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# ENVIRONMENTAL DATA BASE FOR REGIONAL STUDIES IN THE HUMID TROPICS

FINAL REPORT

BY
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AUGUST 1970



UNITED STATES ARMY TROPIC TEST CENTER
FORT CLAYTON, CANAL ZONE

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13. ABSTRACT

This report presents a summation of the Environmental Data Base Project which was undertaken by the US Army Tropic Test Center (USATTC) in 1964. The objective of this project was the gathering and storage of detailed, specific data on militarily significant factors of a humid tropic environment.

Progress reports have been issued on a semiannual basis; they have covered the project activities and methods of data collection and presented selected technical findings and analyses of portions of the data.

Subtasks during the project included collection of basic data on climate, soils and hydrology, vegetation, microbiology and chemistry of the atmosphere, and macrofauna. Collected data were assembled and arranged for computer storage and retrieval. Repositories of data are USATTC; US Army Test and Evaluation Command, Management Sciences and Data Systems Directorate, Aberdeen, Maryland; Earth Sciences Division, US Army Natick Laboratories, Natick, Massachusetts; National Center for Atmospheric Research, Atmospheric Chemical Laboratory, Boulder, Colorado; and National Weather Records Center, Asheville, North Carolina.

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| Canal Zone | | | | | | |
| Climate | | | | | | |
| Soils and Hydrology | | | | | | |
| Vegetation | | | | | | |
| Microbiology and Chemistry of the Atmosphere | | | | | | |
| Macrofauna | | | | | | |
| Micrometeorology | | | | | | |
| Vegetation Succession | | | | | | |
| Environmental Data Base | | | | | | |
| Canopy Foliage | | | | | | |
| Vegetative Debris | | | | | | |
| Meteorological Data Acquisition and Recording Systems | | | | | | |
| Diurnal Temperature Variation | | | | | | |
| Soil Surface Temperature | | | | | | |
| Heat Stress | | | | | | |
| Evaporation | | | | | | |
| Microorganisms on Leaf Surfaces | | | | | | |
| Surface Deposited Microorganisms | | | | | | |
| Airborne Microorganisms | | | | | | |
| Condensation Nuclei | | | | | | |
| Carbon Dioxide in the Tropical Atmosphere | | | | | | |
| Spore Samples | | | | | | |

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This report presents a summation of the Environmental Data Base Project which was undertaken by the US Army Tropic Test Center (USATTC) in 1964. The objective of this project was the gathering and storage of detailed, specific data on militarily significant factors of a humid tropic environment.

Progress reports have been issued on a semiannual basis; they have covered the project activities and methods of data collection and presented selected technical findings and analyses of portions of the data.

Subtasks during the project included collection of basic data on climate, soils and hydrology, vegetation, microbiology and chemistry of the atmosphere, and macrofauna. Collected data were assembled and arranged for computer storage and retrieval. Repositories of data are USATTC; US Army Test and Evaluation Command, Management Sciences and Data Systems Directorate, Aberdeen, Maryland; Earth Sciences Division, US Army Natick Laboratories, Natick, Massachusetts; National Center for Atmospheric Research, Atmospheric Chemical Laboratory, Boulder, Colorado; and National Weather Records Center, Asheville, North Carolina.

# FOREWORD

This project was sponsored by the Office, Secretary of Defense, Advanced Research Projects Agency (ARPA), Directorate of Remote Area Conflict, and by the Department of Army, Office of the Chief of Research and Development, Army Research Office (ARO).

This study reported herein was conducted under the guidance and with the direct participation of the Research Division of the US Army Tropic Test Center. Major contributions to this project were made by Dr. Leo Alpert, Chief of the Research Division during the design phase (1963-1965) of the project, and by Dr. Guy N. Parmenter, Chief of the Research Division during the execution phase (1965-1969). The Center's research personnel who provided significant technical contributions to the project include Mr. Ricardo Ah Chu and Mr. Alfredo Gonzalez.

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## PART I. INTRODUCTION

### 1. Background

This report presents a summation of the Environmental Data Base Project, which was undertaken in 1964 when it became apparent that the available basic information on militarily significant factors of the humid tropical environment in general, and for the Canal Zone in particular, was deficient.

Progress reports (references 1 to 5) have been issued on a semiannual basis; they have covered project activities for the reporting periods and, in addition, have presented selected technical findings and analyses of portions of the data. This final report contains a resume of work accomplished. This report identifies the repositories of data, tells what data have been collected, and identifies storage format of the data.

The US Army has an overall requirement to operate in extreme environments including the humid tropics; however, the data base extant in 1964 contained little useful environmental information that could be utilized in many Research, Development, Test, and Evaluation (RDTE) projects in tropical areas. The Data Base Project was undertaken as a first step toward filling this gap. The project was designed as an interdisciplinary program of observations of the total environment, with closely coordinated sampling schedules at both forested and open sites within a limited area; i.e., sites subject to nearly identical weather factors. Advanced instrumentation and techniques were developed and utilized. This observational program was to be conducted at sites within the three environmental extremes represented in the Canal Zone environs.

Although the scope of the project was reduced during its execution, a large amount of heretofore unavailable knowledge has been compiled. The benefits derived from this data bank, which will accrue indefinitely, will be applicable to all RDTE activity in the humid tropic regions of the world.

### 2. Objectives

The overall objective of the project was the establishment of a storage of detailed, specific data on the environmental variables that influence military activities in the humid tropics and designed to enhance the capability of US and friendly armed forces to successfully conduct operations in the humid tropics. The project was designed to provide a repository of information and analyses derived from observations of selected physical and biological conditions at representative sites in the natural environments of the Canal Zone. A specific objective of the US Army Tropic Test Center was to obtain detailed information concerning the environments in which its tests are conducted. The information is directly applicable to materials deterioration studies.

## 3. Project Description

The project was subdivided into six major fields of investigation: (1) Climate, specifically the meteorological phenomena exhibited from the ground to an approximate height of 50 meters; (2) Soils and Hydrology, with emphasis on data related to trafficability and ground water fluctuation; (3) Vegetation, with emphasis on taxonomy, canopy foliage, plant succession, and accumulation of vegetative debris; (4) Microbiology, with particular respect to numbers and kinds of bacteria and fungi and their transportation and deposition; (5) Atmospheric Chemistry, the chemical and physical contaminants and particulate matter in the air; and (6) Macrofauna, generally limited to selected arthropoda.

Detailed plans providing guidance for the various aspects of each project task were prepared as project memoranda. These memoranda provided detailed instructions for measuring and recording each parameter and gave scheduling and frequency of measurements and maintenance of instrumentation. Their relevance to the project decreased in the latter stages of the project, particularly after installation of the automatic Meteorological Data Acquisition and Recording Systems (MDARS) during 1968.

## 4. Observational Approach

The primary objective of this project was to investigate the spatial and temporal variations of the most significant elements, from a military standpoint, of the physical and biological environments. In order to demonstrate their interrelationships as well as their precise quantitative values, "main" sites were established where a broad range of environmental elements were observed synchronously over relatively long time periods. Other "satellite" sites were established, where physical and biological conditions varied from the main sites, and where data were secured on selected environmental elements (principally soils and meteorology) over shorter periods.

The main sites were paired, one located within a forest, typical of its environmental regime; a second located in an open area, as close as practicable to the forested site. The two main observation sites were on the Pacific side of the Canal Zone (refer to part II).

Some of the observations were made by Tropic Test Center personnel; however, the bulk of the routine measurements were carried out by contractual arrangement with private firms. All work on the observational program was monitored by project personnel of the Tropic Test Center staff, and their guidance governed all stages of the program. The frequency of observations varied according to the parameters being measured, ranging from continuous readings of some meteorological equipment to one-time observation of some soil factors.

## PART II. OBSERVATION SITES

### 1. Site Locations

The two main observation sites were located on the Pacific side of the Canal Zone, which is characterized by moderate precipitation (an average annual rainfall of approximately 70 inches), with pronounced wet and dry seasons, and semideciduous vegetation. The two sites were on the Albrook Air Force Base and at Chiva Chiva (see figure II-1). The Chiva Chiva site was in an open area of mowed grassland four kilometers (2 1/2 miles) from the Albrook site; the latter was located within a forest with a relatively dense canopy of about 16- to 26-meters height and an understory of shrubs and vines with greatest density at about 2-meters height.

Four satellite sites were utilized for observation of soils and hydrology. These were sites for which significant bodies of data had been gathered before the institution of the Data Base Project.* Consequently, it was considered desirable to reactivate these sites since they represented varying aspects of Canal Zone environments. Meteorological data were gathered at the main sites, at the four soil satellite sites, and at one additional site (Rio Hato).

### 2. Site Descriptions

a. Albrook Forest Site

This site was located on a low erosional terrace in the northeastern portion of the Albrook Air Force Base, immediately adjacent to the Fort Clayton military reservation. Elevations at the site range from 30 to 33 meters above sea level. The ground slopes approximately 4 percent to the southeast. The surface is broken only by a one-half- to two-meter-deep channel of an ephemeral stream running southerly across the eastern side of the site. The regional topography is characterized by rounded hills, with elevations up to 130 meters. The nearest lie about 400 meters to the east, and others 600 meters to the northwest. The latter are part of a generally northeast - southwest trending line, with slopes ranging from about 10 to 50 percent. The soil is moderately well drained residual clay with a surface rich in organic matter. The parent material is an agglomeratic tuff (a pyroclastic rock with a fine-grained matrix of volcanic ash containing phenoclasts to 1 centimeter in diameter).

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*The prior work had been carried under the project, "Military Evaluation of Geographic Areas (MEGA);" by the US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, during the period of 1961-1963.

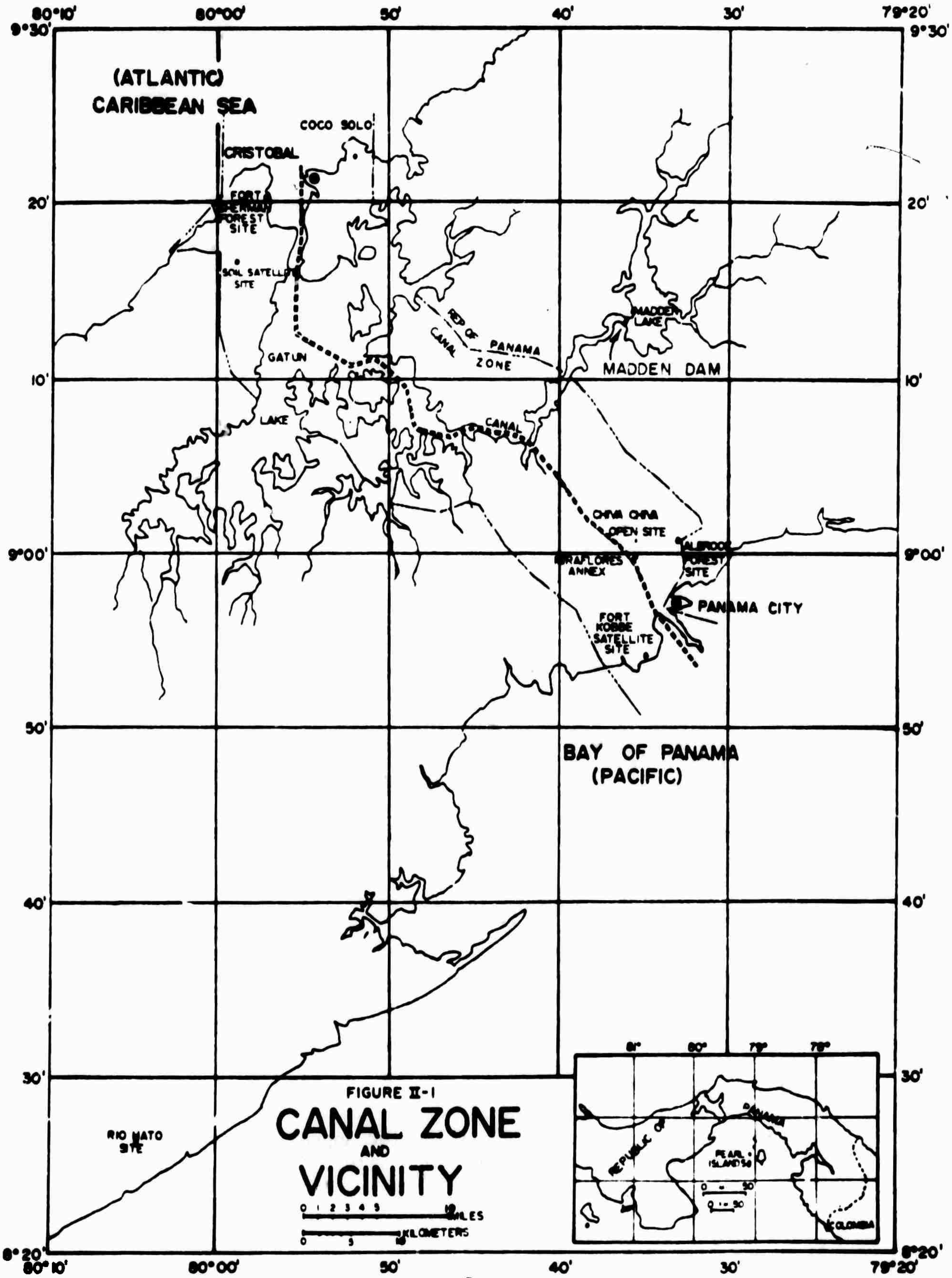


FIGURE II-1
CANAL ZONE AND VICINITY

The vegetation consists of many species of trees, shrubs, and vines. The forest age is approximately 70 years since the last major disturbance. The upper surface of the tree canopy occurred at approximately 26 meters and grew to approximately 30 meters during the course of the project. The forest extends for several kilometers on all sides, except for an area to the east where the large vegetation has been cleared.

A gravel road provides access to a paved highway 3 kilometers distant. A walk-up tower, which was 46 meters high and fabricated from aluminum tubing, was located at the center of the site.

Two generators of 30-kw capacity provided the power required to operate the electrical instrumentation. They were located near the tower within a wire-protected enclosure. A concrete, air-conditioned building was positioned on the perimeter of the site for use by observers; the building also housed the central components of the data acquisition and recording systems.

Figure II-2 is a sketch of the towers at the two main sites, showing the instrumentation array. Instrument locations were changed at various times during the project. The locations indicated are those which existed at the conclusion of the program.

b. Chiva Chiva Open Site

The other main site was located in the northwestern section of the Fort Clayton military reservation approximately four kilometers west-northwest of the Albrook forest site. The location was in an open, grass-covered area at approximately 30 meters above sea level. The clearing extends about one-half kilometer to the northeast and in other directions for nearly one kilometer from the center of the site. Beyond the cleared area lies a forest similar to that at the Albrook site. The site is gently sloping and has a southwesterly aspect. A moderately well-drained clayey residual soil, very sticky and plastic, comprises the surface mantle. The parent material, an agglomerate, is generally similar to that at the forest site.

A tower, identical in structure to that at Albrook, was centrally positioned on the site. This tower carried a smaller number of instruments than the one at the Albrook forest site. Two air-conditioned vans were provided for the observers and the central components of the instrument recording system. Commercial line power provided electricity for the site. Due to the open nature of the site, biological observations were not made as extensively as at the forested site.

c. Albrook Soil Satellite Site

The Albrook soil satellite site was located approximately one-half kilometer southwest of the Albrook main site. The soil is a

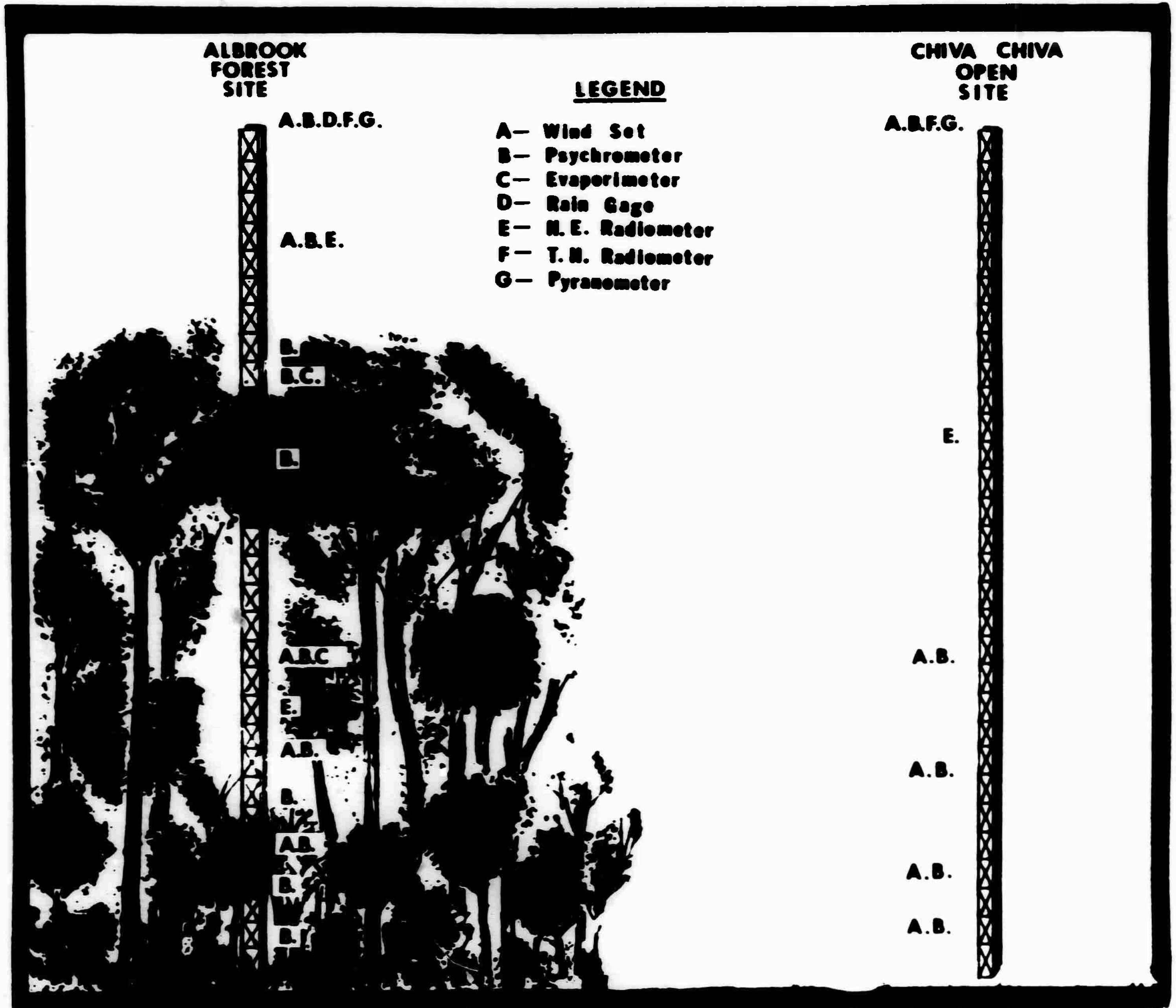



FIGURE II-2 INSTRUMENT LOCATION ON TOWERS
(At Conclusion of Program)

well-drained clay, very sticky and plastic. The physical environment and topographic setting is similar to that at the Albrook forest site. A cased groundwater well, with a water level recorder, a hygrothermograph, and two recording rain gages (one under an opening in the canopy and another under tree cover) made up the installed equipment at that site.

d. Fort Kobbe Soil Satellite Site I

The Fort Kobbe Soil Satellite Site I was situated at an elevation of approximately 20 meters. The soil is a clay, very sticky and plastic. The topography is nearly flat with slopes less than 2 percent. The vegetation is secondary growth, with trees reaching a maximum height of about 9 meters. Two rain gages, in the open and under a canopy; a hygrothermograph; and a cased waterwell with a level recorder were installed at the site.

e. Fort Kobbe Soil Satellite Site II

An additional satellite site for securing soil data was set up in 1967 when observations were concluded at the Albrook forest site. Three separate soil plots were located on terrain with varying slope in order to determine the effect of topographic position on the measured soil parameters. Plot A, in the highest position, was located under a sparse deciduous forest, with the top of the canopy at about 15 meters. Plot B, at a slightly lower position, was on the steepest segment of the slope and covered by more widely spaced trees and shrubs. Plot C was on grass-covered flat ground below the slope and was frequently under several centimeters of water during the rainy season. At plot A the soil surface texture was silty clay loam. At plots B and C the soil surface texture was sandy clay loam. Internal drainage of the soils was varied. Plot A was moderately well drained, Plot B well drained, and Plot C poorly drained.

f. Fort Sherman Soil Satellite Site

This site was located within the Fort Sherman Army Reservation on the Atlantic side of the Canal Zone at an elevation of approximately 80 meters. The terrain was generally broken and was strongly sloping. Soils were yellowish red to red clays, very sticky and plastic, and were well drained. The site is covered by a mature forest with evergreen broadleaf species predominating. The canopy is about 25 meters in height. The meteorological equipment consisted of two rain gages, a hygrothermograph, and a cased waterwell with a level recorder.

g. Rio Hato Site

A limited number of meteorological measurements was made in a savannah-type environment found at the Rio Hato Military Training Reservation located approximately 80 kilometers southwest of the two main sites.

