of temporarily leaving the area as they possess no legal documents of land ownership.

Social Conditions

All residents with few exceptions are poor. Few families earn $200 (U.S. dollars) or more per year. Large families, some of them with 18 children, are the rule. Housing conditions are extremely poor. Neither of the houses which were visited had floors; they consisted of one single room with the beds made of wooden boards placed right below the roof. Open fireplaces are common. Building materials are bamboo sticks and palm leaves for roofing. The kitchen serves as a center for the members of the family and frequently as well for the domesticated animals, including dogs, cats, chickens, turkeys, ducks, horses, oxen and pigs.

Land Ownership

Some of the inhabitants of the area can be regarded as original colonists and very few of them hold legal title to their land due to the fairly steep price which the people have to pay to obtain the title. In many cases the price for obtaining a legal title is higher than the worth of the land. In practice, however, the inhabitants are regarded as the owners of the land they have cultivated.

According to an apparent Costa Rican law, all virgin forests belong to the Government. Mainly, for this reason the consequence of this law has been that the people who move into virgin areas have tried to cut and burn as much forest as fast as possible to become owners of the land. To stop this tendency the legislative assembly recently created a law permitting the state to declare virgin forests as being protected and untouchable. Due to lack of technical personnel and funds, little has been done by the Government to control cutting and burning virgin forest land and the law of protecting virgin forest areas remains largely theoretical.

Costs of Land in the Area

Stony, steep land in the southern tip presently sells for between $6-12 per acre. Average costs for stone-free and reasonably level land is $18-24 per acre.

A farm of one sq mile on the very tip of the peninsula was bought in November of 1960 for $3,000. Recently it was offered to Mr. Wessberg for $4,500, which probably could have been settled for the price of $3,700.

CHAPTER VI

Medical Problems

The health conditions prevalent in the region around Mal Pais and Cabuya depend directly on the low economy, social and sanitary standards prevalent. Numerous domestic animals and the crowded living conditions favor human infection either directly or through food contaminated with parasites and bacteria carried by domesticated animals. Drinking water is frequently not fresh because it is rarely taken from the springs but from small brooks some distance away from the springs. These conditions produce one of the major medical problems, Parasitosis. Most of the population is likely infected by parasites, either Protozoa, like Entameba hystolitica or Helmyutes like the Talnias, Trichuris trichiura and Enterobins vermicularis. Parasitosis is more common among children since the adults may have acquired some degree of resistance.

Malnutrition

The nutritious value of the diet is quite low. Diets consist predominantly of black beans, rice, eggs, bananas and occasionally meat. As a result most children and some adults are underweight and under-developed. Many adults have lost several teeth before reaching middle age. This could be the result of lack of fluorin in drinking water, in addition to low hygiene standards and lack of dental care.

Malaria and Yellow Fever

These two diseases have been very common in the area. They depend on mosquitoes as transmitters and on some human or natural reservoir. No cases were reported after eradication activities were carried out by the Ministry of Health.

Nevertheless, alertness is still required, since ecological conditions favor these two diseases due to the presence of mosquitos and monkeys.

Scenic Description

A trip by boat from Puntarenas to Cabo Blanco in the Gulf of Nicoya is certainly a great pleasure to experience. Some islands and a few villages along the east coast of the Peninsula give a romantic, peaceful impression. A large number of white, sandy beaches intermixed with coral rocks add to the scenic beauty. Flocks of sea gulls, Men-of-war birds and pelicans, swarms of dolphins, occasional sea turtles and sharks will excite any friend of nature. The mainland itself with many singing birds, the howl of the monkeys, large numbers of trails, caves and beautiful green virgin forests can compare quite favorably with many already existing National Parks in the world.

Flowering Trees and Wild Fruit Trees

The most conspicuous flowering trees are:

Tabebuia pentaphylla (Roble)
Colors ranging from pure white to almost pure red.

Tabebuia chrysantha (Cortez amarillo)
Flowers are bright yellow.

Cassia grandis (Carao)
Bright rose to red flowers.

Plumeria alba (Flor blanco)
Beautiful white flowers.

Gliricidia sepium (Madera negra)
Rose to red flowers.

All the above-mentioned species shed their leaves at the beginning of the dry season and shortly before they flower, making them very conspicuous from large distances. The largest proportion of species in this area bear seed from December to May. The most common wild fruit trees according to Mr. Wessberg are:

Diospyros ebenaster (Black zapote)
Achras zapota (Chico-zapote)
Calocarpum mamosum (Zapote colorado)
Lucuma nervosa (Ciguápa)

Physical Hazards

Hazards for visitors of the area may derive mostly from the sea. There are only a few sandy beaches where visitors can safely swim. About 95 per cent of the coast lines consist of sharp coral rock. Winds may arise and turn quickly presenting a hazard for small boats. The only wind protected landings are in Cabuya and Bahía Ballena. A rattlesnake bite is also hazardous since the distance to the hospital is great and transportation facilities scarce.

Recreational Situation

Presently the only recreationists visiting the area are sports-fishermen. On weekends various yachts and motorboats can be seen off the shores of Cabo Blanco. Sports-fishermen are coming as far as from Florida on weekends to fish in these waters for Blue Marlin, Sailfish and Sharks.

With increase of leisure time and with the development of passable roads by jeep or car to this area, the number of recreationists, not only among fishermen, but also among photographers, hikers, campers and scientists will rapidly increase in the future.

Favorable and Unfavorable Characteristics of Creating a National Park

A. Favorable characteristics are:

1. Due to increased interest in tropical scientific research during the past few years, this area can still offer something to most any scientific, biological researcher.
2. Several scenic attractions.
3. Relatively large numbers and varieties of wildlife reported but not seen.
4. One of the pleasant parts of Costa Rica to visit.
5. Unique forest formation and relatively great variety of tree species present, of which there is apparently little left in Costa Rica.
6. Has recreational attractions.
7. Fishing off the coast is good.
8. Archaeological explorations have until now only scratched the surface.
9. Increased support and understanding by the people and the government to set aside National Parks in various regions of Costa Rica for future generations.
10. Price of land is still relatively cheap. It will greatly increase in the near future with the expected explosive increase of population.
11. If left undisturbed from now on the area could provide ideal ecological conditions for fauna and flora.
12. There are no National Parks set aside presently on the American Continent which have the same ecological conditions. The Pittier National Park in Venezuela comes closest to it.

B. Unfavorable Characteristics

1. Only a small percentage of the original forest cover is preserved.
2. A relatively large number of people are already living in the area.
3. The initial price of purchasing the land and resettling the present inhabitants in other areas will be high.
4. Under present circumstances, the Government of Costa Rica will not be able to enforce the laws to keep the steady inflow of squatters out.
5. It will be difficult for the Government of Costa Rica, under present circumstances, to annually provide proper funds for the maintenance of a National Park as remote as Nicoya.
6. Access to the area is still very limited.
7. There may be even more attractive areas, less disturbed and less densely populated, in Costa Rica worthwhile to be set aside as National Parks.
8. The Nicoya area, under proper forest management, could develop into one of Costa Rica's best suited areas to produce valuable timbers for the local market and for export.
9. Law enforcement, because of the area's remoteness, will be extremely difficult and costly.

Weighing the favorable conditions against drawbacks, under the present situation, it will be very problematic for the Government of Costa Rica to establish a National Park in the southern tip of the Nicoya Peninsula by its own resources available for that purpose. It seems more logical to set the area aside as a Wildlife Refuge, Wilderness Area or Forest Reserve which in future years may be turned into a National Park.

CHAPTER VII

Considerations as to Setting This Area Aside

1. If the area still under virgin conditions is to be saved from complete destruction in the next 3-5 years, some action should be taken immediately.

2. Some of the wildlife species can only be saved from extinction in the area of Cabo Blanco if all burning and further clearing of land is stopped as soon as possible.

3. If the area is to be set aside as National Park Wildlife Refuge, Wilderness Area or Forest Reserve it should be done soon. Every day lost will make the proposition more expensive and reduce the values of the land set aside.

4. Increased demand, especially by scientific organizations from the U.S.A. for study areas under different ecological conditions in Costa Rica, call for immediate consideration of areas to be set aside for scientific training and research.

The following considerations assume that the area is to be set aside:

1. It will be necessary to construct a fence to demarcate the boundary lines.

2. Three to five guards recruited from the local population should be put on full salary for their duty.

3. Presently residing families within the boundaries should be bought off their land and provided with a new place to live under similar conditions. If they are only bought off their land, they will drift around for a short time and return to the area.

4. Local guards should be provided with some basic fire fighting equipment.

5. Reasons for law enforcement against burning, illegal hunting and fishing should be explained to people living close to the boundaries by agricultural extension agents.