## PART III. CLIMATE

### 1. Introduction

The climatology sub-task of the Data Base Project was designed to provide detailed micrometeorological data to define a tropic environment in general, and to describe the microclimatic regime in particular. The major continuous collections of climatic data in tropical regions throughout the world have been made by governmental meteorological bureaus and by military agencies. In most instances, however, these data are in the macro and meso scales rather than the micro scale. For example, in the Panama Canal Zone an extensive network of rainfall observations has been in operation for many years in support of the operation of the Panama Canal. The US Air Weather Service and the US Army Meteorological Service have made standard surface weather and upper air radiosonde observations for many years in support of synoptic and aeronautical meteorology and ballistic requirements.

The Data Base Project represents the first major comprehensive data collection effort in support of micrometeorological determinations in a tropic environment. See table III-1 for an indication of the amount of data collected. The several data analyses summarized in this section on climate demonstrate the usefulness of the collected data and the type of information that can be extracted.

Meteorological measurements were made through both the vertical and horizontal planes at two main sites, Albrook and Chiva Chiva. A limited number of measurements were made in the savannah-type environment found at the Rio Hato military training reservation. Some additional meteorological measurements were made at the soil satellite observation sites. Refer to part II for descriptions of these sites.

### 2. Instrumentation

To obtain the meteorological measurements through the vertical plane, corresponding instruments were exposed at selected, equal levels on the towers located at each main observation site. All measurements were made on the same time schedule. Measurements through the horizontal plane were made simultaneously through a similar array of like instruments at each main site; the only major difference was that a greater number of precipitation gages were placed at the ground level at the forest site. Temperature and humidity measurements made at Rio Hato and the satellite soil sites were made at the standard instrument shelter height (4 1/2 feet); the wind at the Rio Hato site was measured at the 4-meter level.

This correlation of measurements at the data base sites makes it possible to define the spatial and temporal variations of this particular

TABLE III-1. NUMBER OF CLIMATIC OBSERVATIONS STORED ON MAGNETIC TAPE

1 May 1965 thru 31 August 1969

| | Main Sites | | Satellite Sites | | | | |
|---|---|---|---|---|---|---|---|
| | Albrook | Chiva | Albrook | Ft. Kobbe | Ft. Sherman | Rio Hato | Total |
| Dry Bulb Temperature | 636,467 | 297,699 | 2,316 | 3,060 | 2,593 | 10,739 | 952,874 |
| Wet Bulb Temperature | 494,268 | 195,521 | - - - | - - - | - - - | - - - | 689,789 |
| Relative Humidity | 582,163 | 272,522 | - - - | - - - | - - - | 10,624 | 865,309 |
| Wind Speed | 518,745 | 231,105 | - - - | - - - | - - - | 6,536 | 756,386 |
| Wind Direction | 490,023 | 174,931 | - - - | - - - | - - - | 6,536 | 671,490 |
| Evaporation | 14,407 | 2,586 | - - - | - - - | - - - | - - - | 16,993 |
| Precipitation | 521,695 | 47,147 | 1,232 | 1,544 | 1,320 | 546 | 573,484 |
| Stem Flow | 39,930 | - - - | - - - | - - - | - - - | - - - | 39,930 |
| Barometric Pressure | 24,126 | 23,626 | - - - | - - - | - - - | - - - | 47,752 |
| WBGT | 54,878 | 55,502 | - - - | - - - | - - - | - - - | 110,380 |
| Vapor Pressure | 420,096 | 117,600 | - - - | - - - | - - - | - - - | 537,696 |
| Saturation Deficit | 420,096 | 117,600 | - - - | - - - | - - - | - - - | 537,696 |
| Radiation | 420,096 | 70,560 | - - - | - - - | - - - | - - - | 490,656 |
| TOTAL | 4,636,990 | 1,606,399 | 3,548 | 4,604 | 3,913 | 34,981 | 6,290,435 |

humid tropical climate in precise terms. The existence of open and forested sites allow isolation of micrometeorological effects caused by tropical vegetation. Detailed information concerning instrumentation and observations is contained in the previous semi-annual reports issued under the Data Base Project. Refer to tables III-2 through III-5 for further information on the instrumentation.

3. Data Analyses Published in the Semiannual Reports

In order to demonstrate the determinations which can be derived from analyses of the meteorological observations of the Data Base Project, several such analyses have been published in the earlier semiannual reports. Brief abstracts follow:



a. Preliminary Meteorological Data

Semiannual Report No. 1/2 contains statistical condensations of meteorological data accumulated to that time. Graphs compare the two sites as well as the two seasons (dry and rainy) with respect to mean temperature and mean relative humidity at different heights. The monthly rainfall totals are also presented for both main sites.

The days on which the diurnal temperature oscillation was less than 5°F in the Albrook forest are listed. All were in the rainy season, with nearly half occurring in October and November.

The annual variation of wind speed reveals large differences between the two sites. For example, the mean wind speed at 46 meters over the open site was 15 mph in February 1966, but only 3 mph at the same height over the forest ground. The graph of wind direction frequencies shows a greater dispersion over the forest site than over the open site. [The following year showed similar velocity variations.]

b. Diurnal Temperature Variation in Forest and Open Sites

This study, published in Semiannual Report No. 3, deals only with 17 days of September 1966. Seven of these days were dry at both stations, while the other 10 had rain at noon at both stations. The results show, among other things, that the highest temperature on the rainy as well as on the dry days occurred at both stations at 1200, and not, as is typical for most parts of the world, between 1400 and 1500 hours. The reasons for this abnormality are discussed in Semiannual Report No. 3. Measurements of the dry season, not discussed in that report, indicate that during the dry season the highest daily temperature does occur between 1400 and 1500 hours.

(Text continued on page 17)

TABLE III-2. INSTRUMENT CODE

(Used in Tables III-3 and III-4)

01. Belfort hygrothermograph (chart recorder)
02. Foxboro hygrothermograph (chart recorder)
03. Sling psychrometer (non-recording)
04. Liquid-in-glass minimum thermometer (non-recording)
05. Honeywell hygrothermograph w/soil temperature probe (chart recorder)

06. Taylor non-aspirated psychrometer (non-recording)
07. WBGT instrument (non-recording)
08. Thermistor psychrometer (non-recording, remote reading)
09. Platinum resistance bulb psychrometer (punch tape recording)
10. Bendix Psychron

11. Belfort anemometer w/Rustrak recorder
12. Belfort hand-held wind set (non-recording)
13. Beckman & Whitley GMQ-12 wind set (chart recording)
14. Belfort Anemograph (chart recording)
15. Cardion-West wind set (punch tape recording)

16. Microbarograph (chart recording)
17. Rain gage ML-17 (dip stick)
18. Weighing & recording rain gage (chart recording)
19. Clear-Vu rain gage (non-recording)
20. Tipping bucket rain gage (chart and punch tape recording)

21. Piche evaporimeter (non-recording)
22. Standard evaporation pan (non-recording)
23. Net exchange radiometer (punch tape recording)
24. Total hemispheric radiometer (punch tape recording)
25. Global pyranometer (punch tape recording)

TABLE III-3. INSTRUMENTATION AS OF 1 MAY 1965
(See table II-2 for instrumentation code)

| Forest Site | Sur | 0.5 | 1.0 | 2.0 | 4.0 | 8.0 | 13.5 | 26.5* | 28.5 | 46.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Dry Bulb Temp:(10)** | | 05 | 03 | 03 | 03 | 02 | 02 | 02 | 02 | 02 |
| Wet Bulb Temp:(10)** | | 05 | 03 | 03 | 03 | | | | | |
| Grass Minimum Temp | 04 | | | | | | | | | |
| Soil Surface Temp | 05 | | | | | | | | | |
| Relative Humidity*** | | C | C | C | C | 02 | 02 | 02 | 02 | 02 |
| Wind Direction | | | | | 14 | | | | | 13 |
| Wind Speed | | | 11 | 11 | 14 | 11 | 11 | 11 | 11 | 13 |
| WBGT Index | 07 | | | | | | | | | |
| Barometric Pressure | 16 | | | | | | | | | |
| Precipitation | 18(3)** | | | | NOT REPRODUCIBLE | | | | | 17 |
| | 19(8)** | | | | | | | | | |
| Stem Flow | 19(3)** | | | | | | | | | |
| Evaporation | 21 | | | | | | 21 | 21 | | 21 |

| Open Site | Sur | 0.5 | 1.0 | 2.0 | 4.0 | 8.0 | 13.5 | 26.5 | 28.5 | 46.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Dry Bulb Temp:(10)** | | 05 | 03 | 06 | 06 | 06 | 06 | 01 | 01 | 01 |
| Wet Bulb Temp:(10)** | | 05 | 03 | 06 | 06 | 06 | 06 | | | |
| Grass Minimum Temp | 04 | | | | | | | | | |
| Soil Surface Temp | 05 | | | | | | | | | |
| Relative Humidity*** | | C | C | C | C | C | C | 01 | 01 | 01 |
| Wind Direction | | | | | 13 | | | | | 12 |
| Wind Speed | | | | | 13 | | | | | 12 |
| WBGT Index | 07 | | | | | | | | | |
| Barometric Pressure | 15 | | | | | | | | | |
| Precipitation | 17 | | | | | | | | | |
| Evaporation | 22 | | | | | | | | | |

Level (meters)

* This was the canopy-top level at that time.
** There were several instruments at the same level, as indicated in parentheses.
*** C - Calculated from dry and wet bulb temperatures.

TABLE III-4. INSTRUMENTATION AS OF MARCH 1968
(See table III-2 for instrumentation code)

| | | Level (meters) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Forest Site:** | Sur | 0.5 | 1.0 | 2.0 | 4.0 | 8.0 | 10.0 | 13.5 | 22.0 | 30.0* | 32.0 | 39.0 | 46.0 |
| Dry and Wet Bulb Thermometers: | | 08 | 08 | 08 | 09 | 08 | | 09 | 09 | 09 | 09 | 08 | 08 |
| Wind Set | | | | 15 | | 15 | | 15 | | | | 15 | 15 |
| Precipitation Gages: | | | | | | | | | | | | | |
| Weighing and recording | 18(3)** | | | | | | | | | | | | |
| Clear-Vu | 19(8)** | | | | | | | | | | | | |
| Tipping bucket | 20(5)** | | | | | | | | | | | | 20 |
| Evaporimeter | 21 | | | | | | | 21 | | 21 | | | |
| Net Exchange Radiometer | | | | | | | 23 | | | | | 23 | |
| Total Hemispheric Radiometer | 24 | | | | | | | | | | | | 24 |
| Global Pyranometer | 25 | | | | | | | | | | | | 25 |
| **Open Site:** | | | | | | | | | | | | | |
| Dry and Wet Bulb Thermometers | | 09 | 09 | | 09 | | | 09 | | | | | 09 |
| Wind Set | | 15 | 15 | | 15 | | | 15 | | | | | 15 |
| Precipitation Gage | 20 | | | | | | | | | | | | |
| Evaporimeter | 21 | | | | | | | | | | | | |
| Net Exchange Radiometer | | | | | | | | | 23 | | | | |
| Total Hemispheric Radiometer | | | | | | | | | | | | | 24 |
| Global Pyranometer | | | | | | | | | | | | | 25 |

* This was the new height of the canopy top.
** There were several instruments at the same level, as indicated in parentheses.

## TABLE III-5. INSTRUMENT ACTIVITY



The following is a chronological recapitulation of the instrument activity throughout the project beginning 1 May 1965 (table III-3):

| | |
|---|---|
| July 1965 - | Due to instrument shortage, the recording instruments were removed from the 8.0- and 28.5-meter levels at both sites. |
| - | Sling psychrometers were replaced with Bendix Psychrons. These "psychrons" were used at the levels having no other type of psychrometer. |
| Sept 1965 - | The hygrothermograph at the 1.0-meter level at the forest site was relocated to the 8.0-meter level. |
| Oct 1965 - | The Piche evaporimeter and the wind set were removed from the 46.0-meter level at the forest site. |
| - | A standard evaporation pan was installed at each site. |
| Nov 1965 - | Measurements of the grass minimum temperature were discontinued at the forest site. It was impossible to maintain a grassy plot on the jungle floor. |
| Dec 1965 - | A locally assembled wind set was installed at the 46.0-meter level at the open site. |
| - | Commercial line power was installed at the open site. |
| Jan 1966 - | All the Rustrak recorders were removed from the open site; wind data were telemetered to a selective switch meter located in the observer van. |
| Feb 1966 - | The Piche evaporimeter emplaced "under cover" at the forest site was removed. |
| Apr 1966 - | The standard evaporation pan at the forest site was removed. This type of evaporimeter cannot be used efficiently in an area of falling debris. |
| - | Piche evaporimeters were emplaced at the 26.5-meter and 46.0-meter levels at the forest site. |
| Jul 1966 - | New Belfort hygrothermographs were installed at the 1.0-, 13.5-, and 26.5-meter levels at the forest site and at the 1.0-meter level at the open site. |
| Aug 1966 - | Reconditioned GMQ-12 wind sets were installed at the 4.0- and 46.0-meter levels at the forest site. |

TABLE III-5. (Cont.)

| | |
|---|---|
| | - A tipping bucket raingage with strip chart recorder was installed at the 46.0-meter level at the forest site. |
| Oct 1966 - | A reconditioned GMQ-12 wind set was installed at the 26.5-meter level at each site. |
| Nov 1966 - | The GMQ-12 wind set at the 26.5-meter level at the forest site was damaged beyond repair by a power surge of the generator. It was replaced with a locally assembled wind set. |
| Aug 1967 - | Locally constructed aspirated psychrometers replaced the temperature sensors at the 13.5- and 46.0-meter levels at the open site. The new sensors utilized a thermistor bead and the data were telemetered to a selective switch meter located in the observer van. |
| Sept 1967 - | The Honeywell ML-499 hygrothermographs were removed from the 0.5-meter level at each site; the measurements are made with the Bendix psychron. |
| | - The new automatic Meteorological Data Acquisition and Recording Systems were received and installation began. |
| | - The stem flow observations were discontinued. |
| Oct 1967 - | The GMQ-12 wind sets began to deteriorate rapidly; they were removed as they became inoperative. |
| Dec 1967 - | The installation of the MDARS was completed. The systems were in operation on a test basis. |
| Jan 1968 - | The MDARS were continued on test; many deficiencies were noted. |
| Mar 1968 - | The deficiencies in the MDARS were corrected through efforts of an engineer from the manufacturer, Cardion Electronics, Inc. and the systems were declared operational. |
| | - As per prior planning, the instrumentation was arranged as shown in Table III-4. |
| May 1968 - | Many component breakdowns and spare part procurement delays rendered the MDARS at the open site inoperative until December 1968. Also after this time until the conclusion of the project, there were long periods of breakdown at Chiva Chiva. |

The highest temperatures measured occur at 50 centimeters at the open site and immediately above the canopy at the forest site. The lowest temperatures, however, occur 2 to 4 meters above the ground at both places. At both stations, the temperature change from the minimum to the maximum is a smooth rise from sunrise to noon. The temperature drop, however, is irregular and sometimes interrupted by brief periods of rising temperatures.

The vertical temperature gradients (lapse rates) drawn for many hours of the rainy days show substantial differences between the two sites. The mean temperature stratification of the lowest layers at Chiva Chiva, Canal Zone, is compared with corresponding conditions at Seabrook, New Jersey. The differences are considerable and may cause different propagation characteristics of acoustic and electromagnetic signals.

Another comparison demonstrates that the actual cooling rates between 1900 and 0700 hours display fluctuations which cannot be explained with Newton's law of cooling.

c. Determination of Temperature of Soil Surface

This study, contained in Semiannual Report No. 3, describes use and calibration of an infrared thermometer to measure the temperature of the surface of the ground. Actual soil temperature measurements were published in Semiannual Report No. 5.

d. Problem Areas in Meteorological Measurements

The measurement of meteorological elements under humid tropic conditions involves many special problems. A discussion of these problems and the attempts to overcome them, particularly with regard to the use of hair hygrometers, thermometers, anemometers, evaporimeters, and radiometers, is presented in Semiannual Report No. 4 and (with specific regard to evaporation measurement) in Semiannual Report No. 5. [Problems associated with the use of hair hygrometers were later solved by the use of aspirated tele-psychrometers.]

Semiannual Report No. 4 contains valuable guidance for a realistic evaluation of the observations of this project that may assist in establishing more effective meteorological data acquisition techniques in the humid tropics.

e. Temperature and Humidity Frequencies

Semiannual Report No. 4 also shows that air temperature and relative humidity have bimodal distributions during the dry season in and over open terrain. Generally each day has a daytime temperature and a nighttime temperature with only a brief transition period between them.

During the rainy season the upper mode of the air temperature disappears completely, and so does the lower mode of the relative humidity. Only a change in the slope of the frequency curve indicates that there is sometimes a real difference between nighttime and daytime temperatures. In many other cases, however, temperatures during or after rain may be lower than at night, and the irregularity of rain spreads these low temperatures over all hours and overcomes the peaking effect of occasional high temperatures.

f. Wet Bulb Globe Temperature (Heat Stress)

The Wet Bulb Globe Temperature (WBGT) was designed to predict the amount of human heat stress. It was measured at hourly intervals at the open site and at the forest site. The paper, published in Semiannual Report No. 5, presents graphs with the monthly mean values of the WBGT for each daytime hour. From comparison of the forest data and observations of personnel, it was concluded that the Albrook WBGT data were too low, which is explained through the discrepancy between the characteristics of the human body and the WBGT instrument. The human body always produces heat which, in a calm tropical forest, forms a shell of warm air around the body; whereas, the WBGT does not produce heat but is subject only to external influences.

Semiannual Report No. 5 contains information on maximum values of the WBGT index, the frequency with which certain threshold values were exceeded, and other data sources in the Canal Zone.

g. Climatological Aspects of Evaporation 

Semiannual Report No. 6/7 summarizes the evaporation measurements made at different sites, different heights, and with different instruments. Comparisons were made with monthly means, daily totals, and, for a short period of time, hourly measurements.

h. Measurement of Evaporation

The climatological evaluation of the data base measurements of evaporation, made on a routine basis, does not determine what the measurements really mean. This study, published in Semiannual Report No. 6/7, focuses on the problem of interpreting measurements of evaporation. The usual instrument measures the conditions at its sensing element. But while most instruments allow unequivocal conclusions from the measurements as to the actual state of natural parameters, this is not the case with evaporimeters. Very detailed experiments were made at Chiva Chiva comparing the standard pan, Piche evaporimeter, Livingstone atmometer, air temperature, water temperature (of the evaporimeters and the pan), humidity of the air, and solar and sky radiation. The smaller instruments were placed in sunshine, shade, and in a Stevenson screen. This study concludes, in support of theory, that there is no purely meteorological parameter "evaporation" or "potential evaporation," and therefore no single instrument can measure natural evaporation. The advantages and disadvantages of the different instruments are discussed, and it is stated that no evaporimeter will properly represent the actual evaporation from a given surface. This paper concludes with a theoretical discussion of evaporation.

The evaporation experiments had three by-products worth mentioning. (1) It was shown that condensation can occur on a water surface, increasing in this way the amount of liquid water at the expense of the humidity of the air. (2) Solar and sky radiation data, obtained during the eight days with the greatest radiation during the observation period, showed a suprisingly large variation. (3) A curve of the mean daily variation of the absolute humidity (vapor pressure, dew point), at 41cm above ground at the peak of the dry season, is presented in Semiannual Report No. 6/7.

4. Future Analyses and Reports

Interested investigators are encouraged to use the micrometeorological data accumulated during this project. Dr. W. H. Portig, USATTC Research Meteorologist, has performed further analyses of these data which will be published as future technical reports.

# PART IV. SOILS AND HYDROLOGY

## 1. Introduction

The soils and hydrology task of the Data Base Project focused on four primary types of data: (a) soil strength measurements, (b) soil sample measurements, (c) soil temperature measurements, and (d) ground-water-level measurements. Soil and hydrological measurements were taken at the two main sites and four satellite sites. Refer to part II for site descriptions.

All measurements were made using standard equipment, instruments, and methods. Soil strength measurements were made with trafficability equipment consisting of the cone penetrometer, remolding equipment, and San Dimas equipment. Standard laboratory methods, and equipment such as the liquid limit apparatus, moisture tension table, and pressure membrane extractor, were used for determining soil sample parameters. Soil temperature measurements were taken by emplaced telethermometer probes and the soil moisture meter with fiber glass units. Manual measurements and automatic water-level recorders were used to determine the ground-water level.

## 2. Data Collected

Table IV-1 shows the soil and hydrological factors as measured at various sites during the Data Base Project. Table IV-2 presents time periods during which the measurements were obtained. Table IV-3 shows the analyses, comparisons, and relationships of data which have been determined and presented in previous project reports.

Detailed soil profile descriptions of the Albrook, Chiva Chiva, and Fort Sherman sites are presented in tables IV-4, IV-5, and IV-6. The soil profile descriptions presented here were prepared in order to provide more detailed information on these sites than had previously been given. These profile descriptions cover the same soils described previously in Semiannual Report No. 3, but extend to a greater depth and utilize a revised approach in descriptive terminology. The procedure used was presented in Semiannual Report No. 5. Soil profile sketches for these three sites are appended to the descriptions as figures IV-1, IV-2, and IV-3.

TABLE IV-1. SOIL AND HYDROLOGICAL FACTORS AS MEASURED AT VARIOUS DATA BASE SITES

| SITE | ALBROOK | CHIVA CHIVA | FORT KOBBE SATELLITE SITE I | FORT KOBBE SATELLITE SITE II | ALBROOK SATELLITE | FORT SHERMAN SATELLITE |
|---|---|---|---|---|---|---|
| Cone Index | X | X | X | X | X | X |
| Remolding Index and Rating Index | X | X | X | X | X | X |
| Moisture Content and Density | X | X | X | X | X | X |
| Bulk Density and Moisture Tension | X | X | X | 0 | X | X |
| Soil Temperature | X | X | 0 | 0 | 0 | 0 |
| Soil Moisture (Electrical Resistance) | X | X | 0 | 0 | 0 | 0 |
| Groundwater Level | X | X | X | X | X | X |

LEGEND: X - Factor was measured.
0 - Factor was not measured.

TABLE IV-2. PERIODS OF MEASUREMENT OF SOIL AND HYDROLOGICAL FACTORS

| SITE | ALBROOK | CHIVA CHIVA | FORT KOBBE SATELLITE SITE I | FORT KOBBE SATELLITE SITE II | ALBROOK SATELLITE | FORT SHERMAN SATELLITE |
|---|---|---|---|---|---|---|
| Cone Index | Mar 65 to Apr 67 | Feb 65 to Feb 67 | Mar 65 to Dec 66 | Aug 67 to Aug 68 | Mar 65 to Jan 67 | Mar 65 to Jan 67 |
| Remolding Index and Rating Index | Mar 65 to Apr 67 | Feb 65 to Feb 67 | Apr 65 to Dec 66 | Aug 67 to Aug 68 | Mar 65 to Nov 66 | Mar 65 to Jan 67 |
| Moisture Content and Density | Mar 65 to Apr 67 | Feb 65 to Feb 67 | Mar 65 to Dec 66 | Aug 67 to Aug 68 | Mar 65 to Jan 67 | Mar 65 to Jan 67 |
| Bulk Density and Moisture Tension | X | X | X | 0 | X | 0 |
| Soil Temperature | Oct 65 to Jan 67 | Oct 65 to Jan 67 | 0 | 0 | 0 | 0 |
| Soil Moisture (Electrical Resistance) | Oct 65 to Jan 67 | Oct 65 to Jan 67 | 0 | 0 | 0 | 0 |
| Groundwater Level | May 65 to Jan 67 | May 65 to Jan 67 | Mar 65 to Dec 66 | Aug 67 to Aug 68 | Mar 65 to Jan 67 | Mar 65 to Jan 67 |

LEGEND: X - One time measurement.
0 - Factor not measured.

TABLE IV-3. COMPARISONS, ANALYSES, AND RELATIONSHIPS DETERMINED FROM SOILS AND HYDROLOGICAL DATA

| SITE | ALBROOK | CHIVA CHIVA | FORT KOBBE SATELLITE SITE I | FORT KOBBE SATELLITE SITE II | ALBROOK SATELLITE | FORT SHERMAN SATELLITE |
|---|---|---|---|---|---|---|
| Monthly Variation - Field Moisture Content | 3 | 3 | 0 | 0 | 0 | 0 |
| Soil Strength Profiles | 3 | 3 | 0 | 0 | 0 | 0 |
| Monthly Variation - Cone Index | 3 | 3 | 0 | 0 | 0 | 0 |
| Comparison of Field Moisture Content Between Sites | 3 | 3 | 0 | 0 | 0 | 0 |
| Comparison of Soil Strength Profiles | 3 | 3 | 0 | 0 | 0 | 0 |
| Moisture Content vs. Cone Index | 3 | 3 | 3 | 0 | 3 | 3 |

TABLE IV-3. (Cont.)

| SITE | ALBROOK | CHIVA CHIVA | FORT KOBBE SATELLITE SITE I | FORT KOBBE SATELLITE SITE II | ALBROOK SATELLITE | FORT SHERMAN SATELLITE |
|---|---|---|---|---|---|---|
| Moisture Content vs. Remolding Index | 1/2 | 1/2 | 1/2 | 0 | 1/2 | 1/2 |
| Moisture Content vs. Rating Cone Index | 3 | 3 | 3 | 0 | 3 | 3 |
| Moisture-density Relationships | 1/2 | 1/2 | 3 | 0 | 3 | 3 |
| Comparison of Mean Soil and Air Temperatures | 0 | 1/2 | 0 | 0 | 0 | 0 |
| Groundwater Level and Rainfall Relation | 1/2 | 1/2 | 0 | 0 | 0 | 0 |
| Frequency Occurrence of Moisture Content | 1/2 | 1/2 | 0 | 0 | 0 | 0 |

TABLE IV-3. (Cont.)

| SITE | ALBROOK | CHIVA CHIVA | FORT KOBBE SATELLITE SITE I | FORT KOBBE SATELLITE SITE II | ALBROOK SATELLITE | FORT SHERMAN SATELLITE |
|---|---|---|---|---|---|---|
| Frequency Occurrence of Cone Index | 1/2 | 1/2 | 0 | 0 | 0 | 0 |
| Textural Classification: USDA and USCS | 3 | 3 | 3 | 3 | 3 | 3 |
| Mechanical Analysis | 3 | 3 | 3 | 6/7 | 3 | 3 |
| Soil Profile Descriptions | 3 | 3 | 3 | 6/7 | 3 | 3 |

LEGEND: 1/2 - Data presented in Semiannual Report No. 1/2.
3 - Data presented in Semiannual Report No. 3
6/7 - Data presented in Semiannual Report No. 6/7.
0 - Data not gathered.

TABLE IV-4. SOIL PROFILE DESCRIPTION, ALBROOK FOREST SITE

**Location**: Albrook AFB, Canal Zone; military grid coordinates 17P-PV-600 960

**Elevation**: 30 meters above sea level

**Slope**: 2 percent

| | | |
|---|---|---|
| $A_1$ | 0-5" | Very dark grayish brown or dark grayish brown (10YR 3/2-4/2) clay loam; moderate medium subangular blocky structure; medium fine roots; few scattered worm casts; firm; slightly acid; abrupt to clear wavy boundary. |
| $A_2$ | 5-14" | Very dark grayish brown or dark grayish brown (10YR 3/2-4/2) clay; moderate medium subangular blocky structure; few fine roots; few medium pores; few worm casts; few fine Fe-Mn concretions; many small pressure faces; firm; slightly acid; clear wavy boundary. |
| $B_1$ | 14-20" | Very dark grayish brown (10YR 3/2) clay; common medium faint yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; few fine Fe-Mn concretions; few medium pressure faces; firm; natural; clear wavy boundary. |
| $B_{22}$ | 20-32" | Grayish brown (10YR 5/2) clay; few fine prominent red (2.5YR 4/8) mottles; moderate medium subangular blocky structure; non-indurated plinthite less than 5 percent; indurated plinthite greater than 5 percent; pressure faces; firm; neutral; clear wavy boundary. |
| $B_3$ | 32-55+" | Gray (10YR 5/1-6/1) clay; many medium prominent red (10R 4/8) mottles; moderate medium subangular blocky structure; non-indurated plinthite less than 5 percent; indurated plinthite greater than 5 percent; pressure faces; firm; neutral. |

Remarks:

Profile described from pit.
All colors for moist soils.
pH determined by Hellige-Truog field kit.

ALBROOK SITE

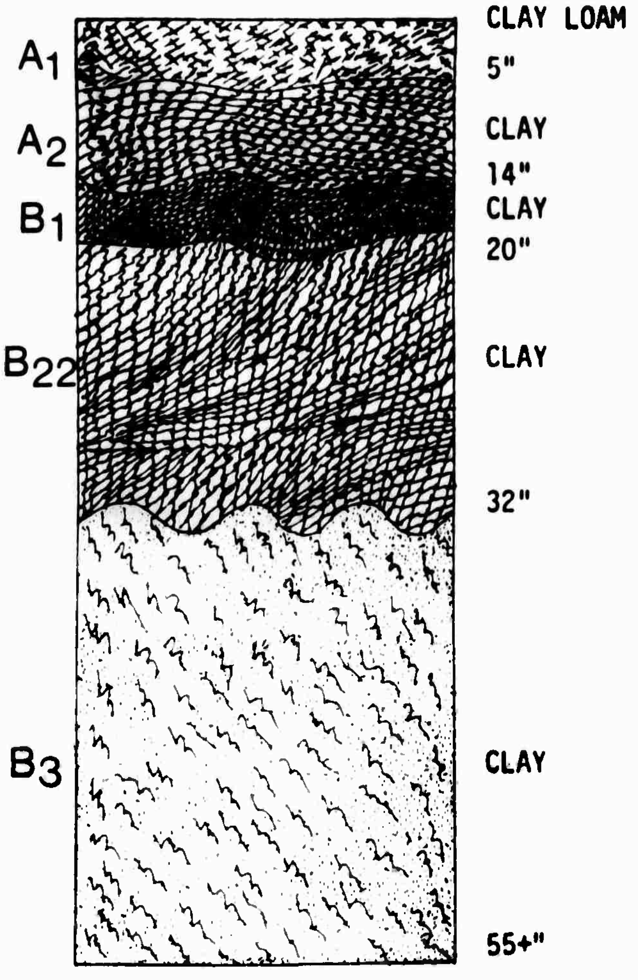



FIGURE IV-1. SOIL PROFILE, ALBROOK FOREST SITE

TABLE IV-5. SOIL PROFILE DESCRIPTION, CHIVA CHIVA SITE

<u>Location</u>: Fort Clayton Military Reservation, Canal Zone; military grid coordinates 17P-PV-562 979

<u>Elevation</u>: 30 meters above sea level

<u>Slope</u>: 3 percent

| | | |
|---|---|---|
| $A_1$ | 0-5" | Dark yellowish brown (10YR 4/4) sandy clay loam; weak fine subangular blocky structure; many fine roots; many fine pores; few fine Fe-Mn concretions; friable; strongly acid; clear wavy boundary. |
| $B_1$ | 5-11" | Yellowish brown (10YR 5/4) clay; weak fine subangular blocky structure; few fine roots; few fine Fe-Mn concretions; friable; very strongly acid; clear wavy boundary. |
| $B_{21t}$ | 11-18" | Yellowish brown (10YR 5/4) clay; weak medium subangular blocky structure; more than 5 percent non-indurated plinthite; few fine pores; thin discontinuous clay films; friable; very strongly acid; clear wavy boundary. |
| $B_{22t}$ | 18-55+" | Light brownish gray (10YR 6/2-2.5Y 6/2) clay; many medium prominent red (10Y 4/6) and yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; few medium pockets of Fe-Mn; 50 percent of horizon composed of non-indurated plinthite; thin discontinuous clay films; friable; very strongly acid. |

Remarks:

Profile described from pit.
All colors for moist soils.
pH determined by Hellige-Truog field kit.

CHIVA CHIVA SITE

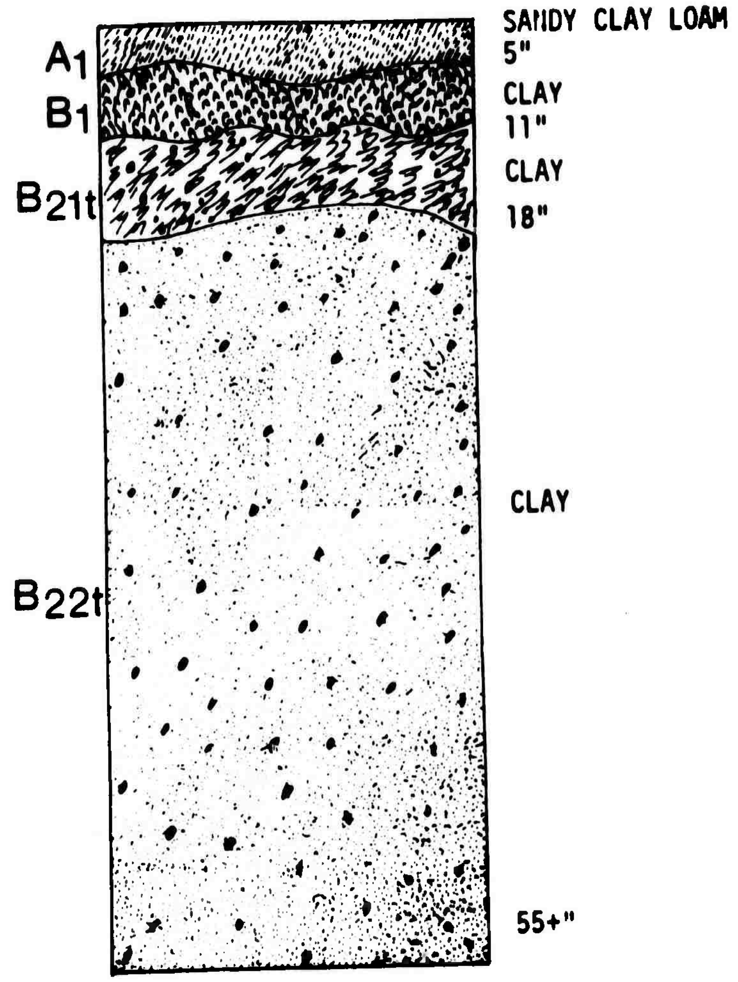



FIGURE IV-2. SOIL PROFILE, CHIVA CHIVA SITE

TABLE IV-6. SOIL PROFILE DESCRIPTION, FORT SHERMAN SITE

Location: Fort Sherman Military Reservation, Canal Zone; military grid coordinates 17P-PA-117 261

Elevation: 80 meters above sea level

Slope: 7 percent

| | | |
|---|---|---|
| $A_1$ | 0-4" | Yellowish red (5YR 4/6) sandy clay; weak fine subangular blocky structure; many fine and medium roots; very friable; very strongly acid; clear wavy boundary. |
| $B_{21}$ | 4-9" | Dark red (2.5YR 3/6) or red (2.5YR 4/6) clay loam; weak medium subangular blocky structure; few fine and medium roots; few medium pores; very friable; very strongly acid; clear wavy boundary. |
| $B_{22}$ | 9-65+" | Red (10R 4/8) clay; few fine prominent strong brown (7.5YR 5/6) mottles, medium moderate subangular blocky structure; few fine roots in upper part of horizon; many fine pressure faces; friable; very strongly acid. |

Remarks:

Profile described from pit.
All colors for moist soils.
pH determined by Hellige-Truog field kit.