6. The small island of Cabo Blanco should, without hesitation, be declared a bird preserve.

CHAPTER VIII

Appendixes

LIST OF NAMES OF FAMILY HOUSEHOLDS LIVING IN THE CABO BLANCO AREA

Maximino Morales

Jaime Mayorga (lives in Delicias)

Victorio Mendoza

Atiliano Mendoza

Carlos Martínez

Nemesio Pineda

Abelardo González

Victor Rodríguez

Carmelino Mejía

Jorge Morales

José Joaquín Rodríguez

Lucas Rodríguez

Luis Rodríguez

Víctor Otárola

Lelo Miranda

Facundo Calero

Constantino Sánchez

Juan Rafael Tenorio

Jova Avilés

Rogelio Rúiz

Marcelino Sánchez

Nicolas González

Alejandro Avilés

Virgilio Avilés

Nino Tenorio

César Barrios

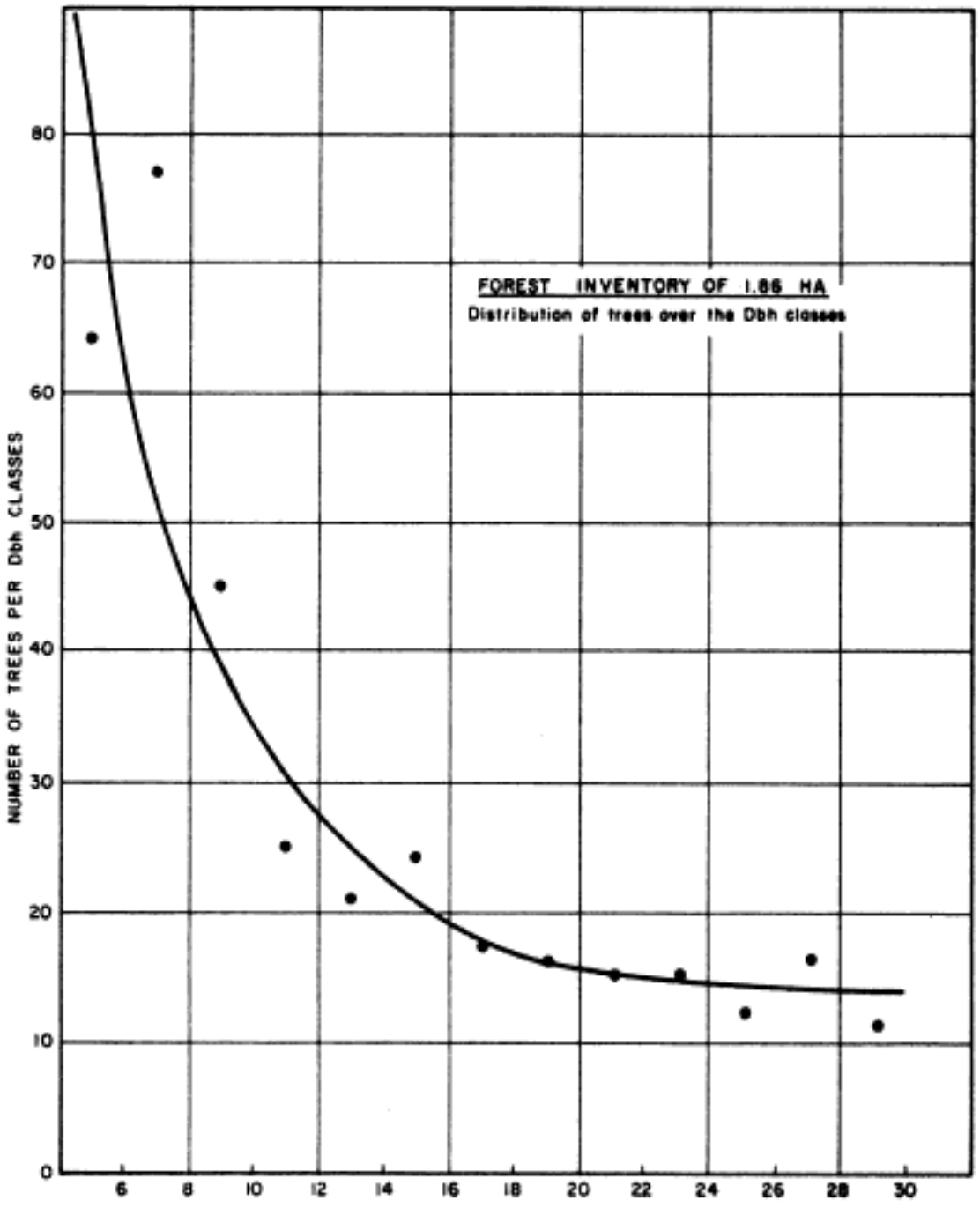
Ramón Avila

Francisco López

Rómulo Mora (lives somewhere else)

Pedro Nolasco

There are some others.



NUMBER OF TREES IN DIFFERENT DBH CLASSES

Local Name	Scientific Name	Dbh in inches 4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28 or more	Total	Per cent
Azulillo	Hamelia patens	4	6	3	3	4	10	1		1	1		3		36	11.8
Balsa	Ochroma lagopus		1												1	0.3
Roble	Tabebuia pentaphylla	3	6	3	4	1	2	1							20	6.6
Pochote	Bombacopsis quinatum	7	7	5	1	1	1		1					4	27	8.8
Capulín	Muntingia calabura	15	5	4	2	1									27	8.8
Espavel	Anacardium excelsum	1		1				1						1	4	1.3
Tucuico	Ardisia sp.	2	1												3	1.0
Madroño	Calycophyllum candidissimum	10	15	11	1	2	1		1						41	13.4
Chaperno	Lonchocarpus spp.	1	6	1	1										9	3.0
Indio desnudo	Bursera simaruba			1	1		1								3	1.0
Jobo	Spondias mombin	1	1		1		1							1	5	1.6
Guácimo	Guazuma ulmifolia													2	2	0.7
Níspero	Achras zapota	5	6	5	4	3	2	2	2	3	1		3	4	40	13.1
Ojoche	Brosimum costaricanum	1	7	3	2	2	2		1	1				4	23	7.5
Fruta pava	Didymopanax morototoni	1	1												2	0.7
Yayo	Xylopia grandifolia	1	1				1								3	1.0
Lorito	Pithecolobium arboreum		1			1									2	0.7
Quebracho	Leguminosae			2							1				3	1.0
Guayaba	Terminalia chiriquensis	1	1		2	1						1			6	2.0
Camíbar	Prioria copaifera											1		1	2	0.7

NUMBER OF TREES IN DIFFERENT DBH CLASSES (Cont.)

Local Name	Scientific Name	Dbh in inches 4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28 or more	Total	Per cent
Quina	Nectandra glabrescens(?)		1		2		1								4	1.3
Copalchi	Croton sp.	1			1										2	0.7
Manteco	Cupania guatemalensis?	2	3	2		3									10	3.3
Guabo	Inga spp.							1							1	0.3
Guarumo	Cecropia peltata	1						1	1						3	1.0
Flor blanco	Plumeria alba		1			1									2	0.7
Carao	Cassia grandis	5	7	1											13	4.3
Danto	Reupala complicata						1								1	0.3
Tercio-pelo	Sloanea picapica													1	1	0.3
Yos	Sapium sp.	1									1				1	0.3
Zapotillo	Pouteria sp.	1									1				2	0.7
Canelo	Ocotea veraguensis			1											1	0.3
Pavo macho	Araliaceae			1											1	0.3
Ceiba	Ceiba pentandra	1				1									2	0.7
Quizarrá	Lauraceae			1			1								2	0.7
Total		64	77	45	25	21	24	7	6	5	5	2	6	18	305	
Percentage		21.0	25.2	14.7	8.2	6.9	7.9	2.3	2.0	1.6	1.6	0.7	2.0	5.9		100.0
Number of trees as calculated on a per ha (2.47 acres) basis in the forest		80	80	50	40	30	50	20	20	10	10	10	10	50	460	

A view of the Ocean beach in "Mal Pais" at low tide.

Typical family household of the Southern tip of the Nicoya Peninsula in Costa Rica.

The untouched dry forest formation.

The first "Parasitos" have arrived to clear small patches of forest.

Stage 1

Stage 2

Successive stages of clearcutting the forest with machete and axe.

Clearcut and burn is completed. The site is ready to be planted into corn, rice, cotton or beans.

Sandy beaches of "Playa Balsitas" at Cabo Blanco.

Island "Cabo Blanco." Black rock turned white from bird droppings during dry season.

Our "residence" at Playa Balsitas.

CONVENCION PARA LA PROTECCION DE LA FLORA, DE LA FAUNA Y DE LAS BELLEZAS ESCENICAS NATURALES DE LOS PAISES DE AMERICA

Los Gobiernos Americanos deseosos de proteger y conservar en su medio ambiente natural, ejemplares de todas las especies y géneros de su flora y su fauna indígenas, incluyendo las aves migratorias, en número suficiente y en regiones lo bastante vastas para evitar su extinción por cualquier medio al alcance del hombre: y

Deseosos de proteger y conservar los paisajes de incomparable belleza, las formaciones geológicas extraordinarias, las regiones y los objetos naturales de interés estético o valor histórico o científico, y los lugares donde existen condiciones primitivas dentro de los casos a que esta Convención se refiere; y

Deseosos de concertar una convención sobre la protección de la flora, la fauna, y las bellezas escénicas naturales dentro de los propósitos arriba enunciados, han convenido en los siguientes artículos:

Articulo I

Definición de los términos y expresiones empleados en esta Convención.

1. Se entenderá por PARQUES NACIONALES:

Las regiones establecidas para la protección y conservación de las bellezas escénicas naturales y de la flora y la fauna de importancia nacional, de las que el público pueda disfrutar al ser puestas bajo la vigilancia oficial.

2. Se entenderá por RESERVAS NACIONALES:

Las regiones establecidas para la conservación y utilización bajo vigilancia oficial, de las riquezas naturales, en las cuales se dará a la flora y la fauna toda protección que sea compatible con los fines para los que son creadas estas reservas.

3. Se entenderá por MONUMENTOS NATURALES:

Las regiones, los objetos o las especies vivas de animales o plantas de interés estético o valor histórico o científico a los cuales se les da protección absoluta. Los Monumentos Naturales se crean con el fin de conservar un objeto específico o una especie determinada de flora o fauna declarando una región, un objeto o una especie aislada, monumento natural inviolable excepto para realizar investigaciones científicas debidamente autorizadas, o inspecciones gubernamentales.

4. Se entenderá por RESERVAS DE REGIONES VIRGENES:

Una región administrada por los poderes públicos, donde existen condiciones primitivas naturales de flora, fauna, vivienda y comunicaciones, con ausencia de caminos para el tráfico de motores y vedada a toda explotación comercial.

5. Se entenderá por AVES MIGRATORIAS:

Las aves pertenecientes a determinadas especies, todos los individuos de las cuales o algunos de ellos, cruzan, en cualquier estación del año, las fronteras de los países de América. Algunas especies de las siguientes familias de aves pueden citarse como ejemplos de aves migratorias: Charadriidae, Scolopacidae, Caprimulgidae, Hirundinidae.

Articulo II

1. Los Gobiernos Contratantes estudiarán inmediatamente la posibilidad de crear, dentro del territorio de sus respectivos países, los parques nacionales, las reservas nacionales, los monumentos naturales, y las reservas de regiones vírgenes definidos en el artículo precedente. En todos aquellos casos en que dicha creación sea factible se comenzará la misma tan pronto como sea conveniente después de entrar en vigor la presente Convención.

2. Si en algún país la creación de parques o reservas nacionales, monumentos naturales o reservas de regiones vírgenes no fuera factible en la actualidad, se seleccionarán a la brevedad posible los sitios, objetos o especies vivas de animales o plantas, según sea el caso, que se transformarán en parques o reservas nacionales, monumentos naturales o reservas de regiones vírgenes tan pronto como a juicio de las autoridades del país, lo permitan las circunstancias.

3. Los Gobiernos Contratantes notificarán a la Unión Panamericana de la creación de parques nacionales, reservas nacionales, monumentos naturales y reservas de regiones vírgenes, y de la legislación y los sistemas administrativos adoptados a este respecto.

Articulo III

Los Gobiernos Contratantes convienen en que los límites de los parques nacionales no serán alterados ni enajenada parte alguna de ellos sino por acción de la autoridad legislativa competente. Las riquezas existentes en ellos no se explotarán con fines comerciales.

Los Gobiernos Contratantes convienen en prohibir la caza, la matanza y la captura de especímenes de la fauna y la destrucción y recolección de ejemplares de la flora en que los parques nacionales, excepto cuando se haga por las autoridades del parque o por orden o bajo la vigilancia de las mismas, o para investigaciones científicas debidamente autorizadas.

Los Gobiernos Contratantes convienen además en proveer los parques nacionales de las facilidades necesarias para el solaz y la educación del público, de acuerdo con los fines que persigue esta Convención.

Articulo IV

Los Gobiernos Contratantes acuerdan mantener las reservas de regiones vírgenes inviolables en tanto sea factible, excepto para la investigación científica debidamente autorizada y para inspección gubernamental, o para otros fines que persigue esta Convención.

Articulo V

1. Los Gobiernos Contratantes convienen en adoptar o en recomendar a sus respectivos cuerpos legislativos competentes, la adopción de leyes y reglamentos que aseguren la protección y conservación de la flora y la fauna dentro de sus respectivos territorios y fuera de los parques y reservas nacionales, monumentos naturales y de las reservas de regiones vírgenes mencionadas en el artículo II. Dichas reglamentaciones contendrán disposiciones que permitirán la caza o recolección de ejemplares de fauna y flora para estudios o investigaciones científicas por individuos y organismos debidamente autorizados.

2. Los Gobiernos Contratantes convienen en adoptar o en recomendar a sus respectivos cuerpos legislativos la adopción de leyes que aseguren la protección y conservación de los paisajes, las formaciones geológicas extraordinarias, y las regiones y los objetos naturales de interés estético de valor histórico o científico.

Articulo VI

Los Gobiernos Contratantes convienen en cooperar los unos con los otros para promover los propósitos de esta Convención. Con este objeto prestarán la ayuda necesaria, que sea compatible con su legislación nacional, a los hombres de ciencia de las República americanas que se dedican a las investigaciones y exploraciones; podrán, cuando las circunstancias lo justifiquen, celebrar convenios los unos con los otros o con instituciones científicas de las Américas que tiendan a aumentar la eficacia de su colaboración y pondrán a la disposición de todas las Repúblicas, por igual, ya sea por medio de su publicación o de cualquier otra manera, los conocimientos científicos que lleguen a obtenerse por medio de estas labores de cooperación.

Articulo VII

Los Gobiernos Contratantes adoptarán las medidas apropiadas para la protección de las aves migratorias de valor económico o de interés estético o para evitar la extinción que amenace a una especie determinada. Se adoptarán medidas que permitan, hasta donde los respectivos Gobiernos lo crean conveniente, utilizar racionalmente las aves migratorias, tanto en el deporte como en la alimentación, el comercio, la industria y para estudios de investigaciones científicas.

Articulo VIII

La protección de las especies mencionadas en el Anexo a esta Convención es de urgencia e importancia especial. Las especies allí incluídas serán protegidas tanto como sea posible y sólo las autoridades competentes del país podrán autorizar la caza, matanza, captura o recolección de ejemplares de dichas especies. Estos permisos podrán concederse solamente en circunstancias especiales cuando sean necesarios para la realización de estudios científicos o cuando sean indispensables en la administración de la región en que dicho animal o planta se encuentra.

Articulo IX

Cada uno de los Gobiernos Contratantes tomará las medidas necesarias para la vigilancia y reglamentación de las importaciones, exportaciones y tránsito de especies protegidas de flora o fauna, o parte alguna de las mismas, por los medios siguientes:

1. Concesión de certificados que autoricen la exportación o tránsito de especies protegidas de flora o fauna, o de sus productos.

2. Prohibición de las importaciones de cualquier ejemplar de la fauna o flora protegido por el país de origen, o parte alguna del mismo, si no está acompañado de un certificado expedido de acuerdo con las disposiciones del Párrafo 1 de este artículo, autorizando su exportación.

Articulo X

1. Las disposiciones de la presente Convención no reemplazan los acuerdos internaciónales celebrados previamente por una o más de las altas partes contratantes.

2. La Unión Panamericana suministrará a los Gobiernos Contratantes toda la información pertinente a los fines de la presente Convención que le sea comunicado por cualquier museo nacional, u organismo nacional o internacional, creado dentro de sus jurisdicciones e interesado en los fines que persigue la Convención.

Articulo XI

1. El original de la presente Convención en español, inglés, portugués y francés será depositado en la Unión Panamericana y abierto a la firma de los Gobiernos Americanos el 12 de Octubre de 1940.

2. La presente Convención quedará abierta a la firma de los Gobiernos Americanos. Los instrumentos de ratificación serán depositados en la Unión Panamericana, la cual notificará el depósito y lafecha del mismo, así como el texto de cualquier declaración o reserva que les acompañe, a todos los Gobiernos Americanos.

3. La presente Convención entrará en vigor tres meses después de que se hayan depositado en la Unión Panamericana no menos de cinco ratificaciones.

4. Cualquier ratificación que se reciba después que la presente Convención entre en vigor tendrá efecto tres meses después de la fecha del depósito de dicha ratificación en la Unión Panamericana.

Articulo XII

1. Cualquiera de los Gobiernos Contratantes podrá denunciar la presente Convención en todo momento dando aviso por escrito a la Unión Panamericana. La denuncia tendrá efecto un año después del recibo de la notificación respectiva por la Unión Panamericana. Ninguna denuncia, sin embargo, surtirá efecto sino cinco años después de entrar en vigor la presente Convención.

2. Si como resultado de denuncias simultáneas o sucesivas el número de Gobiernos Contratantes se reduce a menos de tres, la Convención dejará de tener efecto desde la fecha en que, de acuerdo con las disposiciones del Párrafo precedente, la última de dichas denuncias tenga efecto.

3. La Unión Panamericana notificará a todos los Gobiernos Americanos las denuncias y las fechas en que comiencen a tener efecto.

4. Si la Convención dejara de tener vigencia según lo dispuesto en el Párrafo segundo del presente artículo, la Unión Panamericana notificará a todos los Gobiernos american os la fecha en que la misma cese en sus efectos.

EN FE DE LO CUAL, los infrascritos plenipotenciarios, después de haber depositado sus Plenos Poderes, que se han encontrado en buena y debida forma, firman y sellan esta Convención en la Unión Panamericana, Washington, D. C.; en nombre de sus respectivos Gobiernos, en las fechas indicadas junto a sus firmas.

POR BOLIVA:
(f.) Luis F. Guachalla — Octubre 12, 1940 (SELLO)

POR CUBA:
(f.) Pedro Martínez Fraga — Octubre 12, 1940 (SELLO)

POR EL SALVADOR:
(f.) Héctor David Castro — Octubre 12, 1940 (SELLO)

POR NICARAGUA:
(f.) León de Bayle — Octubre 12, 1940 (SELLO)

POR PERU:
(f.) M. de Freyre S. — Octubre 12, 1940 (SELLO)

POR LA REPUBLICA DOMINICANA:
(f.) Julio Vega Battlle — Octubre 12, 1940 (SELLO)

POR THE UNITED STATES OF AMERICA:
(f.) Cordell Hull — Octubre 12, 1940 (SELLO)

POR VENEZUELA:
(f.) Diógenes Escalante — Octubre 12, 1940 (SELLO)

POR ECUADOR:
(f.) C. E. Alfaro — Octubre 12, 1940 (SELLO)

A BRIEF ECOLOGICAL SURVEY OF THE SOUTHERN TIP OF NICOYA PENINSULA, COSTA RICA

John Milton

Introduction

During the month of April in 1962, I had the interesting opportunity of joining a survey team led by Mr. Waldemar Albertin, associate forester with the Departamento de Dasonomía of the IICA in Turrialba. The purpose of the survey was to make an evaluation of the tip of Costa Rica's Nicoya Peninsula, in order to determine its suitability for a proposed natural preserve. The following report emerged from my studies as ecologist of the group. I have made free use of a great deal of work and data gathered by all of the members of the team, especially in the case of soil analysis, where I was greatly helped by Jean François.