FORT SHERMAN SITE

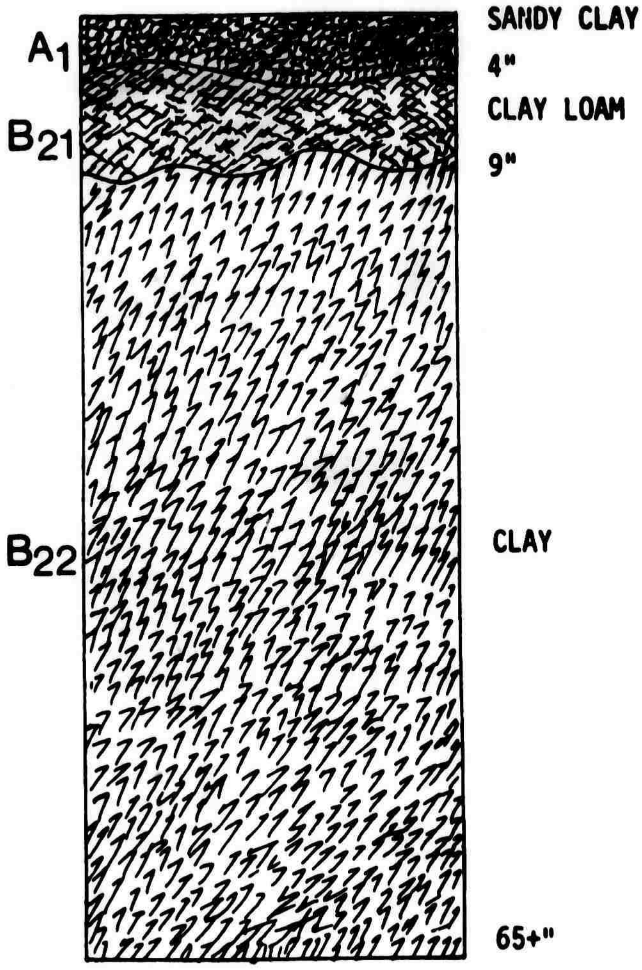



FIGURE IV-3. SOIL PROFILE, FORT SHERMAN SATELLITE SITE

## PART V. VEGETATION

The principal objective of the vegetation sub-task of the Environmental Data Base Project was to enumerate, identify, and locate all plants one inch in diameter and over, within a 3600-square-meter plot at the Albrook forest site. This task was undertaken in order to permit the accumulation of data on rate of growth, seasonal death and replacement, and general stocking and density of the vegetation stand. The first vegetation inventory of the site was completed in June 1965, and was included in Semiannual Report No. 1/2 as appendix I. The inventory was updated in January 1967, and published as appendix C of Semiannual Report No. 3. The final comprehensive study of vegetation was completed in December 1969, and is included in appendix I of this report.

As an aid to the identification of the plants, a herbarium was started in 1965. At the end of the project, some 3500 species of plants had been collected, mounted on herbarium sheets, and filed. This repository, the largest of its kind in Central America, has been transferred to the Panama Canal Company, which has furnished space to house it and a curator for its care. The herbarium is now open to the public.

Several studies of the amount, distribution, and caloric composition of litter on the forest floor were made. The first of these, a study of composition and quantity of litter fall during one year, was published in Semiannual Report No. 1/2. A subsequent study of rate of deterioration of forest litter, completed in May 1967, was reported in Semiannual Report No. 3. Semiannual Report No. 5 contained the final litter-fall analysis, which examined the rate of accumulation of litter from the three most common canopy tree species. The floristics of the Albrook forest site were studied in detail, and reported on in Semiannual Report No. 3. Further study of the role of certain tree species as indicators of the age of the forest resulted in a paper which appeared in Semiannual Report No. 4.

## PART VI. MICROBIOLOGY AND CHEMISTRY OF THE ATMOSPHERE

### 1. Introduction

The microbiological and chemical tasks of the Environmental Data Base Project have included several lines of investigation, dealing with microorganisms deposited on various surfaces or transported by various means, and with the chemical as well as particulate contamination of the atmosphere. Principal investigations were carried out at the Albrook and Chiva Chiva sites, and supplementary investigations were conducted at many localities throughout the Canal Zone and within the Republic of Panama.

### 2. Data Analysis

The investigations performed under this task have been described, and selected analytical discussions have been presented in the previously published semiannual reports of the Data Base Project. They are listed in paragraph 3. Other analyses of the data collected during the project have been prepared by Tropic Test Center scientists and by, or in collaboration with, outside specialists (references 13 through 16). The atmospheric chemistry section of the National Center for Atmospheric Research is also publishing the results of an air sampling program, partially conducted at the data base sites (reference 19).

### 3. Summaries of Previously Published Analyses

a. Microorganisms on Leaf Surfaces

Leaf surfaces seemed to be a most likely source of airborne microorganisms in the tropical forest atmosphere. Pady (reference 6) reported that most of the fungal spores in the atmosphere come from soil. Gregory (reference 7), on the other hand, contended that most atmospheric fungi are derived from the micropopulations on vegetation. The leaves of 20 of the more common forms of vegetation in this observational area were studied. The fungi: *Hormodendrum, Phoma, Trichoderma, Chaetomium, Mucor, Streptomyces, Aspergillus, Nigrospora, Penicillium, Pestalozia, Stemphyllium, Gliocladium,* and *Fusarium* were found most frequently. These were also the most common forms of fungi seen in samplings of air for the same area and time of year, except that a *Monilia* species not found on vegetation was one of the predominant airborne forms. This list of isolates from leaf surfaces is almost identical to the list of fungi recovered from air and soil in northern Nigeria by Dransfield (reference 8). On the other hand the predominant types found by Pathak and Pady (reference 9) for the atmosphere in Kansas were seldom encountered in these samples. *Alternaria,* found most frequently by Pathak and Pady, was not encountered at all in these samples. *Cladosporium,* the next most common type encountered in Kansas, was found in only a few samples.

Some general observations of leaf populations may be of more interest than a comparison of these results with those of other investigators. Thirty-six separate types of fungi were identified. Of the 36 types, 12 were present on some leaves in both the dry and rainy seasons, 12 were present only in the rainy season, and 12 were present only in the dry season. This seems at first glance to be a normal and possibly expected distribution. Numbers of identified types inhabiting leaves of individual plants during the rainy season never exceeded four. The average number of types of fungi per plant was 2.3. On the other hand, the number of types of fungi on individual leaves in the dry season ranged between 3 and 12; the average number per plant was 9.5. Perhaps the most significant observation was the almost complete change of the fungi which could be cultivated from individual leaves between the rainy and the dry season. Eight of the 20 kinds of vegetation showed no seasonal carry-over. Ten plants maintained one type of fungus for both seasons. Overlapping involved only 4 of the 36 forms of fungi. *Hormodendrum* was the persistent fungus in six instances; *Phoma* in four; *Fusarium* once. *Aspergillus* appeared in both cases of double overlapping; once each time with *Hormodendrum* and *Phoma*.

A better understanding of the variability in number of airborne microorganisms, assuming that they are derived from vegetation, will require observations on leaf temperature, leaf wetness, and determination of the effects of air movement within the forest canopy. Possibly other, as yet unknown, elements of the environment will also be involved.

b. Surface Deposited Microorganisms

The environments of the humid tropics are optimum or near optimum for microbial life. Temperature is always warm, with prevailing levels varying only a few degrees from an average of 80 to 85°F. Moisture is abundant and relative humidity is high. Dying vegetation continuously provides a supply of organic matter from which microorganisms derive energy. Leaves of living plants provide much of the surface upon which microbial forms grow as well as shade for protection against direct sunlight. In this optimum environment biotic activity is intense; and microbial populations, particularly of degradative and parasitic genera, are generally more numerous than those found elsewhere.

Since exposed surfaces in the tropical environment are subjected to infestation and subsequent deterioration by microbial forms, the environmental factors that influence the manner in which contamination takes place could have practical importance. For example, substantial monetary losses have resulted and are continuing to result from bio-deterioration of military materiel in humid tropical environments.

Surfaces initially free of microorganisms become heavily contaminated when they are exposed to the tropical atmosphere. The nature and extent of contamination have generally been observed to vary with region, season, and other characteristics of the environment.

Gregory (reference 12) described the gravity Petri dish method of collecting microorganisms. Numbers of bacteria and fungi falling on surfaces were determined by exposing nutrient-free agar plates to the atmosphere for one hour. Plates were exposed at data base sites at approximately 0300, 0900, 1500, and 2100 hours once every seven days. Petri plates containing non-nutrient agar were exposed inside open-ended sterile fiber glass tubes 5 inches in diameter and 16 inches long. The tubes served to shield the plates from insect and plant debris as well as rain. Tube-plate sets were exposed in pairs, one tube being oriented north-south and the other east-west. Over the period of observation, the numbers of microorganisms collected in the north-south and in the east-west tubes were practically equal. Based on this observation, the overall effect of wind direction was assumed to be negligible and the sets of tubes were regarded as duplicates. After sampling, the plates were brought to the laboratory and overlaid with sterile nutrient-enriched pads. Colonies of fungi and bacteria growing on plates fortified with Czapeck's and nutrient broth media, respectively, were counted and numbers deposited per 100-square centimeter surface were calculated. A paper by Hutton, *et al* (reference 13) was published on a portion of this work.

c. Distribution of Airborne Microorganisms

Air samples were taken at the Albrook forest and the Chiva Chiva sites for analysis of content of living bacteria and fungi. Data collection was started on an experimental basis in November 1965, but continuous sampling was not established until March 1966. Samples were taken at ground level, 15, 21, and 46 meters at 0300, 0900, 1500, and 2100 hours daily. Sampling was conducted during the first five working days of each month. Samples were analyzed to determine the seasonal and diurnal variations occurring at different heights.

Du Buy, *et al* (reference 10) conducted a study of nine methods for sampling airborne microorganisms and stated that the devices could be classified into two categories: impinger devices and atomizer devices. This Center tried several variations of these methods. Significantly, early trials showed that capture of microorganisms on a dry sterile membrane filter from air drawn directly through the filter gave the highest number of organisms and the most consistent results. This is in contrast to results from sampling in more temperate climates.

Significant losses in viability often occur when sampling is conducted by direct filtration of air. In temperate climates, maximum numbers of viable organisms are obtained only when air being sampled is bubbled through liquid, usually nutrient, media. In this method, microorganisms pass from the air into the liquid and are later captured on filter membranes by liquid filtration, or the impinging fluid containing the trapped cells is diluted and plated on solid nutrient media. Reduced numbers obtained by direct sampling in temperate regions are attributed to an adverse effect of prolonged contact of trapped microorganisms with the relatively dry air being sampled. Presumably because of higher moisture content, tropical air passing through membrane filters does not cause detectable injury to the microorganisms already deposited on the filter.

A special filtering device was designed which was described in Semi-annual Report No. 1/2. Reduced air pressure, supplied by a piston pump, was available at all levels through a permanently installed line which extended the length of the towers. Outlet valves, located at 6-meter intervals, were closed except during sampling.

The number of microorganisms in and about a deciduous forest in the Canal Zone, and at a nearby cleared area were compared. The numbers of bacteria and fungi per unit volume of air were determined and the frequency of occurrence of the 15 predominant genera of fungi was observed. The variability due to seasons, time of day, and elevation above ground was reported. The air spora above the forest canopy (46 meters) did not differ appreciably from that found at the same level in the cleared area. At both sites the numbers of microorganisms were usually highest in the early morning hours; however, seasonal trends were not significant. Hutton, *et al* (reference 13) published a paper that covered data obtained between July 1966 and December 1966.

d. Microorganisms as Sources of Atmospheric Contaminants

Microbial activity may contribute measurably to the chemical content of the atmosphere in tropical environments. Gas chromatography was performed to determine what is present in atmospheres in which microorganisms are growing profusely.

It was revealed in early investigations that surfaces of materials exposed in the tropical environment tend to acquire a heavy layer of contamination of foreign matter and microorganisms. This contamination occurs so rapidly that the property of being biologically inert, sometimes attributed to inorganic materials and the less reactive plastics, can be questioned. Inabilities to correlate the results from exposure tests in real and simulated (chamber) tropical environments have been reported. These inabilities may be associated with the fact that, in a simulated tropical environment, contamination of surfaces is not normally heavy and debris accumulate slowly, if at all. These facts provide a rationale for a re-examination of the tropical environment in order to characterize its unique elements or features, and/or to describe and detect quantitatively the factors responsible for the corrosive and degradative reactions observed to occur.

Concentrations of volatile organic substances derived from microorganisms growing in association with plants were first reported in Panama by Hutton and Rasmussen (reference 11).

Microorganisms as sources of atmospheric contamination and as factors in establishing microbial populations on biologically inert surfaces are summarized in a paper published by Rasmussen, Hutton, and Garner (reference 16). The following is extracted from a summary written by the three scientists:

> "A marked variation was seen in the relationship between the airborne microorganisms found in and above vegetation in a semi-deciduous forest area at Fort Clayton, Canal Zone, and the extent of microbial contamination collecting on an exposed surface in this environment. The form of variation between calculated and observed relative rates of deposition of airborne forms on surfaces appear to be related to all the environmental factors measured in simple terms of site, time, elevation, and season. Specific elements other than those of climate, such as condensible organic volatiles and aerosols, apparently exert primary influences which interact to provide a proper milieu for a microbial community.
>
> "Patterns of organic volatiles were obtained for almost all biological surfaces. The contamination of a clean surface predictably altered the pattern of volatiles coming from that surface. Comparison of the data obtained from controlled atmospheres in small chambers (with and without microorganisms) with atmosphere beneath the tropical forest canopy suggests that microbiology and chemistry of forest atmospheres is influenced by the heavy canopies of leaves (surfaces).
>
> "This interaction of surface, micro-organisms, condensible volatile chemicals, aerocolloidal matter, and diffusophoresis was studied to explore and define the effect of trace levels of chemicals in the atmosphere on micro-organism growth. The role of these naturally occurring organic volatiles in biological systems is not well defined; but experimental results strongly suggest a fate associated with entrainment with water vapor, condensation and absorption on inert or viable surfaces, and their metabolism by micro-organisms. These phenomena may exert a primary ecological influence in establishing a microbial population through the build-up of organic layers by condensation of water vapor and diffusophoretic enrichment of the condensate with organic volatile material found in the atmosphere.

"Tests comparing microbial growth on agar plates or inert metal surfaces, with and without the addition of volatile chemicals condensed from the atmosphere and temperature cycling, showed growth stimulation by the chemicals condensed from the air. Results suggest the adjuvant properties of the cold trap products, and also a possible chemical-microbe relation which is not observed by the methods normally used. Possibly a new approach for studying microbial ecology exists in the study of these interacting phenomena."

e. Microbial Inhabitants of Soil in a Tropical Semievergreen Forest

Results of this study, prepared by Dr. Eugene E. Staffeldt, who served as a consultant to the Data Base Project and is a professor of Biology at New Mexico State University, were originally presented in Semiannual Report No. 3. Information included in this report is primarily involved with the microorganisms that grow in the organic substrates of the soil at several sites in the Canal Zone.

Soil core samples were obtained on a monthly basis from May 1965 through April 1966 by Tropic Test Center personnel. These were kept refrigerated until analyzed. Standard bacteriological techniques to determine qualitative and quantitative data on both aerobic and anaerobic microbial populations were employed in analyses of samples.

The density of bacteria per gram of soil was relatively low throughout the examination period. The occurrence of $10^4$ to $10^6$ total bacterial cells per gram of soil was recorded. Peak populations of aerobic bacteria were found during the months of August and October. There was a slight increase in the number of anaerobic bacteria during March and April. The relationship of aerobic and anaerobic bacteria to the wet and dry seasons requires further examination. The predominant soil fungi encountered were in the genera *Fusarium, Penicillium,* and *Trichoderma.* During the 10 months of sampling, these organisms were found in all samples. High numbers were usually followed by a fairly rapid decline. These three genera did not appear to be drastically affected by seasonal trends, except in total number of organisms. Twenty-four genera of fungi aside from the three most common were isolated and identified. These were, in order of most common to least common:
*Phoma, Hyalopus, Streptomyces, Aspergillus, Masoniella, Myrothecium, Stachybotrys, Alternaria, Pythium, Xylaria, Cunninghamella, Cladosporium, Gliocladium, Saksenaea, Monilia, Curvularia, Mucor, Pyrenochaeta, Nigrospora, Volutella, Chaetomium, Helminthosporium, Sphaeronema,* and *Ophiostoma.*

f. Microbiology of Rainwater

Airborne microorganisms may be deposited on surfaces directly or they may be washed out of the air by rain. The observations on the microbial content of rainwater described herein were made as a part of the broader investigations of air and surface microbial populations in a tropical region. This investigation was designed to determine the number of bacteria and fungi per 100 milliliters of rainwater samples collected at selected sites in the Canal Zone.

Rainwater samples were collected in sterile beakers placed 1 meter above the ground in an area open to the sky, well away from buildings, at Miraflores Annex. Samples were collected every 15 minutes during heavy rain, though the collection of a usable sample required 30 to 60 minutes when rains were light. Each sample was analyzed separately.

The processing of the collected samples was performed by drawing the sample through a 0.45-micron pore sized membrane filter field monitor. After filtration, the volume of water was measured. The filter pad was infused with sterile nutrient broth, capped, and incubated at 28°C for three days. The number of colonies which appeared were counted and the number recorded. Data were collected from 79 samples between 9 May 1966 and 8 December 1966.

g. Condensation Nuclei

Several brief observations of very small particles in the atmosphere were made from air samples collected at two locations in the Canal Zone during July 1966. A condensation nuclei detector was used to determine relative concentrations of the submicroscopic liquid and solid airborne particles which form condensation nuclei. The particulates and nuclei are significant factors in cloud and precipitation formation and for air contamination; they contribute to the accumulation of surface films on exposed items.