A general examination of the edaphic, climatic, and biotic factors acting upon the area will be attempted here, in order to give at least a preliminary ecological description of the region. In particular, the short time for an analysis of the climatic factors presents a great lack in the realm of temperature, relative humidity, evapotranspiration, and precipitation values, but I felt that a brief examination was far better than no examination at all and many facets of the climate can valuably be inferred from the available data.

Geological History

During the Pensilvanian and middle Cretaceous periods, the Caribbean Sea extended over what is now the Peninsula of Nicoya, including the lower tip of the peninsula, the Cabo Blanco area (Amador, 1954). It was during this period that the formation, Complejo de Nicoya, was laid down in long, narrow sedimentary beds that run along the eastern tip of the peninsula from a few kilometers north of Cabo Blanco to Punta Piedra Amarilla, where it spreads out widely to the west. The great bulk of this formation dates back to the Cretaceous Inferior, but nowhere is it of great importance outside of the narrow eastern coastal strip of the Cabuya area.

In the Eocene, the Nicoya area rose out of the sea, as did much of the rest of Costa Rica and Panamá, but the ancient link between the Caribbean and Pacific remained sea-covered across the Isthmus of Lake Nicaragua, not emerging until the Oligocene Superior. Although much of the Peninsula remained above sea level during the Oligocene, parts of the coastal sediments of the Masachapa Formation were laid down in the Oligocene Tertiary above El Carmen on the west coast, just north of the study area. The major portion of the Cabo Blanco area, its steep hills and high plateaus to the north, and the west coast of the peninsula south of El Carmen were laid down in the Miocene Tertiary. This is the formation known as Punta Carballo. Finally, deriving from the start of the Pliocene Tertiary, the formation Montezuma was deposited, reaching south into the central part of the northern hills of the study area, south of San Isidro.

The Pleistocene was marked by various patterns of water erosion which are still in the process of cutting away the central hills and plateaus, slowly changing the face of the land. With the introduction of cutting and burning of the protective forests, this geological process has been greatly speeded up, causing tremendous amounts of soil to be lost in the cut over areas during the short, but powerful rains that occur during the rainy season.

Geographic Description

The Peninsula of Nicoya juts out and down from the Northwestern corner of Costa Rica with the Pacific Ocean on its western coast and the Gulf of Nicoya on its eastern coast. Lying some 70 miles along its longest axis, Cabo Blanco forms the southernmost tip of the peninsula. The only all-weather road in the Peninsula runs down from Liberia, on the Pan American Highway, down through the middle of the upper half of the peninsula to end at Puerto Jesús. Most of the Pacific coast, and nearly all of the southern half of Nicoya are covered by only a few ox and jeep trails.

Politically, Nicoya lies within the Province of Puntarenas, but its long separation from the rest of Costa Rica has left it a land apart, neglected, and until recently, little studied. The study area with which the survey team was concerned covered only the very tip of the Peninsula, lying south of a line drawn from Mal País to Cabuya, which would be about four miles across. A line drawn from the tip of Cabo Blanco due north to the point of intersection with this east-west line would cover a little under four miles. In general, the center of this area is covered by a rolling plateau at around 300 meters above sea level. There is a lesser plateau on the southeast at 200 meters, and a higher one in the north at 350 meters, all three inter-connected by more abrupt slopes. On all sides of these high plateaus, which cover about two square miles of the study area, very steep slopes drop away, with numerous ravines dissecting them. In all parts of the study area, except on the northeast, in the area of the Cabuya flats, the steep slopes drop sharply down to the sea. The heavy erosion that has taken place since the start of the Pleistocene has completely dissected the former plateau in many places, especially in the portion just east of Mal País. Here the landscape is a confused jumble of rounded hills and steep valleys, with no trace of the former plateau left. To the south the erosional process is less advanced, and some portions of the plateau still exist, although the streams eating into its flank are continuing to carry the land into the sea at an even faster clip once it has been cleared for agriculture.

Cabo Blanco itself is separated from the main height of land by a narrow gooseneck of low ridge which joins the humped cape to the rest of the peninsula. Under half a mile in diameter, most of the cape is forested, and from either shore, on the northwest and northeast, long sand beaches curve up their respective coasts, semi-protected by the cape at one end and rocky points at the other. The Playa Balsitas, the beach lying within the western cove, is especially wild and beautiful with large portions of forest coming right down to the shore. In its north end sand is non-existent, save for one or two tiny patches. The rest of the beach at this end is made up of large cobblestones which are being constantly tossed and churned by the breakers. The further south one goes along the shore, however, the smaller become the stones until at just about the halfway point the beach becomes sandy. At the very southern limits, a very fine, almost powdery sand is encountered, with some past evidence that the area is at least occasionally used by sea-turtles to lay their eggs.

A little over a mile due south of the Cape lies Isla Cabo Blanco, a great, steep-walled rock approximately 500 meters long and 150 meters wide. During the dry season the rock turns bright white due to the collected guano from a very large rookery of magnificent frigate-birds (Fregata magnificens). The colony visible at midday was well over 500, and the total population may well be over 1000.

During the Pleistocene, as large areas of the plateau were eroded away by the constant encroachment of the streams that were cutting into its surface, large amounts of sediment were washed down and out of the short, steep canyons and into the open flats and sea. Alluvial fans built up here and there, especially in the northeast part of the study area, where the steep slopes of the plateau's eastern border grade down gently into foothills and flats around Cabuya. In the bay of Playa Balsitas as well, there is a broad reach of shallows derived from the action of water erosion. Here and there, especially in the area 700 yards south of Mal País, caves have been carved out of the limestone rock. I entered a series of three caves in all, all of which were characterized by large initial chambers with high ceilings, quickly narrowing down to a restricted area towards the end. Typical stalagtite flow formations are found in all of the caves, and great numbers of leaf-nosed bats spend the day among the grooves of the flowstone. One of the caves is of particular interest, being found on the top of a hill slope where it passes completely under the hill with a large central chamber and two large entrances on either side. It is possible to see right through the hill, whose top is about 100 feet above the entrances, creating the effect of a natural bridge or tunnel.

In 1522, under the first Spanish expedition into the Nicoya, the conquerors discovered that the whole of the peninsula was occupied by the Chorotega Indians, a people who represented the southernmost limit of the great Mexican-Guatemala Pre-Hispanic civilization (Wagner, 1958). Inasmuch as the Cabo Blanco area is the southernmost point of the Nicoya Peninsula, it would also represent the very southern limit, geographically, of Middle American high culture. The means of subsistence today is essentially the same as it was in the days of the Chorotega, who followed slash and burn agriculture and grew maize, beans, cotton, cacao, and fruits. On the finca of Mr. Mayorga, on the western coast of the area, there is a large stone, about six feet in diameter, and carved into the image of a tortoise. On a nearby hillside, long rows of stones were also reported by Mayorga, presumably related to the stone tortoise. The existence of this turtle motif, which is representative of the culture, definitely extends their range down to the tip of the peninsula. Pottery, pipes, occasional goldwork, and shell mounds are also reported by the people to exist in the area. As a result of all this evidence, we can assume that the area has been supporting agriculture to some extent back into pre-Hispanic times, a factor to be kept in mind in considering the ecological communities found in the area today.

Edaphology

The soils of the Cabo Blanco area are derived almost entirely from coastal sedimentary limestone. Soil profiles were taken from both the high, level plateaus and a variety of slopes from steep to moderate. Whenever possible, natural fresh exposures were utilized, such as erosional gullies, uprooted tree holes, and slides. In other cases, pits were dug in representative areas. pH readings were taken with pHydracid papers, which were found to be accurate within 0.5 pH. pH readings taken of streams in the area were found to be uniformly 7, or neutral, due to the high incidence in the soil of limestone bedrock and thin humus, layer, which counteracted each other in solution.

In general, three basic soil types were noted:

1. Black Clay Soil
2. Grey Clay Loam
3. Grey Alluvial Clay

As was noted before, three different types of topography were encountered, and the three soil types each correspond closely to a particular class of topography. High level plateaus, steep slopes, and gently sloping alluvial basins are all different due to the erosion that has been taking place in the area since the Pleistocene. The climate is generally uniform, except for a slightly higher amount of precipitation on the south-facing slopes, which tend to pick up more rainfall during the rainy season as the dry Northeast Trades diminish in intensity and the moisture-laden winds begin to move in off the Pacific. Most of the soil variation, however, seems to be more directly due to erosional differences. The level plateaus tend to build up a richer, more highly developed profile than the slopes since erosion operates far less effectively in these areas. The covering of rich forest protects the soil from leaching in the short, but very heavy rains characteristic of the climate. On the steep slopes, however, erosion is of great effect, and the buildup of soil is constantly being carried away by erosion, even under heavy forest, to eventually be deposited in the alluvial soils below or in the sea. Where areas of slope have been exposed for agricultural use, erosion quickly takes the upper hand and the equilibrium between soil buildup and soil erosion that was true under conditions of forest cover is destroyed. In several years the topsoil is gone, scrubby weed growth invades the cleared areas, and the slow buildup towards a climax equilibrium begins all over again.

1. Black Clay Soil

This is the soil characteristic of the high, level plateaus, where the slope is under ten degrees, allowing organic deposition and buildup.

0 - 5 cm: Silty clay loam, dark black, of angular block structure and very well developed. Sticky when wet, cracks present in soil when dry. Excellent development of root hairs.

5 - 37 cm: Silty clay, black, angular blocks are less well developed than above. Very sticky. No mottling (this would be an indication of oxydation-reduction). Excellent root development. Transition into following horizon gradual.

Below 37 cm: Compact clay, dark brown in color. Massive structure. Round nodules of limestone present. No roots.

2. Grey Clay Loam

This is a lithosole characteristic of steep slopes over ten degrees and including a high percentage of rocks, varying from 60 to 70 per cent of the total upper profiles. This loam was the most common soil in the study area and supported nearly all of the remaining undisturbed forest.

0 - 3 cm: Dead leaves and other vegetable debris, largely undecomposed. Lower 1 cm partially decomposed.

3 - 5 cm: Fine sandy loam, dark grey or brown. Not plastic. Not sticky. Hair roots well-developed, indicating good aeration. pH 6.5

5 - 20 cm: Coarse gravelly clay loam. Grey. Not sticky and without specific structure. High percentage of rocks. No change from one profile to the next. Color variable from light to medium to dark grey. pH7. These soils are partly alluvial on lower sides of hills.

3. Grey Alluvial Clay

These soils are characteristic of the lower plains and gradual slopes, as in the Cabuya region of the northeast sector of the study area. Generally, these soils are deeper and more stable. The thickness of the grey alluvial clay is about one meter. When wet, the soil agglutinizes; when dry, the soil cracks. Fertility is moderate, and given proper drainage and soil moisture, the soil is good for crops.

Climate

Rainfall data for the southern tip of Nicoya have been taken by the Servicio Meteorologico y Sismológico of Costa Rica in Cobano, which lies just to the north of the study area about 16 kilometers from the tip of Cabo Blanco. Cobano lies inland from the coast about seven kilometers, on the eastern side of the watershed. The data appears to be a good reflection of the rainfall in the Cabo Blanco area, although there are doubtless some variations between the two zones.

No temperature records are available over a yearly period, but I was able to make short term measurements during the period of our stay in order to obtain at least an indication of conditions occurring in the Cabo Blanco area. Ecologically, the most important factors directly affecting plant formations are:

1. Water Contact of Soil
2. Soil Solutes
3. Soil Air
4. Temperature
5. Light
6. Humidity

For the measurement of climatic factors, a hygrothermograph was utilized, along with three maximum-minimum thermometers and a psychrometer, in order to obtain temperature and relative humidity records. A measure of the total light radiation received was made with the use of two livingston atmometers, one with a white clay bulb, the other with a black clay bulb. The difference between the amount of water evaporated by the two in the open was taken to be a measure of the amount of radiation falling on the area over a given period of time. In addition to these direct factors, windspeed was taken twice a day, and an altimeter was utilized for the determination of elevation.

The peninsula of Nicoya, when taken as a whole, shows considerable variation in the amount of rainfall per year. There are three major zones of rainfall crossing the peninsula in a northwest-southeast line, paralleling the central mountain ranges of Costa Rica to the east. In the northernmost zone, rainfall is least, ranging between one and two meters per year. The central zone of the peninsula, including the towns of Nicoya and Sta. Cruz, receives more or less about two meters of rainfall per year. The southernmost zone, which falls below a line running from the small town of Pochote on the east and Samara on the west, receives the highest rainfall of all, from two to three meters of rain per year. From this it is apparent that:

1. There is a tendency towards increased rainfall the further south one goes on the peninsula.

2. In general, along points of the same latitude, there is a higher rainfall on the west coast of Nicoya than on the east.

3. The Cabo Blanco area falls into the area of highest rainfall on the peninsula, a factor of great importance in any consideration of the overall pattern of vegetation.

The following two tables were compiled from data generously supplied by the Servicio Meteorologico from their station at the town of Cobano, altitude: 152 meters.

TABLE I

Days with Rain

Year	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
1959									14	19	12	0
1960							25	15	11	22	7	0
1961	0	0	0	8	9	18	17	15	17	23	15	6
1962	0											

TABLE II

Rainfall (in mm)

Month	1959	1960	1961	1962
January			0.0	0.0
February			0.0	
March			0.0	
April			28.8	
May			127.9	
June			275.5	
July		332.2	386.8	
August		534.7	249.1	
September	327.0	124.1	356.9	
October	428.2	766.7	694.2	
November	179.8	88.4	218.3	
December	0.0	0.0	39.7	
			2377.2	

From the preceding data it is apparent that the dry months are from December through March, with the dry season beginning quite abruptly in December, and merging more slowly into the rainy season in April. The rainy season extends from May through November, with the heaviest periods of rain coming in October. Rains are often of short duration in the area, but are extremely heavy while occurring, one of the main reasons for the heavy erosion found. A good deal of the rainfall that is not lost through surface runoff and evaporation goes into the water table, accounting for the numerous springs found along the slopes.

Up until a few years ago, a small lake, called simply "Laguna" by the local people, existed on the upper part of the south-facing slope draining into Playa Balsitas. At that time, the slopes above and around the lake were all in forest and great numbers of waterfowl frequented its surface. Less than three years after partial clearing of the surrounding slopes, the Laguna was nearly filled with silt from erosion, creating a swamp during the rainy season and leaving only a small pool of water during the dry season. Under these conditions of short, but powerful rainfall, all efforts should be made to prevent all of the slopes over ten degrees from ever being cleared of their protective forest.

The tip of Nicoya lies within the 24° to 27° C Isotherm, which places it within the tropical formations of Holdridge, (1947). Differences between day and night temperatures are more pronounced than might be expected in areas of higher humidity. A series of max.-min. readings were taken in three different locations: Station 1, at 10 meters above sea level, on open ground at the north end of Playa Balsitas; Station 2, at 200 meters above sea level in high forest above Station 1; Station 3, also at 200 meters, but at the edge of a milpa clearing in the forest of Station 2.

TABLE III

Max. Min. Temp., Station 1 (1962)

Month	Date	Maximum (°F)	Minimum (°F)
April	9	92	77
April	10	91	76
April	11	--	74

These readings are calculated according to the 24 hours previous to 6 P.M. of the day indicated, at 1 meter above the ground.

TABLE IV

Max.-Min. Temp., Station 2 and 3 (1962)

Station	Maximum (°F)	Minimum (°F)
Station 2	89	74
Station 3	92	72

The maximum-minimum readings of Table IV are for a time period of from April 9 at 7:00 a.m. to April 11 at 7:00 a.m., at one meter above the ground.

Hygrothermograph readings taken at Station 1 showed that the lows in temperature occurred between 4 and 6 a.m., while the highs for the day occurred between 1 and 3 p.m. An examination of Table IV shows the marked ability of the forest to modify temperature. Station 2, located within the forest, showed a variation of 14 degrees as compared to a variation of 20 degrees at Station 3 out in the open a few meters away. In addition, the minimum was higher and the maximum lower in Station 2 than in Station 3, indicating the greater stability of temperature in the forest climate.

In a comparison of Station 3, at 200 meters, and Station 1, at 10, the maximums reached were the same, but minima were a good deal lower in the case of Station 3, as might be expected due to its higher altitude.

In an attempt to get an indication of evapo-transpiration and light intensity values, two atmometers were set up in the open, unshaded, at Station 1. Day readings were from 6 a.m. to 6 p.m., night readings from 6 p.m. to 6 a.m.

TABLE V

Atmometer Readings (measured in milliliters)

Date	Period	White Bulb	Black Bulb	Difference
April 9	Day	30 ml	50 ml	20 ml
	Night	0	0	0
April 10	Day	40 ml	65 ml	25 ml
	Night	5 ml	5 ml	0

The atmometer is an excellent measure of the evaporative power of the air. It is of special use in the comparison of the evaporative potential of the atmosphere at either different times, as in this study, or at different places. These readings were taken at ground level, and the coefficient of the two bulbs was 0.79.

Two factors combined to give the low evaporative power of the air at night as compared with the day. Hygrothermograph readings showed that the relative humidity followed a regular cycle at Station 1 as follows: the maximum relative humidity readings hit a plateau at 90 to 95 per cent from 12 o'clock midnight to 4 a.m. From 4 a.m. to 6 a.m. there was a slight drop in relative humidity to around 80 per cent. Then, with sunrise around 6 a.m., the figure dropped sharply to the minimum point of the cycle at 50 per cent about 8 a.m. During the rest of the day, there was a slow, steady rise in relative humidity until another maximum plateau was reached from 12 midnight to 4 a.m.

The period from 6 p.m. to 6 a.m., therefore, corresponded with the period of maximum relative humidity, lowering the evaporative power of the air, and contributing to the lowered atmometer readings during the night.

The second factor to be considered is the increased amount of radiant energy reaching the earth during the day, which is again reflected in both higher daily temperatures and a corresponding jump in the ability of the air to evaporate. The black bulb showed a 30 to 40 per cent greater ability to evaporate during the day than did the white bulb. This was due to the ability of black to absorb a maximum of radiant energy, while the white bulb reflected a maximum of radiant energy. The total evaporation from the black bulb, which averaged 57.5 milliliters per day, is therefore taken as a measure of the average amount of radiant energy falling upon the area over the given time period. The veracity of this measure is further seen when the difference between evaporation of the two bulbs during the night period is examined. There was virtually no difference in evaporative power of the bulbs during the night, due to the fact that there was no radiant energy being received directly from the sun, only indirect heat energy stored in the air, atmosphere, and earth, none of which were of significance.

The final climatic factors to be considered are those of wind speed and cloud conditions, both of which can act as limiting factors in certain environments where they are carried to an extreme, and which always act as contributing factors to plant communities. Wind direction is directly correlated with rainfall patterns, since northerlies and northeasterlies must pass over the high central range of Costa Rica, dropping all their rainfall on the eastern slopes of these mountains, then flowing on as dry, rainless winds to pass over Nicoya. On the other hand, when winds dominate from the west, south, and southwest, they carry with them moisture from the Pacific, and are prone to turn into the short, turbulent rainstorms that characterize the peninsula of Nicoya as they strike the coast, rise, cool, and condense. A breakdown of wind direction as derived from the Servicio Meteorológico correlated with minimum, medium, and maximum periods of rainfall are as follows:

Wind Source	Rainfall
North	minimum
Northeast	minimum
East	medium
Southeast	medium
South	medium
Southwest	maximum

With an increase in altitude, there is far greater exposure to wind and, under some conditions, evapo-transpiration increases. In addition, wind damage increases with altitude, in particular on the south-facing slopes.