Limited observations employing the condensation nuclei detector were made; however, difficulties encountered in operation were considerable. At first the detector was placed in an air-conditioned environment and air was drawn into the machine from outside the enclosure. Condensate from the sampled air quickly upset the steady-state operation of the machine and results were not reliable. Operation of the machine in the ambient atmosphere was impossible because both the electronic and optical components failed after short periods of operation.

Limited data were obtained at the Miraflores Annex and the Albrook forest site using the detector. The data obtained are shown in figures VII-5 and VII-6, respectively, of Semiannual Report No. 1/2. The Miraflores Annex is in a flat grassy area which is burned annually. During the rainy season, the grass (Panicum Maximum) reaches its maximum height of 51 inches. The annex is situated near the Panama Canal and a 25,000-kilowatt steam-generated power plant. The peaks of the curves which appear in the figure probably reflect the presence of a high content of particulate and chemical matter attributable to the passage of ships through the Canal and the operation of the power plant. The numbers of condensate nuclei obtained under the canopy at the Albrook forest site were 5 to 50 times smaller than those found at the Miraflores Annex. Incidences of high readings occurred consistently before or during periods when rain fell.

h. Particulate Matter-Paper Tape Sampler

Air contamination has long been recognized as a significant cause of damage to materiel in urban areas. Stern (reference 18) emphasized the effect of airborne particulate matter in deterioration caused by exposure to polluted atmospheres. He indicated that deposited particulate matter markedly accelerates the corrosion of metals. The majority of reports citing deterioration of materiels caused by air pollutants deals with observations made in and around cities. The deterioration of materiel in tropical regions, on the other hand, is seldom associated with contaminated atmosphere. Instead, reports on tropical deterioration cite effects of moisture, high temperature, and microbiological action as the main factors responsible for deterioration and corrosion. There is a paucity of reports on the particulate content of tropical atmospheres, but air in such regions is usually assumed to be relatively free from pollutants because of general lack of major urban influence and the fact that it is washed frequently by torrential rains.

This section is limited to a presentation of data from extended and continuous observations of large (greater than 40 microns) atmospheric particles. Investigations of particles large enough to be seen should include microscopic examination to determine structure, size, and composition. For example, particulates may be fibrous; and they may consist of minerals, industrial wastes, or biological substances. Particulates should also be subjected to chemical analysis, if appropriate. Neither manpower nor equipment was available for microscopic examination or chemical analysis. Instead, air was sampled approximately every two hours and the amount of contaminant present was determined.

A modified Gelman paper tape sampler was used. The sampler was modified by inserting a silica cartridge between the vacuum source and under the jaw of the filter head. Air was sampled continuously. Each sample of air collected over a two-hour period was drawn by reduced pressure through a Whatman #41 filter paper. The filter paper strip was fed automatically from the tape dispenser through the sampling head, along the tape guide, and taken up on a storage spool. At the end of each 24-hour sampling period the exposed filter paper strip was removed and dated, and the sampler was put back into operation. Optical density measurements were made with the Gelman paper tape densitometer, and the readings were converted to coefficient of haze (COH) units. The air sampler was located 46 meters above ground on the tower at the Chiva Chiva open site and samples were taken from 1 April 1966 until 28 September 1967. On 28 September the sampler was moved to the 2-meter level at the Albrook forest site Data were collected at that site until 3 May 1968.

i. Concentration of Carbon Dioxide in the Tropical Atmosphere

This is a report of carbon dioxide ($CO_2$) content of atmosphere at two sites in the Canal Zone, one in a grass area near Miraflores Annex and the other at the Albrook forest site. Special attention was given to the marked short-timed fluctuations in the concentration of $CO_2$ existing at both sites. These fluctuations took place below the 4-meter level at Albrook and below the 2.5-meter level at Miraflores.

Measurements of $CO_2$ were made on a continuous basis by drawing 1.20 liters per minute of air through a Beckman IR 215 Infrared $CO_2$ Analyzer coupled with a potentiometric recorder. All connections between the sampling points and instruments were made with natural gum tubing (½-inch inside diameter), and the analyzer section was calibrated twice a day with nitrogen and a $CO_2$ secondary standard prepared in the laboratory.

The Albrook forest data were obtained by sampling under the canopy at four different levels (0.3, 1.2, 2.5, and 4 meters) approximately 10 meters from the tower at the Albrook forest site. This area was surrounded by high trees and had a considerable amount of litter at ground level. The Miraflores Annex data were obtained by sampling at three different levels (0.3, 1.2, and 2.5 meters) in a grass-covered (2.5 meters tall) field adjoining Miraflores Annex.

Two types of data were obtained at each site: (a) Sampling on a continuous basis at the 0.3-meter level to obtain from the recorded output weekly averages of hourly carbon dioxide concentrations. This level was chosen because the $CO_2$ fluctuations were more frequent at this height. (b) Sampling for periods of 10 minutes at each consecutive level and recording the measurements by hand at 10-second intervals. This was done to obtain more accurate information on the $CO_2$ fluctuations present at the different levels during a specified period of time. To allow continuous sampling from one level to the other, an array of simple and economical valves was designed in a control panel, which provided accurate measurements without equilibration time loss.

(1) Albrook Data - 0.3-Meter Level. The diurnal variation in $CO_2$ concentration approximated the following: Starting at midnight with a concentration of about 470 parts per million (ppm), the value rose to a maximum of 500ppm at 0700 hours, then fell sharply to minimum of 400ppm at about 1100 hours, varied only moderately until about 1700 to 1800 hours, then increased throughout the night hours. The short-term fluctuations during the 24-hour period were less frequent and of lower magnitude at night.

(2) Miraflores Annex Data - 0.3-Meter Level. The diurnal pattern of variation in average $CO_2$ concentration was very similar to that exhibited

at the Albrook forest site; i.e., the maximum concentration occurred shortly after sunrise, with a sharp drop in the early daytime hours and continuing at a low level in the afternoon, followed by a gradual increase during the night. The short-time fluctutations, on the other hand, were greater during the hours of darkness and showed a decreased amplitude with time.

(3) Albrook Data at Four Levels. (a) 0.3-meter level: The $CO_2$ measurements at this level showed a high frequency of fluctuation with well defined peaks having a maximum value of 450ppm and a minimum of 365ppm. The highest variation during a 50-second period was 80ppm in magnitude, though the average carbon dioxide concentration for the 10-minute period was 410ppm. (b) 1.2-meter level: A high frequency of fluctuation with sharp peaks still prevailed at this level, but the magnitude of fluctuation had decreased by half. The fluctuation range was from 388 to 360ppm. The highest variation in ppm during a 50-second reading was 44ppm, and the average $CO_2$ concentration for the 10-minute sampling period was 370ppm. (c) 2.5-meter level: This level showed broadened peaks with more plateaus. The fluctuation frequency was much lower, with a range of $CO_2$ concentration from 350 to 373ppm. The highest change during a 50-second period was 25ppm, and the average $CO_2$ concentration was 368ppm, over a 10-minute period. (d) 4-meter level: This level showed still fewer peaks and more plateaus, and the fluctuation was much less prominent. The highest change in concentration during a 50-second period was 12ppm, and the average $CO_2$ concentration for 10 minutes was 365ppm. Above the 4-meter level $CO_2$ fluctuations were not detected.

(4) Miraflores Annex Data at Three Levels. The $CO_2$ fluctuations at Miraflores Annex also varied from level to level, and there was a marked decrease in the magnitude and frequency of the fluctuations between the 0.3 and 2.5-meter levels. The maximum fluctuations encountered for a 50-second period were 60, 45, and 10ppm for the 0.3-, 1.2-, and 2.5-meter levels respectively; also the average $CO_2$ concentrations for the 10-minute period were 485, 470, and 446ppm for the same levels respectively. No $CO_2$ fluctuations were detected above the 2.5-meter level.

j. Spore Trap Samples

This subtask was established to determine content of spores, plant and insect parts, and chemical crystals in the humid tropical atmosphere by use of a Kramer-Collins spore sampler. The spore trap was run for a 15-minute interval every hour at both sites. The trap consists of the following components: vacuum pump, intake tube, flow meter, timing mechanism, and a standard 1- by 3-inch microscope slide with a slide advancing mechanism. Air to be sampled is drawn into the sampler, and the particulate matter is impinged on the microscope slide at 2-millimeter intervals. Air is taken in at a flow rate of 0.8 cubic feet per minute. At this operational rate, air flow is isokinetic at a wind speed of approximately two miles per hour. Under these conditions, efficiency is nearly 100 percent in collecting fungus spores, pollen grains, and other particulate matter down to 3 microns in size.

Four samplers were used. Samples were taken at the 1-meter and 46-meter levels at both the Chiva Chiva site and the Albrook forest site. Samples were taken each working day, except when technical problems prevented, at each level and site from 30 August 1967 until 15 September 1968. Optical density of representative slides was recorded using a modified Model 14000 Gelman Densitometer. No further analysis of these slides was performed.

## PART VII. MACROFAUNA

The sub-task involving investigation of the macrofauna was restricted to superficial examination of those organisms which could be expected to contribute to the reduction and decay of vegetation. These were defined as the arthropoda occurring in the litter layer. Collections of litter were made at monthly intervals at the Albrook forest site, and the samples subjected to Berlaze funnel extractions. These organisms were counted but identifications were not accomplished.

As an adjunct to the Environmental Data Base Project, Dr. Robert T. Allen, entomologist at the University of Arkansas, made a detailed study of the Coleoptera (beetles) collected at the Albrook forest site. Dr. Allen provided counts, by family, of insects collected by use of black light traps, as reported previously in Semiannual Reports 4 and 6/7. Drs. Allen and R.S. Hutton based a paper on data from this project (reference 17).

The litter extraction samples taken monthly at the Albrook forest site are stored at this Center. Counts of organisms occurring in these samples with a superficial breakdown into types are available.

The count of insects taken from the black light traps has been transcribed onto IBM punch cards and is stored at the National Center for Atmospheric Research, Boulder, Colorado, and at the Tropic Test Center.

## PART VIII. DATA ORGANIZATION AND STORAGE

### 1. General

All data collected, measured, and recorded under the Environmental Data Base Project have been stored on magnetic disks and tapes, with the exception of data pertaining to vegetation and the insect collection program. Data pertaining to the insect collection program were not placed on magnetic media; however, they were stored on punch cards and may be retrieved. The data collected on vegetation were not considered to be subject to numerical manipulation to extent that they could be so indexed. The output of the project studies on this task is contained in the semiannual project reports in the form of the vegetation inventories and the individual analytical studies and papers.

### 2. Code Format

Each message on the punch cards and, correspondingly, on the magnetic disks and tapes consists of an eight-digit identifier plus the measurements. The cards contain from 1 to 24 measurements, according to the element. For quarter-hourly measurements, the contents of four consecutive cards appear on the disk (or tape) under the same "identifier." The identifier is formatted as follows:

Format of Identifier

| Column | Significance |
|---|---|
| 1 | Site (Table VIII-1) |
| 2 | Last Digit of Year (e.g., 6 for 1966) |
| 3, 4, 5 | Julian Calendar Date |
| 6, 7 | Element (Table VIII-1) |
| 8 | Level or Special Code (Table VIII-2) |

Table VIII-1 shows the code assignment of all environmental elements measured under the Data Base Project. Table VIII-2 shows the height (or level) and some special codes.

Dry Bulb Temperature (01, 81)
Wet Bulb Temperature (04, 84)
Grass Minimum Temperature (02)
Ground Surface Temperature (03)
Relative Humidity (05, 85)
Wind Direction (06, 83)
Wind Speed (07, 82)
Barometric Pressure (09)
Recording Rain Gages (10)
Evaporation (12)
Clear-Vu Rain Gages (13)
Vapor Pressure (69, 79)
Saturation Deficit (70, 80)
Net Exchange Radiation (86)
Total Hemispheric Radiation (87)
Global Radiation (88)

3. Availability

The available meteorological data for the above list of elements are stored on the magnetic media in this sequence. For element codes in parentheses, see table VIII-1.

The magnetic disks, punch cards (or tape), original recorder charts, and all other forms of "raw" data are stored at the US Army Tropic Test Center, Fort Clayton, Canal Zone. Duplicate magnetic tapes are on deposit at the HQ, US Army Test and Evaluation Command, Aberdeen Proving Ground, Maryland, and with the Earth Sciences Division, US Army Natick Laboratories, Natick, Massachusetts. Other depositories of the information will be the National Center for Atmospheric Research, Boulder, Colorado (biological and air chemical data with correlated meteorological data) and the National Weather Records Center, Asheville, North Carolina (meteorological data).

Qualified organizations or individuals may secure access to the data on official request to the primary repository at the US Army Natick Laboratories.

## TABLE VIII-1. DATA BASE SITE AND ELEMENT CODES
(Column 1, and 6 and 7 of the Identifier)

| LOCATION | CODE |
|---|---|
| Albrook Forest | 1 |
| Chiva Chiva | 2 |
| Coco Solo Forest | 3 |
| Coco Solo Open | 4 |
| Rio Hato | 5 |
| WES (Albrook) | 6 |
| WES (Fort Kobbe) | 7 |
| WES (Fort Sherman) | 8 |

| ELEMENT | CODE |
|---|---|
| Temperature, Dry Bulb | 01 |
| Temperature, Grass Minimum | 02 |
| Temperature, Surface | 03 |
| Temperature, Wet Bulb | 04 |
| Relative Humidity | 05 |
| Wind Direction | 06 |
| Wind Speed | 07 |
| Temperature, Wet Bulb Globe | 08 |
| Barometric Pressure | 09 |
| Precipitation | 10 |
| Stem Flow | 11 |
| Evaporation | 12 |
| Clear-Vu Rain Gage | 13 |
| WES Maximum Temperature | 14[d] |
| WES Minimum Temperature | 15 |
| WES Maximum Relative Humidity | 16 |
| WES Minimum Relative Humidity | 17 |
| WES Rain Gage No. 1, Open Area | 18 |
| WES Rain Gage No. 2, Under Canopy | 19 |
| Syringe Sample (Gas Chromatrograph) | 20 |
| Gas Sample, Short Term | 21 |
| Gas Sample, Long Term | 22 |
| Gas Sample, Cumulative | 23 |
| Carbon Dioxide | 24 |
| Particulate Sample (less than one hour) | 25 |
| High Volume Sample | 26 |
| Tape Sample, Sequential | 27 |
| Tape Sample, Cumulative | 28 |
| Special Sample | 29 |
| Surface Deposition | 30 |

| ELEMENT | CODE |
|---|---|
| Airborne Microorganisms | 31 |
| Leaf Deposition | 32 |
| Rain Water Sample | 33 |
| Spore Sample | 34 |
| 35 - 39 Unassigned | - |
| Pan Litter | 40 |
| Ground Litter | 41 |
| Litter Decomposition | 42 |
| Litter Accumulation | 43 |
| Insects | 44 |
| Insects Nitrogen | 45 |
| 46 - 49 Unassigned | - |
| Soil Data (see table IV-1 for details) | |
| Cone Index | 50 |
| Remolding Index | 51 |
| Rating Index | 52 |
| Moisture Content | 53 |
| Density | 54 |
| Soil Temperature Plot A | 55 |
| Soil Temperature Plot B | 56 |
| Soil Temperature Plot C | 57 |
| Soil Moisture Plot A | 58 |
| Soil Moisture Plot B | 59 |
| Soil Moisture Plot C | 60 |
| Water Table Level | 61 |
| 62 - 68 Unassigned | - |
| Vapor Pressure (from 01 & 04) | 69 |
| Saturation Deficit (from 01 & 04) | 70 |
| 71 - 78 Unassigned | - |
| Vapor Pressure (from 81 & 84) | 79[b] |
| Saturation Deficit (from 81 & 84) | 80[b] |
| Temperature, Dry Bulb | 81[a,c] |
| Wind Speed | 82[a] |
| Wind Direction | 83[a] |
| Temperature, Wet Bulb | 84[a,c] |
| Relative Humidity | 85[a,c] |
| Solar and Sky Radiation | |
| Net Exchange | 86[a] |
| Total Hemispheric | 87 |
| Global | 88 |
| 89 - 99 Unassigned | - |

*a* - Added Level Code
*b* - Same Level Code as for 05 and 85
*c* - Applies to the 22.0 and 39.0 meter levels only
*d* - Data obtained from Waterways Experiment Station MEGA Project
WES - US Army Waterways Experiment Station, Vicksburg, Mississippi, made some of these measurements.

TABLE VIII-2. DATA BASE SITE AND ELEMENT CODES

(Column 8 of the Identifier)

| Code * | Tower Level (Elements 01, 04, 05, 06, 07, 87, 88) | |
|---|---|---|
| 1 | 46.0 Meters | |
| 2 | 32.0 Meters | (after February 1968) |
| 2 | 28.5 Meters | (through February 1968) |
| 3 | 30.0 Meters | (after February 1968) |
| 3 | 26.5 Meters | (through February 1968) |
| 4 | 13.5 Meters | |
| 5 | 8.0 Meters | |
| 6 | 4.0 Meters | |
| 7 | 2.0 Meters | |
| 8 | 1.0 Meters | |
| 9 | 0.5 Meters | |
| (Blank) | Ground Surface | |
| | **Tower Level (Elements 78 through 86)** | |
| 1 | 39.0 Meters | |
| 4 | 22.0 Meters | |
| 5 | 10.0 Meters | |
| | **WBGT (Element 08)** | |
| 1 | Index | |
| 2 | Dry Bulb Temperature | |
| 3 | Wet Bulb Temperature | |
| 4 | Black Globe Temperature | |
| | **Precipitation (Elements 10 and 13)** | |
| 0 | Number of the rain gage on the ground (this code for Chiva Chiva only) | |
| 1 | Top of Albrook Tower (Element 10) | |
| 1 | Number of the rain gage on the ground (Element 13) | |
| 2 | Number of the rain gage on the ground (Elements 10 and 13) | |
| 3 | Number of the rain gage on the ground (Elements 10 and 13) | |
| 4 | Number of the rain gage on the ground (Elements 10 and 13) | |
| 5 | Number of the rain gage on the ground (Elements 10 and 13) | |
| 6 | Number of the rain gage on the ground (Elements 10 and 13) | |
| 7 | Number of the rain gage on the ground (Elements 10 and 13) | |
| 8 | Number of the rain gage on the ground (Elements 10 and 13) | |
| 9 | Number of the rain gage on the ground (Element 10) | |

TABLE VIII-2. (Cont.)

| | Stem Flow (Element 11) | |
|---|---|---|
| 1 | Large tree | |
| 2 | Small tree | |
| 3 | Medium tree | |

| | Evaporation (Element 12) |
|---|---|
| Blank | Chiva Chiva, Piche at surface |
| 1 | Chiva Chiva, Pan at surface |
| 2 | Albrook, Piche at 46.0 meters |
| 3 | Albrook, Piche at 26.5 meters |
| 4 | Albrook, Piche at 13.5 meters |
| 5 | Albrook, Piche at Surface, uncovered |
| 6 | Albrook, Pan at Surface, covered |
| 7 | Albrook, Piche at Surface, covered |

| | Layer Depth (Element 50) | |
|---|---|---|
| 1 | 0-3 | Inches |
| 2 | 3-6 | Inches |
| 3 | 0-6 | Inches |
| 4 | 6-9 | Inches |
| 5 | 9-12 | Inches |
| 6 | 9-12 | Inches |
| 7 | 12-15 | Inches |
| 8 | 15-18 | Inches |
| 9 | 12-18 | Inches |

| | Depth | (Elements 55 through 60) |
|---|---|---|
| 1 | 4 | Centimeters |
| 2 | 11 | Centimeters |
| 3 | 19 | Centimeters |
| 4 | 27 | Centimeters |
| 5 | 34 | Centimeters |
| 6 | 42 | Centimeters |
| 7 | 50 | Centimeters |
| 8 | 100 | Centimeters |

* The significance of these "Code" numbers depends on the element coded in columns 6 and 7 of the identifier, as indicated in parentheses.