The climatic data in Table VI were recorded twice a day at Station 1 at 6 a.m. and 6 p.m. from April 8 through April 11.

Even during the short time period of the climatic data in Table VI, a confirmation of the correlation between wind direction and precipitation can be seen. During the three days of southerly winds, cloudy conditions with some rain occurred. On the evening of April 10, winds shifted to the northeast, then the northwest on April 11, combined with a disappearance of the clouds. This correlates exactly with predicted conditions.

TABLE VI

Date	Time	Rel. Hum.	Temp. (°F)	Wind	Cloud Cond.
April 8	6 P.M.	91%	77	South 1-3 mph gusts 5 mph	100% heavy low clouds
April 9	6 A.M.	87%	80	South 0 - 1 mph	50% cloudy 50% clear
	6 P.M.	83%	83	Southwest 1 - 2 mph	100% clear
April 10	6 A.M.	87%	80	South 1 - 2 mph	90% cloudy 10% clear
	6 P.M.	86%	84	Northeast	100% clear
April 11	6 A.M.	64%	80	Northwest 3 - 5 mph gusts 12 mph	100% clear

All of the preceding climatic and edaphic data are interrelated into a complex whole, a whole reflecting the dynamic state of the environment. Temperature, soil solutes, soil air, and humidity are all extremely favorable to plant life. Only when we consider the factors of precipitations and the resulting water content of the plant substrate do we meet limiting conditions for plant growth. The tip of Nicoya is characterized by a pronounced seasonality of rainfall, with a dry season of three months when often only 0.0 inches of rain fall as recorded in 1961. This pronounced dry season, in combination with the highly porous bedrock of the area, has resulted in an edaphic climax forest formation intermediate between the tropical dry and tropical moist formations of Holdridge, or falling under the evergreen seasonal formation of Beard. The forest ecosystem of any area is a result of the complex of climatic, edaphic, and biotic factors, resulting in either an edaphic or climatic climax, according to the limiting conditions present in the ecosystem. Some of these ecological factors will be considered in the next section, through an examination of the forest as an expression of these factors.

Ecological Considerations

I have organized the following data from the results of the survey team led by G. F. Schreuder, in a transect taken along a 3,720 meter line from Playa Balsitas, on the west coast, to a point just north of Mount Cabuya, on the east coast; the results were as follows:

Area measured: 18,600 m^2.
- 35% culled and undisturbed forest
- 40% cultivated land
- 20% brushland
- 5% young secondary forest

Number of species encountered: 35

One-fourth of stand made up of:	Percentage:
Madrono (Calycophyllum candidissimum)	13.4
Nispero (Achras zapota)	13.1
Together with the above two species, two-thirds of stand made up of:	
Azulillo (Haematoxylon campechianum)	11.8
Pochote (Bombacopsis quinatum)	8.8
Capulin (Muntingia calabura)	8.8
Ojoche (Brosimum costaricanum)	7.5
Roble (Tabebuia pentaphylla)	6.6
Remaining species included:	
Carao (Cassia grandis)	4.3
Manteco	3.3
Chaperno (Lonchocarpus sp.)	3.0
Guayaba (Terminalia chiriquensis)	2.0
Jobo (Spondias mombin)	1.6
Espavel (Anacardium excelsum)	1.3
Quina (Nectandra glabrescens)	1.3
Tucuico (Ardisia sp.)	1.0
Indio desnudo (Bursera simaruba)	1.0
Yayo (Xylopia sp.)	1.0
Quebracho	1.0
Guarumo (Guazuma ulmifolia)	1.0
Guacimo (Guazuma ulmifolia)	0.7
Fruta pava	0.7
Camibar (Prioria copaifera)	0.7
Copalchi (Croton sp.)	0.7
Flor blanco (Plumeria alba)	0.7
Zapotillo	0.7
Ceiba (Ceiba pentandra)	0.7
Quizarra Nectandra sp.	0.7
Lorito	0.7
Balsa (Ochroma lagopus)	0.3
Guabo (Inga sp.)	0.3
Danto (Roupala complicata)	0.3
Terciopelo (Sloanea quadrivalvis)	0.3
Yos (Sapium sp.)	0.3
Canelo (Ocotea veraguensis)	0.3
Pavo macho (Didymopanax morototoni)	0.3

Given an Isotherm between 24° to 27° C, plus an annual rainfall as calculated in 1961 at Cobano of 2177.2 mm, this would place the tip of the Peninsula of Nicoya within the tropical moist forest formation of Holdridge. However, due to the short, heavy nature of the rainfall, in addition to a very pronounced dry season of three months with virtually no rainfall, there were some tendencies toward xerophytic vegetation noted as well. Geologically, the area consists of limestone bedrock, a situation differing greatly from those areas with a base of volcanic ash, igneous, or metamorphic rock. A good deal of the rainfall received is quickly absorbed into the porous limestone, in many places sinking below the effective level for plant utilization.

Due to these factors of pronounced seasonality of rainfall, short, turbulent rainstorms, and the porous nature of the bedrock, the forest formation under the Holdridge system is best described as an edaphic association of the tropical moist forest formation.

In addition, it should be realized that annual rainfall records were available only for the year of 1961, and there are doubtless considerable variations in rainfall from year to year which could have been averaged had the records of other years been available.

A comparison of the species noted on the survey with a list of the timber species of the tropical lowland formations of Northern Tropical America as prepared by L. R. Holdridge is as follows (percentage figures are taken from the previous list on page 47):

Formation	Species	Per cent of total stand
Tropical Wet	Ochroma lagopus	0.3
Tropical Moist	Terminalis chiriquensis	2.0
	Anacardium excelsum	1.3
	Didymopanax morototoni	0.3
	Hieronyma alchorneoides	0.3
Tropical Dry	Calycophyllum candidissima	13.4
	Achras zapota	13.1
	Bombacopsis quinatum	8.8
	Tabebuia pantaphylla	6.6
Tropical Very Dry		0.0

A summary of the above information, according to formation, shows a definite weighting towards the tropical dry formation:

Formation	Per cent of total stand
Tropical Wet	0.3
Tropical Moist	3.9
Tropical Dry	41.9
Tropical Very Dry	0.0

In an examination of the above summary, it should be remembered that Azulillo, Capulín, and Roble, all of which were important forest components, were not included since Holdridge does not mention them in his paper. Future work with these species may bring a change in weighting of the formations.

In the areas of uncut and undisturbed forest, which were for the most part limited to areas of slope, a tall, 80 per cent evergreen forest was noted, composed

of Ojoche, Nispero, Pochote, and Espavel as the dominants over 30 meters high. According to the general classification of forest types according to Beard, (1944, 1955), the remaining areas of virgin forest would fall under two different formations: Evergreen Seasonal forest and Dry Evergreen Woodland. Of the 35 per cent of the study area remaining in forest, some 20 per cent was in the process of being cut or culled, with only 15 per cent remaining in a completely undisturbed condition. Nearly all of this undisturbed forest is to be found on areas of slope over ten degrees, placing the formations within the grey clay loam soil discussed earlier. Nearly all of the virgin forest of the black clay soil of the high plateaus and the grey alluvial clay of the lower plains has been or is in the process of being destroyed.

Within the grey clay loam of the slopes, both the dry evergreen woodland and evergreen seasonal forest formations were found. The limiting factor in operation here seems to be drainage. In areas where the nature of the limestone carries the rainfall quickly below the effective root levels of the trees, the plant community has far less actual water available for utilization within the community than in areas where the water table is higher, and the availability of water greater to plant life. The lithosole is composed of a very high percentage of rocks, and very often the roots are able to penetrate to only a short depth before reaching bedrock. Bombacopsis quinatum does particularly well in areas where the bedrock comes close to the surface. Many old individuals were observed with broad, shallow root systems, allowing the species to flourish on areas where other species were literally unable to gain a foothold. Stand regeneration of Bombacopsis is uncommon.

The evergreen seasonal forest, in nearly all cases, was found in areas where the water table was higher: in steep ravines, along watercourses, and over level, even slopes towards the bottoms of hills. This formation was characterized by a high forest of three strata: the first discontinuous at 30 to 35 meters, the second continuous at 15 to 22 meters, and the third discontinuous at 4 to 10 meters. Lianas were very abundant, but few had a diameter of over one inch. Ground vegetation consisted of a common small palm, biscoyol, numerous ferns, and small anconfor trees. For the most part, however, ground cover was extremely sparse. With an open forest floor covered with dead leaves, the aspect it presented was much like that of an old-growth beach forest of the North. Epiphytes were moderately abundant, a great variety of tree orchids being especially numerous. Most of the leaves were of masophyll leaf size, with a tendency towards larger surface area per leaf in the lower strata. In addition, leaves were usually thin, without drip-tips, and shiny. Buttressing in the dominants was common, although less pronounced than that found in wetter, well-drained formations.

The other formation, dry evergreen woodland, was found in areas of low water table: on tops of ridges, raised areas above the general trend of drainage on slopes, and on ridge-flanks near the tops of the high plateaus. This forest was characterized by a profile of only two strata, instead of three, as in the previous formation. The top strata was lower here, reaching to 20 and rarely 25 meters high, but with still a very high percentage of the dominants evergreen. The evergreen seasonal forest averaged 80 to 85 per cent evergreen, all strata taken together; the dry evergreen woodland averaged 70 to 75 per cent evergreen, reflecting the decreased water supply both in reduced number of strata and increased deciduous habit. Nevertheless, the striking characteristic of this formation was the high percentage of evergreen species found, a very interesting situation considering the low moisture and pronounced seasonal character of the rains. Bombacopsis was probably the most common of the deciduous components of this forest. Calycophyllum and Achras were also found among

the dominants typical of Holdridge's tropical dry forest, but Terminalia, Anacardium, and Didymopanax of the tropical moist formation were also found. Crowns were umbrella-like, and branching was lower than in the previous formation. Lower strata 5 to 15 meters with thin boles completed the profile, and both epiphytes and lianas were less numerous in this formation than before. In this case, the lower story formed the more continuous canopy, while the upper story was emergent.