NOTE: Further details for chemical and biological data coding format can be found in the paper to be published by the National Center for Atmospheric Research dealing with Chemical and Biological Data (Data Base Program), prepared by Mr. J. B. Pate.

## APPENDIX I. VEGETATION INVENTORY

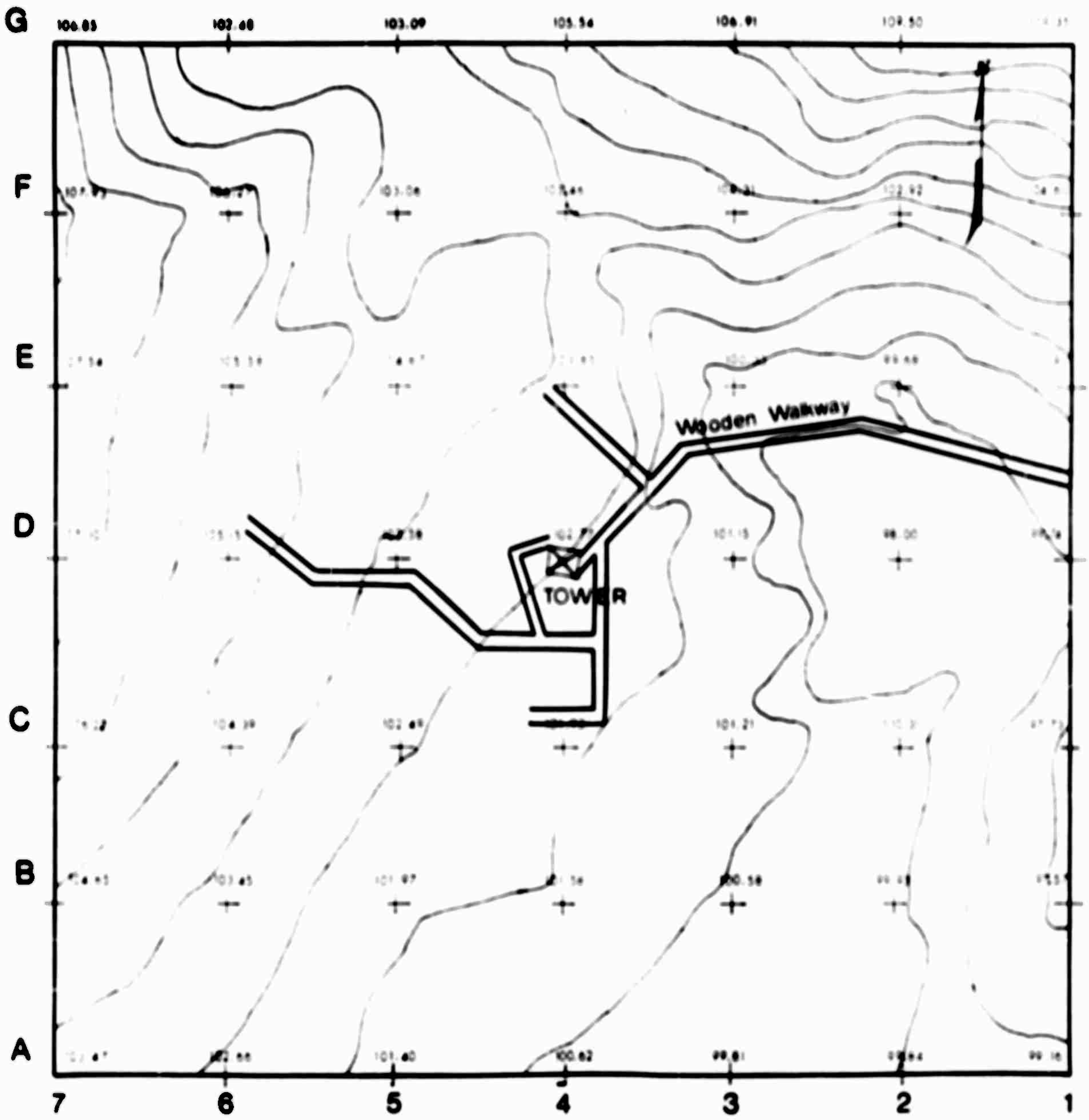
This inventory of shrubs and trees within a 3600-square-meter plot, divided into thirty-six 10-meter-square plots, at the Albrook forest site is based on surveys performed in December 1966 and November 1969. Location of trees and shrubs, diameter at 120 centimeters above the ground [diameter at breast height (DBH)], height to first branch, and overall height are all listed numerically under appropriate tabular headings. Trees are also grouped numerically, by reference to numbered drawings (figure A-7), into seven representative shapes. The change of format enables accumulation of more information and will permit machine analyses of accumulated data to reveal occurrence of growth, emergence of new specimens, and other changes which take place with the passage of time.

Figure A-1 of the inventory is a topographic map of the 60-meter-square grid of the observational area. Corners of the thirty-six 10-meter-square plots within the area have letter-number designations to locate the position and orientation of the plot within the grid. Letters and numbers indicate north-south and east-west locations, respectively.

Table A-1 contains names of the more common species of plants found in the area. Approximate top and intermediate coverage are indicated in figures A-2 through A-6. Each of the 36 plots of the vegetation inventory (table A-2) contains information about one 10-meter-square plot. Each plot is numbered to permit its identification within the grid area. For example the last plot, G7G6F7F6, represents the upper left hand plot in the grid. Numbers in the left hand (X Y) column of each plot give the location of each specimen within the plot. That is, in plot G7G6F7F6 the number 0 1 in the X & Y column locates a *Cecropia* tree was located between zero and one meter right of the Y line and between one and two meters above the X line.

The description of the *Cecropia* tree above is continued in succeeding columns of the referenced table. Shape III is in reference to the seven representative drawings found in figure A-7. DBH indicates diameter at breast height (120 centimeters above ground). Height to first branch and height overall are given in meters.

The inventory is intended to serve several purposes: (a) copies are available for observers and visitors for use as required; (b) a master copy will be maintained to record notes concerning phenological events and corrections that are found necessary; and (c) copies will be provided any investigator wishing to use the site to record location of points of interest and points that are not to be disturbed by other investigators.

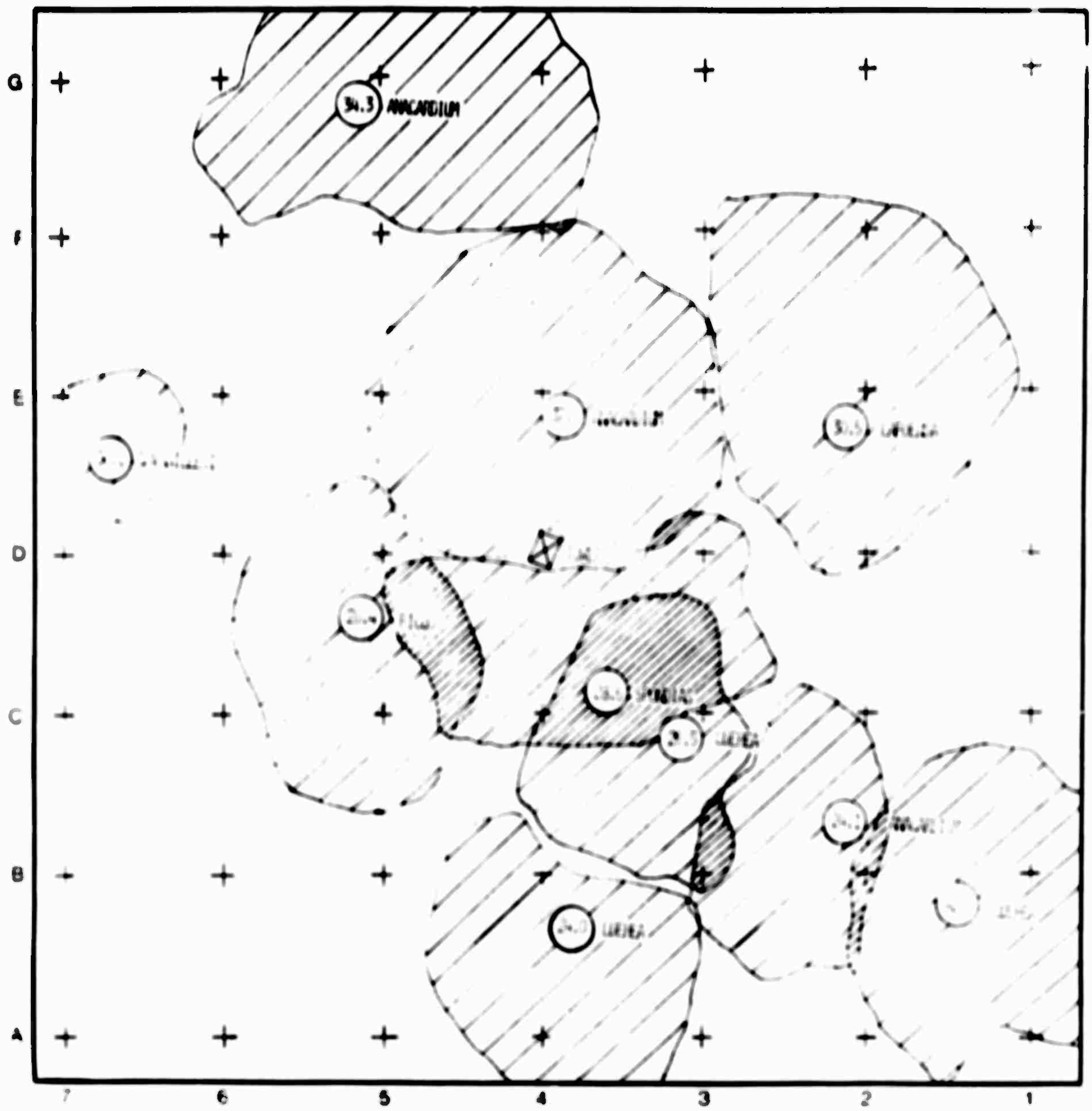



10 Meters

+ Indicates Location Of Plot Corners

Numbers Near Indicated Plot Corners Denote Height Above Mean Sea Level In Feet

FIGURE A-1 ALBROOK FOREST SITE GRID ORIENTOR SHOWING GROUND CONTOUR, ELEVATION, AND GRID LOCATIONS

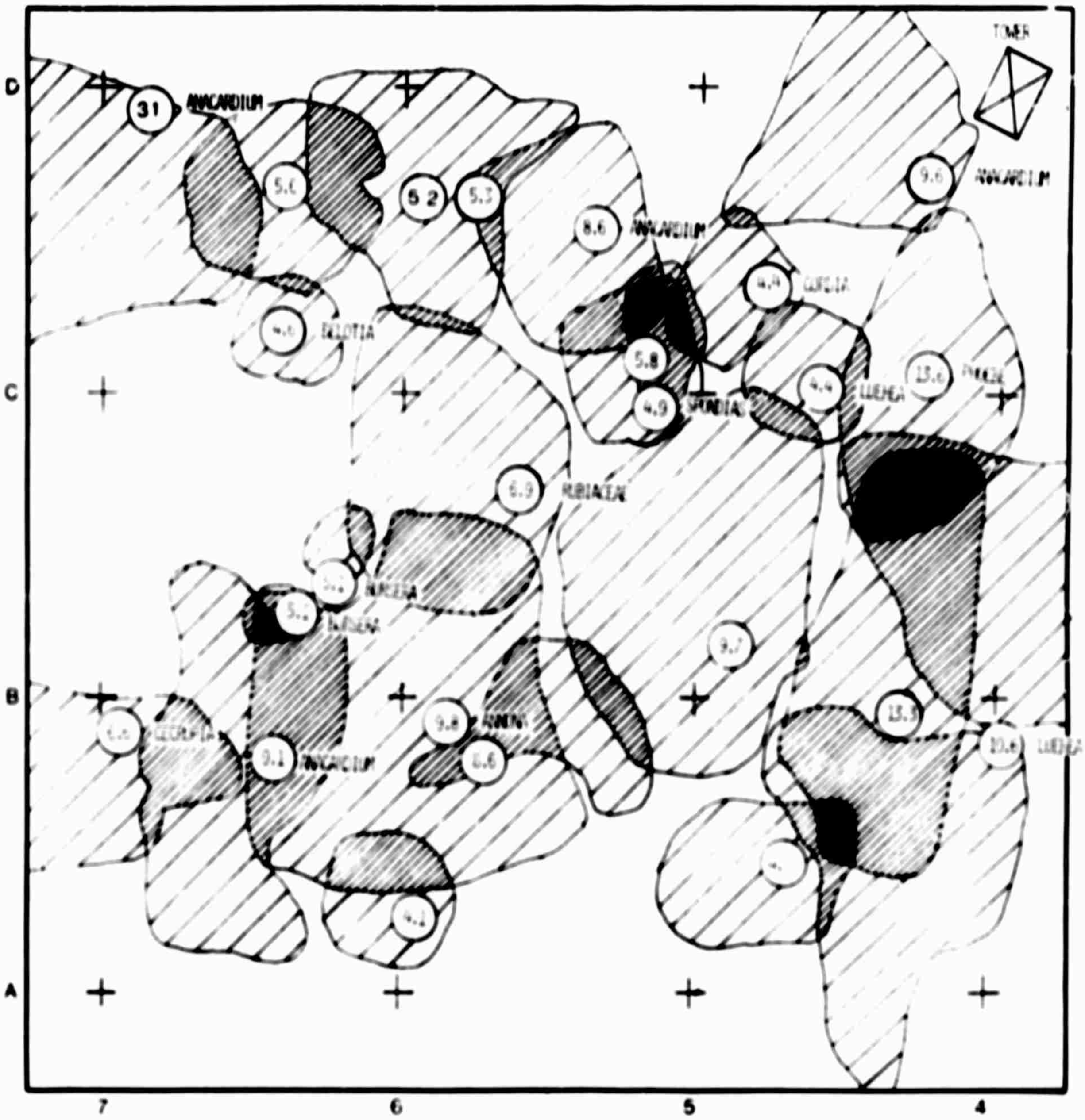



10 Meters

Indicates DBH in cm as of June 1965

Indicates plot corners

FIGURE A-2 TOP STORY COVERAGE (above 27 meters)




10 Meters

Indicates DBH in cm as of June 1985

Indicates plot corners

FIGURE A-3 INTERMEDIATE STORY COVERAGE: SW QUADRANT
(below 27 meters)