The evergreen seasonal forest was very well-developed in the ravines and slopes of the east side of the peninsula. Very little of the area showed signs of previous cutting or burning, and the forest here was higher, lusher, and more humid in character than that of the west slopes, where the evergreen seasonal formation was lower and somewhat drier in appearance. Numerous springs were noted on the east side, while the west side had fewer. Possibly the trend of bedrock drainage favors a flow from west to east, causing the soil conditions on the east side to be wetter.

The dry evergreen woodland was more common on the western slopes, and cutting and burning of the forest has reached far greater proportions here than on the east side. Often large areas of forest have been logged, save for a long narrow strip of forest following the watercourses, which have not been cut. There seems to be very little selective cutting of species, except in regard to size.

One interesting association was often found made up of nearly 100 per cent pure stands of Muntingia calabura present on all types of slope. The stands are made up of large numbers of small individuals, not over 15 cm in diameter. The ground cover was of long grasses, and the association was not found in areas of rocky soil. The stand seems to be a result of past clearing and burning, and the association will doubtless be of importance in clearings abandoned to second growth. On the rocky soils, occasional nearly pure stands of Bombacopsis quinatum were noted. This tree, along with Achras zapota, which is favored for its fruit, may have been planted or left uncut in either pre- or post-Hispanic times. One other explanation of the pure stands of Bombacopsis may also be found in the very broad, shallow root system which it develops, often reaching 30 to 40 feet in diameter. New trees might develop from these roots, creating eventually a pure stand. Bombacopsis shows many of the characteristics of xerophytic vegetation, such as deciduous character in order to reduce water loss through transpiration, extensive root systems to obtain the maximum amount of water possible over a large mass of soil containing a small percentage of moisture, and the presence of sharp thorns that cover the bark of the tree possibly as a protection against grazing animals during seasons when less food is available and herbivores are reduced to eating bark.

Ecologically, xerophytic conditions are those where plants are adapted to grow on a substratum that becomes depleted of water to a depth of at least 2 cm. In the areas of uncut forest, the soil can more easily be maintained in a moist condition, for the temperature is far more moderate, the evaporation rate lower, and the loam better protected against erosion than in cutover areas. Under these conditions a true xerophytic micro-climate may never develop. However, should the forest be cut and the land burned for milpas, the spongy loam is washed away in rains, and the soil is quickly dried out during the dry season under the direct exposure to the sun, wind, and greater extremes of relative humidity. Under these conditions, and with a dry season of 0.0 mm of rainfall over three months, xerophytic conditions can be expected to develop, at least until through succession, the vegetation of the climatic climax is once again reached and the soil micro-climate stabilized.

A series of three sample plots were taken within the evergreen seasonal formation, two of them on slopes over 10 degrees, and one of them on the southern tip of the plateau area. The two slope plots each covered an acre square. The plot taken on the plateau was taken along a line of 108 meters, 4 meters in width. On one of the slope plots and the plateau plot, all trees over 4 inches in diam. were measured, heights taken, and ground cover noted. On the other slope plot, a detailed analysis of height, diameter, buttressing, epiphytism, tree form, crown diameter, and first branching was made on all trees over 4 inches dbh. Only the two slope plots will be considered in this report.

The following table comprises the heights and diameters of the tallest trees encountered in my three plots and the survey taken by Schreuder.

TABLE VII

Name	Height (meters)	Diameter (at 4 ft above ground or 3 ft above buttress) in inches
Brosimum costaricanum	38	45.0
Brosimum costaricanum	31	40.0
Brosimum costaricanum	31	27.0
Bombacopsis quinatum	37	35.0
Bombacopsis quinatum	35	50.0
Bombacopsis quinatum	32	45.0
Achras zapota	37	33.0
Achras zapota	34	33.0
Achras zapota	31	27.0
Haematoxylon campechianum	35	30.5
Haematoxylon campechianum	33	14.0
Ceiba pentandra	35	45.0
Anacardium excelsum	33	47.0
Anacardium excelsum	30	45.0
Terminalia chiriquensis	28	13.0
Terminalia chiriquensis	27	25.0
Guazuma ulmifolia	27	43.0
Sloanea quadrivalvis	22	30.0

The above species make up nearly all of the dominants of the upper, third strata, of the evergreen seasonal forest of the study area. Bombacopsis quinatum, Achras zapota, and Haematoxylon campechianum are by far the most numerous species. Brosimum costaricanum, the largest of them all, is only slightly less abundant.

On the plots taken on the slope areas, the following species over 4 inches dbh. were recorded on the two, one-acre, sample plots:

PLOT 1

Species	Number on Plot
Yayo (Xylopia sp.)	5
Nispero (Achras zapota)	3
Azulillo (Haematoxylon campechianum)	3
Manzano (Hippomane mancinella)	2
Cedro macho (Carapa slaterii)	2
Guabo (Inga sp.)	1
Espavel (Anacardium excelsum)	1
	17

PLOT 2

Species	Number on Plot
Espavel (Anacardium excelsum)	5
Guasimo (Guazuma ulmifolia)	2
Anconfor (Protium sp.)	2
Pochote (Bombacopsis quinatum)	1
Guabo (Inga sp.)	1
Ceiba (Ceiba pentandra)	1
Cedro macho (Cerapa slaterii)	1
Madroño (Calycophyllum candidissimum)	1
	14

Plot 1 was taken at an elevation of 220 meters on the west side of the peninsula on a SSE-facing slope. Conditions were of undisturbed forest, but with noticeable wind or lightning damage to the large Anacardium occidentalis and one large Hippomane mancinella. The ground slope was 30 degrees above, increasing to 40 degrees below.

Plot 2 was also taken at an elevation of 220 meters, but about a kilometer due south of plot 1, on a directly west-facing slope. The forest was completely undisturbed, and none of the trees showed any signs of damage by wind, fire, or lightning. The ground slope was 30 degrees.

Both plots showed the grey clay loam lithosol to be present, as was mentioned in the earlier part of the report under Edaphology.

The relation of the height of the various species found in both plots was correlated to the three tree strata found in the typical evergreen seasonal forest. In the case of plot 2, the upper strata was discontinuous, the middle strata continuous, and the lower strata discontinuous and very poorly developed. On plot 2, the shrub and herb strata was very widely dispersed, and an open, leaf-covered floor covered 80 per cent of the total ground area.

TABLE VIII
(Plot 2)

Name	Height (meters)
Upper Strata: (30 - 35 m)	
Anacardium excelsum	31
Anacardium excelsum	30
Anacardium excelsum	30
Anacardium excelsum	30
Middle Strata: (15 - 22 m)	
Ceiba pentandra	23
Guazuma ulmifolia	23
Guazuma ulmifolia	21
Bombacopsis quinatum	21
Carapa slaterii	18
Anacardium excelsum	17
Calycophyllum candidissimum	16
Lower Strata: (4 - 10 m)	
Protium sp.	8
Protium sp.	7
Inga sp.	5
Ground Shrub - Tall Herb Strata; (0.5 - 3 m)	
Biscoyol palm (7% of forest floor)	1.5 - 3
Protium sp. (8% of forest floor)	1.5 - 3
Cordoncillo (2% of forest floor)	1.5 - 2
Palo del Río (3% of forest floor)	0.5 - 1.5
Open floor (80%)	

On plot 1, the upper emergent strata was much less prominent than was the case in plot 2. This was due to heavy wind or lightning damage to the upper parts of many of the larger trees. The middle strata, however, formed a definitely continuous canopy. The ground shrub-tall herb strata reflected the increased amount of light available to it due to the reduced upper strata by a much heavier, more prolific growth. The lower strata was still not a prominent one and was much the same as in plot 2 in its discontinuous nature.

In the case of plot 2, a much more detailed study was made of the one acre sample than in plot 1. A similar examination of the forest profile was made, but with the addition of dbh, buttressing, epiphytism, tree form, crown diameter, and first branching data:

TABLE IX
(Plot 1)

Name	Height (m)	Dbh. (in.)	Buttres. (in.)	Epiph.	Form	Tree Crown diam. (m)	First branch (m)
Upper Strata: (30-35 m)							
Anacardium excelsum	33	45	96	heavy moss on N. side. 7 Bromeliads 50+ Orchids on branches	st.*	18	16
Middle Strata: (14 - 22 m)							
Hippomane mancinella	24	22	72	heavy moss 4 Bromel. 20 Orchids	st.*	11	11
Xylopia sp.	22	12	-	-	st.	4	18
Haematoxulon campechianum	20	9	-	-	st.	4	11
Haematoxylon campechianum	18	10	-	1 Bromel.	crkd.*	11	7.5
Xylopia sp.	18	9	-	-	st.	4	18
Xylopia sp.	18	8	-	moss on N. side trunk	st.	6	11
Hippomane mancinella	16	17	-	-	st.	dead	1.2
Carapa slaterii	16	8	-	1 Bromel. 2 Orchids num. vines	crkd.	9	9
Achras zapota	14	10	-	light moss 1 Bromel.	st.	7	7.5
Achras zapota	14	8	-	-	crkd.*	3.5	7.5
Xylopia sp.	14	5	-		st.	dead	9
Xylopia sp.	14	5		-	st.	7.5	6
Lower Strata: (6-11 m)							
Haematoxylon campechianum	11	9	-	light moss	crkd.	7.5	6
Carapa slaterii	10	8	-	-	st.	dead	6
Achras zapota	6	4	-	-	crkd.	3.5	3.5
Inga sp.	6	4	-	-	crkd.	dead	2.5

Ground Shrub - Tall Herb Strata: (0.2 - 3 m)

Palo del Rio (0.2-1.5 m) covers 55% of forest floor in shaded areas.
Biscoyol palm (1.5 - 3 m) covers 15% of forest floor.
Protium sp. (2-3 m) covers 3% of forest floor.
Miscellaneous plants cover 7% of forest floor.
Open floor covers 20% of area.

*The following symbols are used: (st.) Straight
(crkd.) crooked

Only the two trees over 21 inches dbh. on plot 1, Anacardium excelsium (45") and Hippomane mancinella (22"), showed any signs of buttressing. Nearly all of the Anacardium, Ceiba, and Guazuma over 22 meters high on plot 2 showed buttressing, a total of six trees on the plot. The minimum size tree on plot 1 that supported any epiphytes, shade or sun tolerant, was 16 meters high and 8 inches dbh. None of the smaller trees were supporting ephiphytes, save for a few small patches of moss on the limbs. The Bromeliads and Orchids were all predominantly sun epiphytes that required larger trees both for support and to bring them into the light of the higher reaches of the forest profile. The heavy growth of moss on the northern sides of tree trunks was probably correlated with the light penetrating the forest on the SSE - facing slope.

The three tree strata and one ground shrub—tall herb strata described in tables VIII and IX fall under the classification (Davis and Richards, 1933 and 1934) of plants not dependent upon others for support. Also they are all nutritionally independent plants. Climbing plants, lianas, bushropes, and epiphytes (both autotrophic and parasitic) all fall under the classification of plants dependent upon others for support. In plots 1 and 2, lianas and climbing plants were most abundant in the middle strata, especially in the case of plot 1, where the upper strata had been catastrophically reduced. Root climbers, those lianas with narrow stems and which extend only into the lower canopy, were much more abundant in plot 1 than the typical lianas, which extend into the upper part of the canopy before producing foliage and usually have large woody stems. In plot 2, where the upper strata was undisturbed, the typical lianas were more abundant than the root climbers and dominated the climbing plants. Nowhere were thick woody stems seen, however, except in forested gullies, where the soil moisture was sufficient to support thicker growth. Although the thickness of stems in lianas is also often an indication of how long the forest has been undisturbed, in this area the thin stems seemed to be more a reflection of limiting soil moisture conditions.

In the case of the large 33 meter Anacardium excelsum on plot 1, an interesting case appeared where a young sucker from the same tree had developed, growing up the trunk of the tree in the manner of a strangler fig, and was now competing with the old tree for the light available in their common canopy area. Climbers on the undergrowth were non-existent on plot 2, but several small herbaceous climbers were noted as small vines among the Palo del Rio on plot 1.

Among the various types of autotrophic epiphytes, shade epiphytes such as ferns and some of the Orchidaceae were uncommon in both plot 1 and 2. Sun epiphytes, including the families of Orchidaceae and Bromeliaceae, were fairly common in both plot 1 and plot 2, usually being found on the high, exposed branches and tree crowns. None of the extreme xeromorphic epiphytes such as Tillandsia and Cactaceae were observed, although some of the Orchidaceae extended out onto the very exposed areas of the emergent crowns where temperature and moisture conditions are more variable than in more protected portions of the canopy and so could be classed as xeromorphic. No epiphytic parasites were observed on either of the study plots, although several of the mistletoes were observed occurring in the dry evergreen woodland formation.

In the area of animal ecology, tropical vegetation is usually divided into desert, tropical savannah, and tropical forest biomes, formed according to the physiognomy of the vegetation important to animal life (Kendeigh, 1961, Animal Ecology, p. 343). The Cabo Blanco area clearly falls under the tropical forest biome, and the animal life found there is a reflection of this type. The following list of animals was worked out by Mr. Olof Wessburg, who has lived near and made a number of trips to the study

area over the past seven years. I have arranged the list according to the trophic levels of the food chain: herbivores, small carnivores, and large carnivores. In the cases of animals such as the raccoon, which is both a herbivore and a carnivore, they have been placed in the higher carnivore trophic level. This list includes only those species definitely seen by Wessburg, and for this reason a great deal of further study should be very productive in the smaller animals such as rodents, Herpetofauna, microfauna, small carnivora, and bird life.

Herbivores (Primary consumers)

White-lipped peccary (Tayassu peccari)
Collared peccary (Tayassu tajacu)
Tapir (Tapirus bairdii)
White tailed deer (Dama virginiana)
Black-browed miriki or Spider monkey (Alteles geoffroy frontatus)
Howler monkey or Congo (Alouatta villosa)
Capuchin monkey (Cebus capucinus)
Mexican porcupine (Coendu mexicanus)
Paca (Agouti paca)
Agouti (Dasyprocta punctata)
Variegated squirrel (Sciurus variegatoides)

Curassow (Crax rubra)
Crested guan (Penelope purpurascens)
Chachalaca (Ortalis sp.)

Small carnivores (Secondary consumers)

Coati (Nasua narica)
Raccoon (Procyon loter)
Kinkajou (Potos flavus)
Hog-nosed skunk (Conepatus semistriatus)
Spotted skunk (Spilogale angustifrons)
Opossum (Didelphis marsupialis)
Armadillo (Dasypus novemcynctus)
Two-toed anteater (Cyclopes didactylus)
Collared anteater (Tamandus tetradactyla)

Basilisk lizards (Basiliscus plumifrons)
Skink
Fence lizard (Sceloperus sp.)
Chameleon (Anolis sp.)
Various Salientia
Various Serpentes (Oxybelis sp., Crotalus sp., Lampropeltis sp. were observed.)

Large carnivores (tertiary consumers)

Margay (Felis wiedii)
Jaguarundi (Felis yagnaroundi)
Ocelot (Felis pardalis)
Puma (Felis concolor)
Jaguar (Felis onca)

The above list is intended to show only those species which are known to exist in the area of Cabo Blanco. Further study, especially of the birds, insects, and herpetofauna would yield rich results. The Isla Blanca is an outstanding colony of Man-o-war birds, and should be included within the prospective park area.

Wessburg comments on the bird life of the area as follows:
"In the wet season, many kinds of waders stay in the overflowed lands near Cabuya. Different kinds of herons are also common at this time. Migratory birds pass along the beaches in seasons of migration. Fifteen to 32 birds a minute were counted passing at 5:30 p.m. on April 10 of 1962."

One of the most unusual features of the area are the great numbers of land crabs which abound all through the Cabo Blanco area up to 300 meters. Their bodies are black on top, orange below, with purple claws and claw-arms. Bright orange spots surround the eyes. They first appear from their underground burrows in March, and they remain active until June, at which time they return underground until the following March. During their period of activity, they are the most noticeable animal in the area, numerous in forests and farms alike. In the evening, I noticed large numbers of them coming down to the beaches to bathe in the wash of the ocean, sometimes covering the beach so thickly that they obscured the sand.

As is true in nearly all food chains, the total biomass of the herbivores is greater than the total biomass of the small carnivores, and the total biomass of the small carnivores is greater than the total biomass of the large carnivores for any given area. This pattern was reflected in the abundance of Howler monkeys, pacas, agoutis, squirrels, insects, and fruit-eating birds in comparison to the small carnivores. All of the large carnivores are now uncommon, especially the jaguar, although the smaller members of this group, such as the margay, are still able to be supported by the area and escape being hunted out. The great variety of animals in the area can be traced back to the greatly increased inter-species competition for available environmental niches in the tropics, where the physical environment is often ideal for life and competition becomes the most important factor in animal adaptation. The Cabo Blanco area differs from the equatorial wet tropics in the pronounced seasonality of its rainfall, a factor as important to animal life as it is to plant life. The life cycle of the land crabs seem related to seasonality, and the deciduous nature of some of the forest trees, such as the Pochote, doubtless has some effect upon the herbivores which depend upon it for food. A great deal of potential research into problems such as these remains to be done, and it is the hope of the author that the area may be saved before the environment and forest ecosystem is destroyed through wasteful cutting and burning of land which will only provide several years of crops before being abandoned.

Conclusion

An attempt was made in this report to deal with the forest ecosystem of the Cabo Blanco region in all of its aspects: climatic, edaphic, and biotic. This led to a consideration of the Geological and human history of the area, in order to be able to correctly interpret the associations and formations found there today. It should always be kept in mind, when reading a report such as this, that all of the many factors influencing the ecosystem of the Cabo Blanco or any other region must in the final analysis be considered as they operate in real life: simultaneously. The ecosystem of the Cabo Blanco remains in a state of delicate balance between the processes of biotic and abiotic interaction. The producer organisms, utilizing the abiotic

substances of water, air, and minerals, are able to capture and maintain a steady flow of energy from the sun, transforming it into food which is then available for the various levels of consumers. The energy available to each trophic level of consumers is always less than that available to the level which is closer to the producers, causing a diminishment of active biomass with each removed level. The final units in the ecosystem are the decomposers, which break down the complex organic compounds into simple products of the soil which can then be re-used by the producers in the production of more food as derived from the sun's energy. Any disturbance of any one of these levels must inevitably result in a loss of energy to the ecosystem. Taken as a whole, the forest ecosystem of the Cabo Blanco is one of the most efficient systems for the capture of available energy over a long period of time possible on the area. Destruction of the forest results in rich crops for a year or two, but after that the soil is ruined and the land returned to brushland an association of a much lower capacity for the capture of the available light energy. The highest and wisest use of the region, both for science and the economy of Costa Rica, is in forest. It is hoped that action will be taken quickly enough to save the area remaining in an undisturbed state.

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