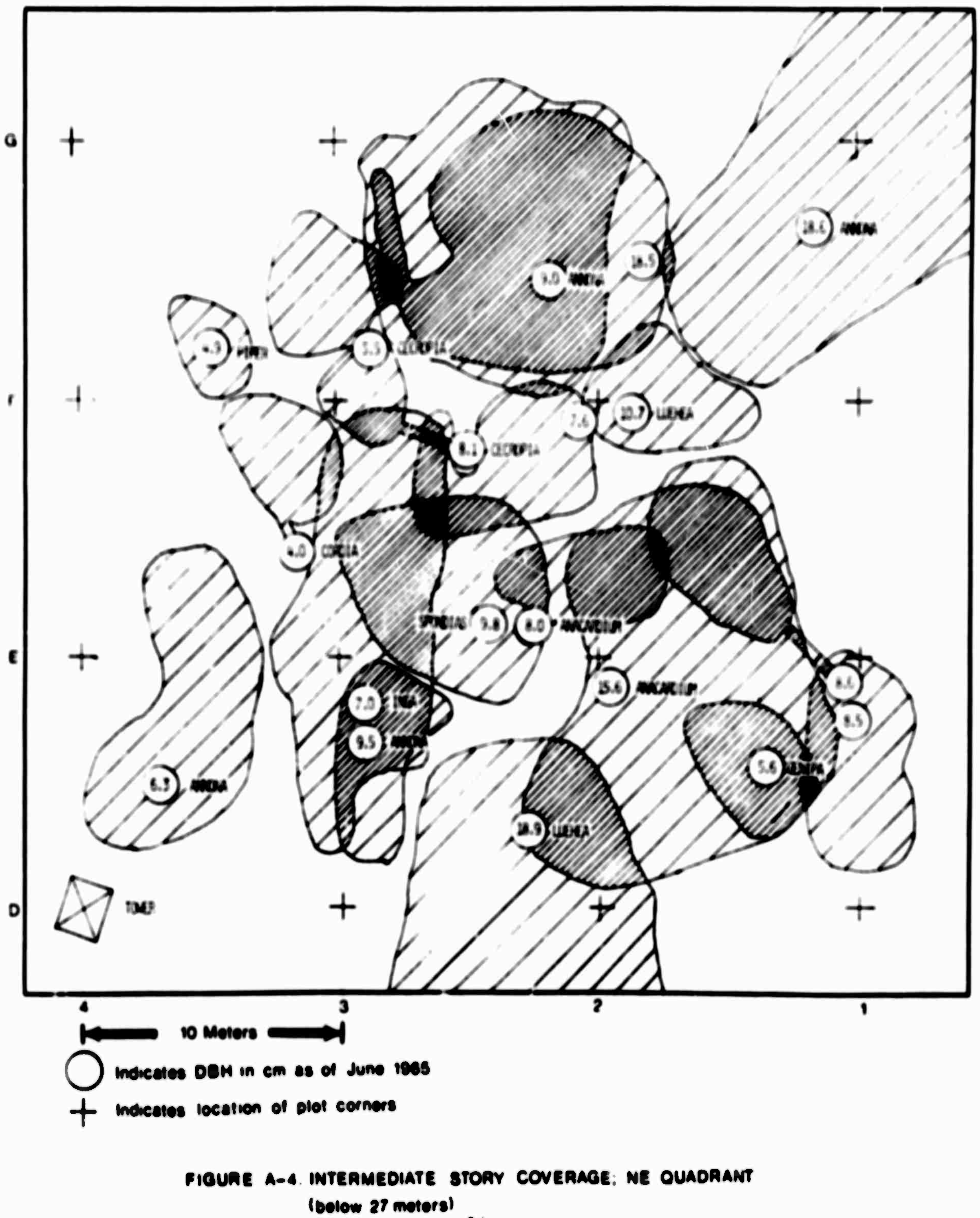
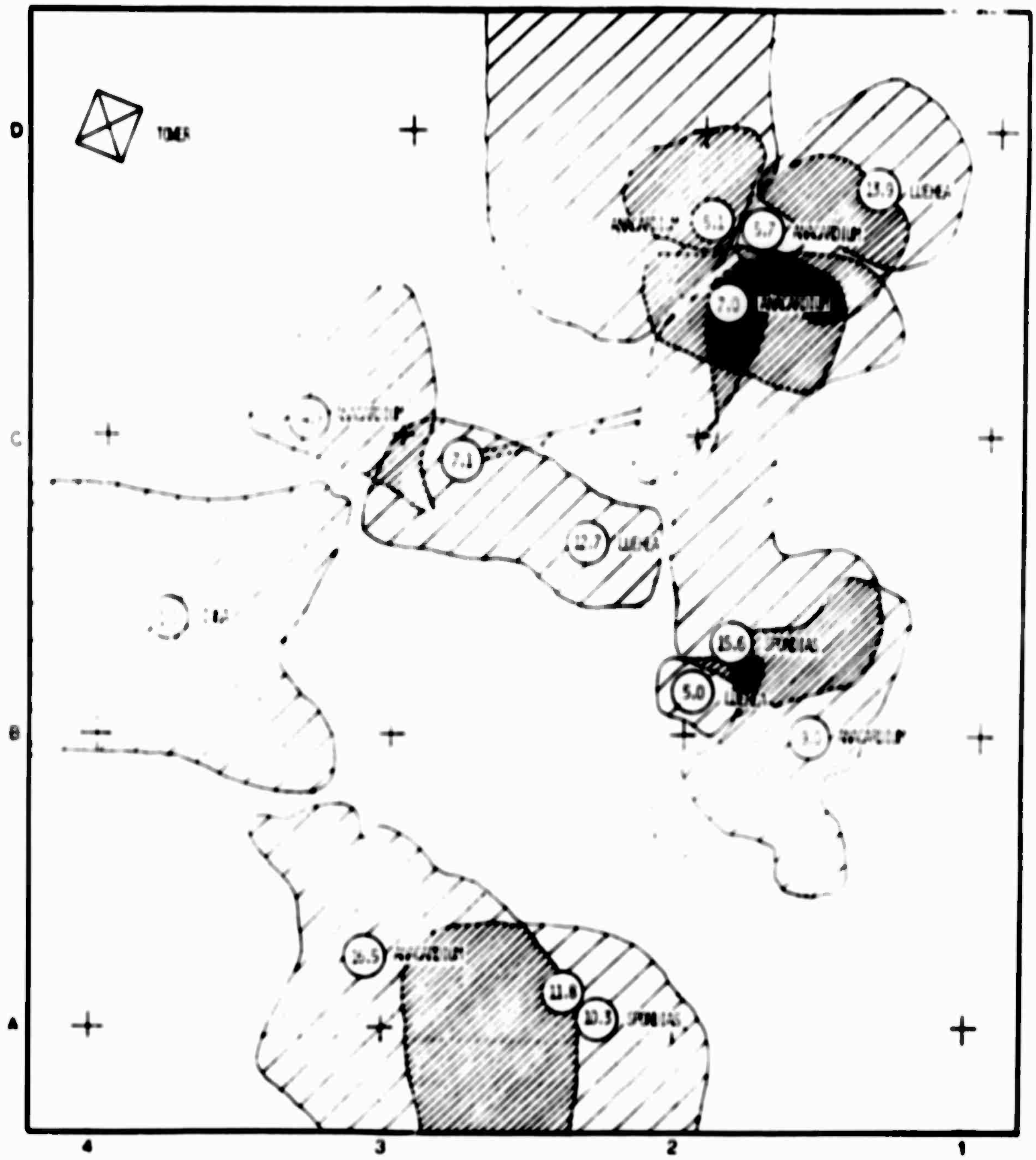



FIGURE A-4. INTERMEDIATE STORY COVERAGE; NE QUADRANT
(below 27 meters)

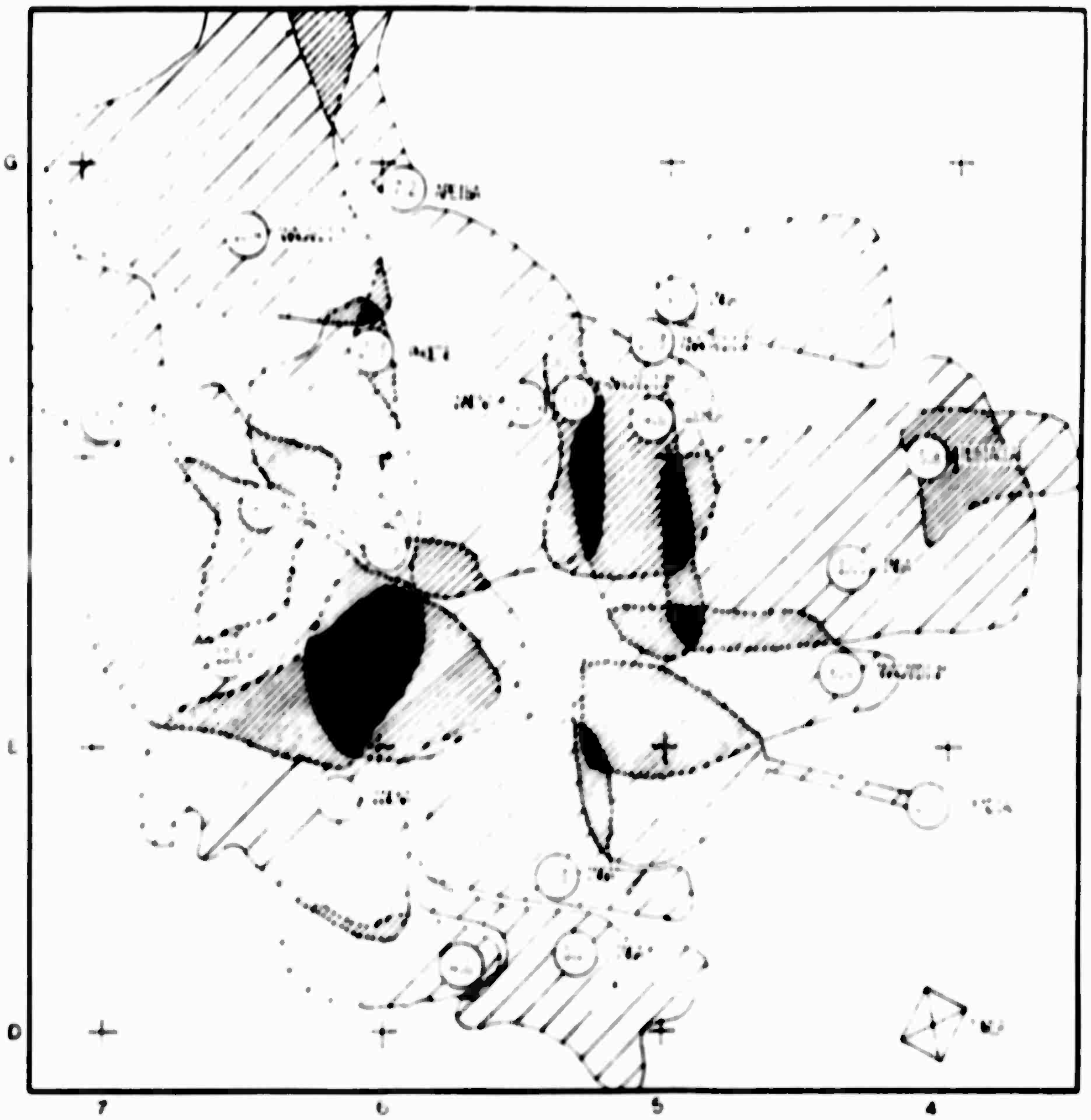


10 Meters

Indicates DBH In Cm As Of June 1965

Indicates Location Of Plot Corners

FIGURE A-5 INTERMEDIATE STORY COVERAGE, SE QUADRANT (below 27 meters)




10 Meters

Indicates DBH in cm as of June 1965

Indicates location of plot corners

FIGURE A-6 INTERMEDIATE STORY COVERAGE, NW QUADRANT
(below 27 meters)

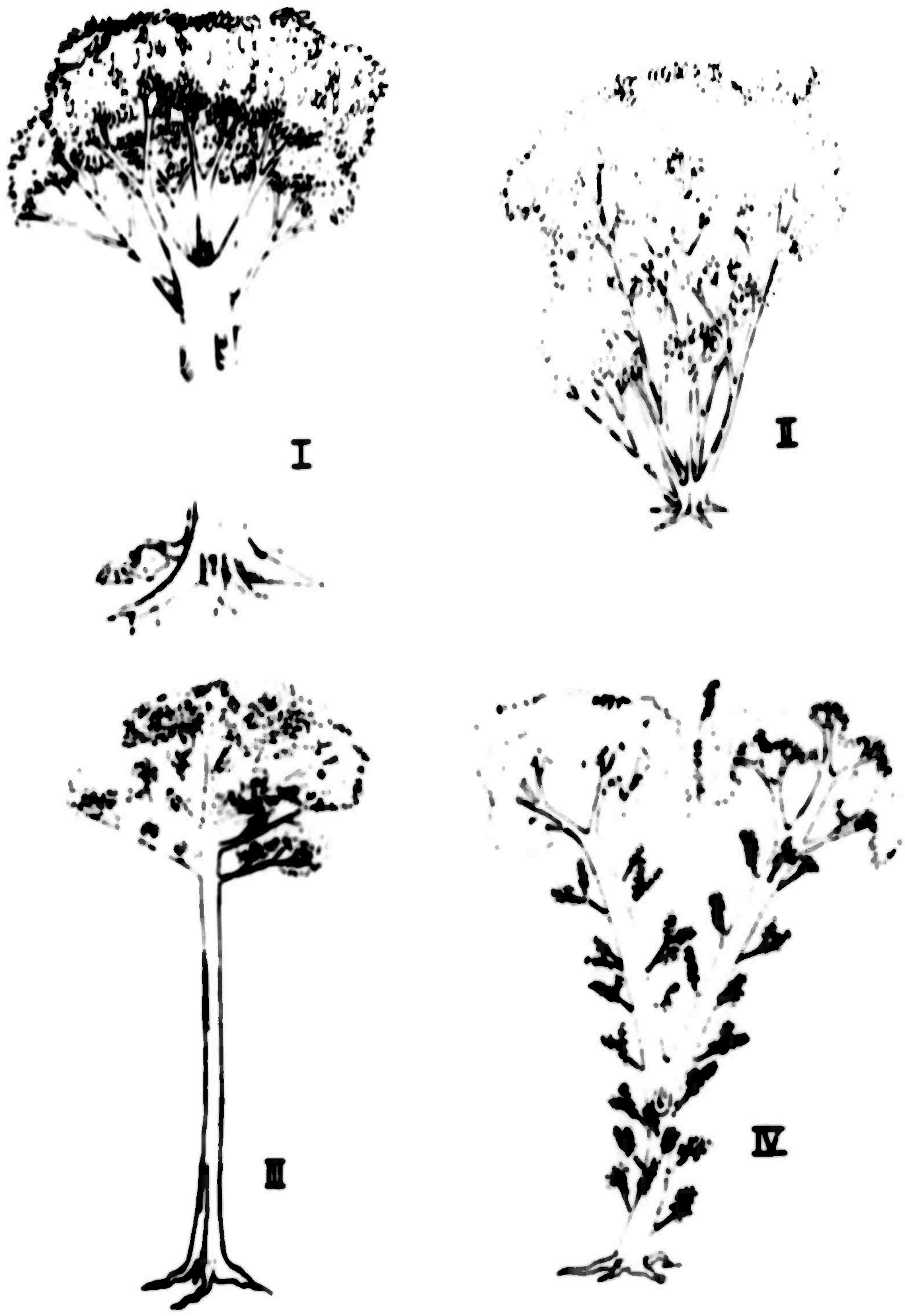



FIGURE A-7. REPRESENTATIVE SHAPES OF TREES OCCURRING IN ALBROOK FOREST

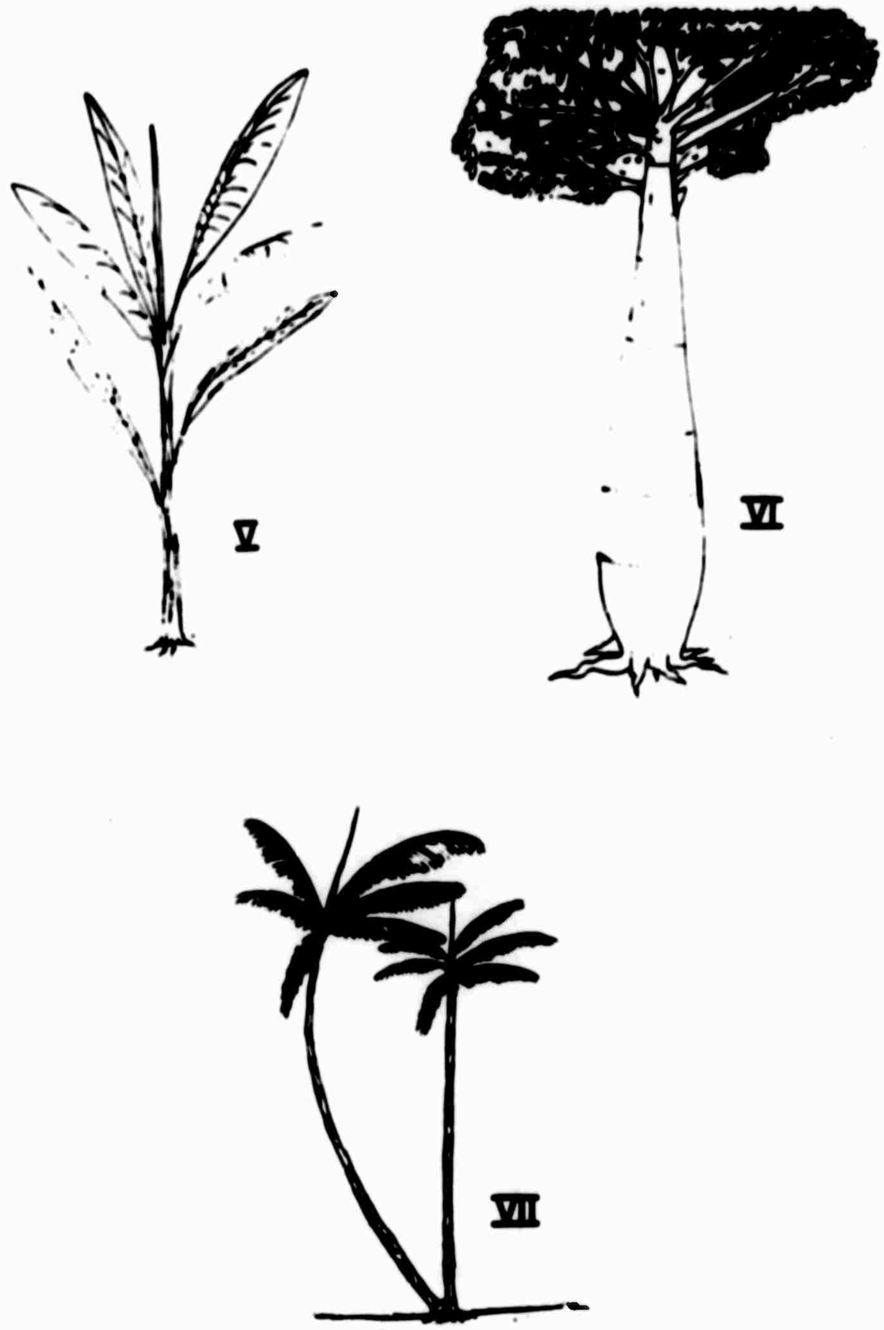



FIGURE A-7. REPRESENTATIVE SHAPES OF TREES OCCURRING IN ALBROOK FOREST (Cont.)

TABLE A-1. COMMON SPECIES OF PLANTS FOUND AT ALBROOK FOREST SITE IN JUNE 1965

Anacardium excelsum (Bert. + Balb.) Skeels. (Anacardiaceae)
Alibertia edulis (L. Rich) A. Rich (Rubiaceae)
Andira enermis H.B.K. (Fabaceae)
Annona (1) hayessii Suff. (Annonaceae)
Annona (2) purpurea Moc. + Sessi (Annonaceae)
Aphelandra deppeana Schlecht. + Cham (Acanthaceae)
Bactris balanoidea (Oerst.) Wndl. (Phoenicaceae)
Banara guianensis Aubl. (Flacortiaceae)
Belotia panamensis Pittier (Tiliaceae)
Bursera simaruba Sarg. (Burseraceae)
Cavanillesia platanifolia H.B.K. (Bombacaceae)
Cecropia (1) longipes Pittier ? (Moraceae)
Cecropia (2) obtusifolia Bertol. (Moraceae)
Cecropia (3) peltata L. (Moraceae)
Chrysophyllum cainito L. (Sapotaceae)
Conostegia speciosa (Melastomaceae)
Copaifera panamensis (Britton) Standley
Cordia alliodora (Ruiz + Pan) Roem + Schult (Boraginaceae)
Costus villosissimus Jacq. (Costaceae)
Croton panamensis (Klotzsch) Muell. Arg (Euphorbiaceae)
Cupania cinerea Poepp + Endll. (Sapindaceae)
Genipa caruta var americana (Rubiaceae)
Guazuma ulmifolia Lam. (Sterculiaceae)
Heliconia platystochys Baker. (Musaceae)
Helicteres guazumifolia H.B.K. (Sterculiaceae)
Hirtella (1) racemosa L. (Rosaceae)
Hirtella (2) triandra Swartz. (Rosaceae)
Inga (1) hayessii Bents. (Mimosaceae)
Inga (2) oerstediana Willd. (Mimosaceae)
Lacistema aggregatum (Berg.) Rusby (Lacistemaceae)
Lagoensia punicifolia DC. (Lythraceae)
Luehea seemanii Triana + Planch. (Tiliaceae)
Miconia (1) argentea (Swartz) Don. (Melastomaceae)
Miconia (2) impetrolaris (Swartz) DC. (Melastomaceae)
Nectandra sp. (Lauraceae)
Palicourea guianensis Aubl. (Rubiaceae)
Piper (1) aduncum L. (Piperaceae)
Piper (2) reticulatum L. (Piperaceae)
Phoebe costaricana Mez + Pittier (Lauraceae)
Pittoniotis trichantha Griseb (Rubiaceae)
Posequeria latifolia (Rudge) Roem + Schult. (Rubiaceae)
Rourea glibra H.B.K. (Connaraceae)
Sloanea sp. (Eleocarpaceae)
Spondias mombin L. (Anacardiaceae)

TABLE A-1. (Cont.)

Tabebuia pentaphylla (L.) Hemsl. (Bignoniaceae)
Talisia nervosa Radlk. (Sapindaceae)
Trema micrantha (L.) Blume (Ulmaceae)
Xylopia frutescens Aubl. (Annonaceae)

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE

Plot 1[1]

| B2 A2 X | B1 A1 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | Andira | I | 4.6 | 5.8 | 2.5 | 4.2 | 4.9 | |
| 3 | 6 | | | 4.0 | | 2.8 | 3.0 | | Dead |
| 5 | 2 | Piper | II | 3.2 | 3.0 | 0.8 | 3.9 | 4.7 | Two |
| 5 | 2 | Piper | III | 2.2 | 2.3 | 1.8 | 3.3 | 3.7 | Stems |
| 5 | 4 | Annona | III | 2.6 | 4.3 | 3.3 | 3.9 | 4.5 | |
| 5 | 8 | Luehea | I | 147.5 | 147.5 | 14.0 | 28.5 | 29.0 | |
| 7 | 3 | Copaifera | I | 3.0 | 3.8 | 3.0 | 3.9 | 4.5 | |
| 7 | 4 | | I | 3.0 | 3.0 | 0.8 | 3.6 | 3.9 | |
| 8 | 5 | Cavanillesia | III | 3.0 | 2.5 | 3.6 | 4.2 | | Cut Off |
| 8 | 6 | | I | 2.4 | 2.5 | 1.5 | 3.0 | 3.6 | |
| 8 | 7 | | I | 2.8 | 2.6 | 1.8 | 3.6 | 3.9 | |
| 8 | 7 | Ardesia | I | 2.3 | 2.4 | 1.5 | 3.9 | 4.5 | Replaced |

Plot 2[1]

| B3 A3 X | B2 A2 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 8 | | I | 3.0 | | 1.5 | 3.3 | | Dead |
| 4 | 4 | Miconia | I | 2.2 | 2.3 | 6.0 | 9.0 | 4.0 | |
| 5 | 4 | Black Palm | VII | 5.0 | 5.0 | 3.3 | 4.5 | 4.9 | |
| 5 | 4 | Black Palm | VII | 4.4 | 4.4 | 1.2 | 3.6 | 3.9 | |
| 5 | 4 | Black Palm | VII | | 3.1 | | | 3.0 | |
| 5 | 4 | Black Palm | VII | | 3.5 | | | 3.3 | |
| 5 | 4 | Black Palm | VII | | 4.0 | | | 3.7 | |
| 5 | 4 | Black Palm | VII | | 3.2 | | | 3.0 | |
| 5 | 5 | Black Palm | VII | 3.1 | 3.1 | 3.9 | 4.5 | 4.9 | |
| 6 | 1 | Spondias | I | 32.5 | 27.2 | 9.5 | 22.0 | 23.0 | Two |
| 6 | 1 | Spondias | I | 35.1 | 31.2 | 9.5 | 22.0 | 23.0 | Stems |
| 6 | 4 | Black Palm | VII | | 3.7 | | | 4.0 | |
| 6 | 4 | Black Palm | VII | 3.7 | 3.7 | 0.8 | 3.3 | 3.5 | |
| 6 | 4 | Black Palm | VII | 3.7 | 3.8 | 1.5 | 3.9 | 4.4 | |
| 8 | 0 | | I | 7.8 | 8.1 | 3.9 | 6.6 | 7.0 | |
| 8 | 6 | Hirtella | II | 3.0 | 3.0 | 0.3 | 4.5 | 5.8 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 3[1]

| B4 A4 X | B3 A3 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 8 | Luehea | I | 26.8 | 29.2 | 6.0 | 13.5 | 14.0 | Dying |
| 1 | 4 | Annona | III | 4.9 | 4.3 | 4.5 | 6.0 | 6.2 | |
| 1 | 9 | Andira | III | 9.9 | 9.9 | 6.0 | 8.4 | 8.9 | |
| 2 | 3 | Heliconia | I | 3.4 | 3.4 | 1.5 | 3.9 | 4.5 | |
| 2 | 6 | Luehea | I | 74.3 | 83.1 | 12.0 | 26.0 | 26.0 | |
| 2 | 6 | | III | 2.8 | | 3.0 | 4.8 | | Missing |
| 2 | 6 | Ardesia | II | | 2.1 | | | 2.5 | Sprout |
| 4 | 6 | Anacardium | I | 5.2 | 6.4 | 2.8 | 4.8 | 5.8 | |
| 5 | 5 | | II | | 2.3 | | | 5.0 | |
| 7 | 9 | Piper | I | | 3.3 | | | 4.6 | |
| 8 | 2 | | II | | 2.6 | | | 3.1 | |
| 9 | 2 | Anacardium | I | 45.8 | 51.6 | 3.3 | 28.0 | 28.5 | |

Plot 4[1]

| B5 A5 X | B4 A4 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 4 | | I | 2.7 | | 0.8 | 3.3 | | Missing |
| 0 | 4 | | | 4.4 | | 1.2 | 1.2 | | Dead |
| 0 | 8 | | I | 2.4 | | 1.2 | 4.5 | | Missing |
| 0 | 8 | | I | 9.2 | | 0.8 | 6.6 | | Missing |
| 1 | 1 | | V | 3.1 | | 1.8 | 3.6 | | Missing |
| 1 | 2 | | I | 3.1 | 3.6 | 1.5 | 3.0 | 3.4 | |
| 1 | 2 | | IV | 2.1 | | 0.3 | 2.5 | | Missing |
| 1 | 3 | | IV | 3.0 | | 0.5 | 1.8 | | Missing |
| 2 | 0 | Heliconia | V | 4.2 | 4.2 | 2.0 | 5.4 | 5.6 | |
| 2 | 0 | Heliconia | V | 4.2 | 4.2 | 3.0 | 5.2 | 5.6 | |
| 2 | 0 | | IV | 4.5 | 4.8 | 3.0 | 5.4 | 5.8 | Dying |
| 2 | 1 | Heliconia | V | 3.2 | 3.2 | 1.9 | 4.5 | 4.7 | |
| 2 | 1 | Heliconia | V | 3.4 | 3.5 | 3.3 | 5.0 | 5.0 | |
| 2 | 6 | Heliconia | V | 2.2 | 2.6 | 0.3 | 3.3 | 3.5 | |
| 3 | 3 | Piper | I | | 2.4 | | | 3.1 | |
| 3 | 4 | Lafoensia | III | 10.5 | 11.7 | 10.0 | 12.0 | 13.0 | |
| 3 | 7 | Hirtella | II | | 2.8 | | | 4.0 | |
| 4 | 9 | | II | 4.0 | 4.0 | 1.5 | 1.7 | 2.0 | |
| 6 | 8 | Spondias | I | 33.3 | 25.6 | 12.0 | 24.5 | 25.0 | |
| 8 | 1 | | I | 2.5 | | 0.5 | 2.8 | | Dead |
| 9 | 5 | Flacourtiaceae | III | 4.8 | 5.3 | 4.8 | 5.4 | 5.8 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 5[1]

| B6 A6 X | B5 A5 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | Andira | I | 10.5 | 10.4 | 2.8 | 6.9 | 7.3 | |
| 0 | 5 | | I | 3.4 | 2.5 | 1.0 | 2.5 | 2.8 | |
| 0 | 9 | Annona | I | 25.0 | 26.9 | 5.7 | 16.0 | 17.0 | |
| 1 | 2 | | IV | 1.8 | | | 3.3 | | Missing |
| 2 | 1 | | | 3.6 | | | 3.6 | | Dead |
| 2 | 4 | | VII | 3.7 | | 2.0 | 3.0 | | Missing |
| 2 | 9 | | I | 21.0 | 23.1 | 4.8 | 14.5 | 15.0 | |
| 3 | 3 | Black Palm | VII | 3.7 | 3.7 | 3.0 | 4.2 | 3.5 | |
| 3 | 3 | Black Palm | VII | 3.4 | 3.4 | 3.6 | 4.5 | 4.5 | |
| 3 | 4 | Black Palm | VII | 3.4 | 3.4 | 3.6 | 5.1 | 5.4 | |
| 3 | 5 | Black Palm | VII | 3.7 | 3.7 | 3.0 | 4.2 | 4.3 | |
| 3 | 5 | Black Palm | VII | 3.1 | 3.1 | 1.0 | 2.9 | 3.1 | |
| 3 | 5 | Black Palm | VII | 2.7 | 2.7 | 1.8 | 3.0 | 3.1 | |
| 3 | 5 | Black Palm | VII | | 3.4 | | | 4.0 | |
| 3 | 7 | Lafoensia | III | 8.2 | 8.4 | 3.6 | 5.4 | 5.9 | |
| 4 | 4 | Black Palm | VII | 3.7 | 3.8 | 2.5 | 3.9 | 3.9 | |
| 4 | 4 | Black Palm | VII | 3.1 | 3.1 | 3.0 | 5.4 | 5.7 | |
| 4 | 4 | Black Palm | VII | 2.5 | 2.6 | 2.5 | 3.9 | 4.0 | |
| 4 | 4 | Black Palm | VII | | 3.1 | | | 3.7 | |
| 4 | 4 | Black Palm | VII | 2.5 | 2.6 | 2.5 | 3.9 | 4.0 | |
| 4 | 4 | Black Palm | VII | | 3.1 | | | 3.7 | |
| 4 | 8 | Posequeria | I | 3.0 | 4.3 | 1.2 | 3.9 | 4.2 | |
| 6 | 4 | | I | 3.0 | 3.6 | 1.8 | 3.3 | 3.5 | |
| 6 | 5 | | I | 3.0 | 2.6 | 0.8 | 2.8 | 3.0 | |
| 8 | 0 | Anacardium | I | | 2.1 | | | 2.0 | |
| 8 | 9 | Anacardium | I | 5.1 | 5.3 | 0.8 | 4.5 | 5.1 | |
| 9 | 2 | Croton | I | 1.8 | 2.2 | 0.8 | 2.8 | 3.1 | |
| 9 | 8 | | II | | 9.1 | | | 6.3 | |

Plot 6[1]

| B7 A7 X | B6 A6 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | Ardesia | II | | 2.1 | | | 1.5 | |
| 0 | 8 | Heliconia | | 3.2 | 3.2 | 3.0 | 4.5 | 4.7 | |
| 0 | 8 | Heliconia | | 4.2 | 4.2 | 2.8 | 4.2 | 4.5 | |
| 0 | 8 | Heliconia | | 4.0 | 4.1 | 2.5 | 4.8 | 5.0 | |
| 0 | 8 | Heliconia | | 4.0 | 4.0 | 2.8 | 5.1 | 5.6 | |
| 0 | 8 | Heliconia | | 4.2 | 4.2 | 1.8 | 4.5 | 4.9 | |
| 0 | 9 | Cecropia | III | 17.5 | 18.5 | 8.0 | 19.0 | 19.5 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 6[1] (Continued)

| B7 A7 X | B6 A6 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | | II | | 2.3 | 3.0 | | 5.6 | Replaced |
| 1 | 8 | | II | 4.0 | 2.5 | 3.0 | 5.1 | 5.1 | |
| 1 | 8 | Heliconia | V | 4.4 | 4.0 | 0.8 | 4.8 | 4.9 | |
| 2 | 3 | Croton | II | 4.2 | 4.8 | | 3.3 | 3.7 | |
| 2 | 7 | Croton | I | 4.2 | | 1.2 | 3.4 | | Dead |
| 3 | 1 | Inga | III | 4.0 | 4.9 | 3.9 | 5.1 | 5.3 | Dead |
| 3 | 9 | Piper | I | 2.7 | | 0.8 | 3.3 | | Missing |
| 5 | 1 | Black Palm | VII | 2.7 | 3.0 | 5.4 | 6.9 | 7.0 | |
| 5 | 1 | Black Palm | VII | 3.1 | 3.2 | 3.6 | 5.7 | 5.9 | |
| 5 | 2 | Black Palm | VII | 3.4 | 3.4 | 3.0 | 4.5 | 4.7 | |
| 5 | 2 | Black Palm | VII | 2.5 | | 2.5 | 2.5 | | Dead |
| 5 | 2 | Black Palm | VII | | 2.5 | | | 4.0 | |
| 5 | 2 | Black Palm | VII | | 2.6 | | | 4.0 | |
| 5 | 7 | Anacardium | I | 25.0 | 26.2 | 2.7 | 18.0 | 19.0 | |
| 6 | 1 | Black Palm | VII | 3.7 | 3.8 | 3.0 | 4.5 | 4.7 | |
| 6 | 1 | Black Palm | VII | 3.4 | 3.4 | 0.8 | 2.8 | 3.3 | |
| 6 | 2 | Black Palm | VII | 3.7 | 3.6 | 3.6 | 5.4 | 5.7 | |
| 6 | 2 | Black Palm | VII | 2.7 | 2.7 | 4.8 | 5.4 | 5.8 | |
| 6 | 2 | Black Palm | VII | 3.7 | 3.7 | 3.0 | 4.8 | 5.0 | |
| 6 | 2 | Black Palm | VII | | 2.8 | | | 4.1 | |
| 6 | 2 | Black Palm | VII | | 3.0 | | | 5.0 | |
| 6 | 2 | Black Palm | VII | | 2.7 | | | 3.9 | |
| 6 | 3 | Copaifera | III | 5.0 | 5.3 | 3.3 | 3.9 | 4.4 | |

Plot 7[1]

| C2 B2 X | C1 B1 Y | Species | Shape | DBH (cm) 1 Jan 1967 | DBH (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | Luehea | I | 22.0 | 13.9 | | 5.4 | | |
| 0 | 1 | | | 2.6 | | | 1.5 | | Dead |
| 0 | 1 | | I | 2.4 | 3.8 | 1.2 | 3.6 | | |
| 0 | 7 | | | | | | | | Missing |
| 1 | 3 | Spondias | I | 39.2 | 42.2 | 10.5 | 25.0 | | |
| 1 | 5 | Talisia | III | 4.8 | 5.3 | 4.8 | 6.0 | | |
| 3 | 1 | Piper | I | | 2.3 | | 3.1 | | |
| 3 | 8 | | | 2.4 | 2.4 | 0.8 | 2.5 | | |
| 4 | 0 | Anacardium | I | 23.0 | 24.9 | 6.9 | 15.0 | | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 7[1] (Continued)

| C2 B2 X | C1 B1 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 3 | | III | 5.2 | 2.6 | 4.2 | 6.0 | 4.0 | |
| 4 | 4 | Lacistema | I | 3.4 | 4.7 | 2.0 | 4.2 | | |
| 5 | 0 | | II | 2.2 | 2.4 | 0.8 | 2.8 | | |
| 5 | 6 | Black Palm | VII | 3.7 | 3.7 | 2.8 | 4.2 | | |
| 5 | 6 | Piper | II | | 2.4 | 0.8 | 1.8 | 2.4 | Replacement |
| 6 | 0 | Miconia | IV | | | 0.5 | 3.8 | | Missing |
| 7 | 1 | Lafoensia | I | 3.4 | 2.5 | 1.2 | 3.6 | | |
| 7 | 3 | | II | 2.4 | 2.4 | 1.8 | 3.6 | | |
| 7 | 3 | | II | 2.4 | 2.4 | 1.5 | 3.6 | | |
| 7 | 8 | | I | 2.6 | | 1.6 | 3.6 | | Missing |
| 7 | 9 | Rubiaceae | I | 2.8 | 3.3 | 0.8 | 5.1 | 5.5 | |
| 7 | 9 | | I | | | | 0.5 | 4.5 | Missing |
| 8 | 0 | | IV | | 2.4 | | 3.9 | | |
| 8 | 0 | Miconia | I | | 2.9 | | 4.1 | | |
| 8 | 2 | Flacourtiaceae | I | 4.8 | 3.1 | 1.5 | 4.5 | | |
| 8 | 5 | | | | | | | | Chopped |
| 8 | 7 | Black Palm | VII | 5.6 | 4.2 | 1.8 | 3.9 | 4.4 | |
| 8 | 7 | Black Palm | VII | 5.0 | 4.0 | 1.8 | 5.1 | 5.4 | |
| 8 | 7 | Black Palm | VII | | 4.1 | | | | |
| 8 | 7 | Black Palm | VII | | 3.9 | | | | |

Plot 8[1]

| C3 B3 X | C2 B2 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | Chrysophyllum | I | | 2.4 | | | 3.4 | |
| 0 | 3 | | II | 2.8 | 2.8 | 0.8 | 4.2 | 2.5 | Replacement |
| 0 | 5 | Heliconia | V | 3.0 | 3.0 | 2.8 | 5.4 | 4.5 | Replacement |
| 2 | 8 | Xylopia | III | 18.5 | 22.1 | 14.0 | 18.5 | 19.0 | |
| 3 | 6 | Black Palm | VII | 3.1 | 3.2 | 3.9 | 5.4 | 5.8 | |
| 3 | 7 | Black Palm | VII | 4.4 | 4.6 | 3.3 | 4.5 | 4.9 | |
| 4 | 2 | Black Palm | VII | 3.7 | 3.7 | 3.6 | 4.2 | 4.5 | |
| 4 | 3 | Black Palm | VII | 4.4 | 4.6 | 3.6 | 4.8 | 5.0 | |
| 4 | 3 | Black Palm | VII | 2.5 | 2.6 | 4.5 | 3.6 | 3.8 | |
| 4 | 3 | Black Palm | VII | 2.5 | 2.5 | 1.5 | 3.6 | 3.9 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 8[1] (Continued)

| C3 B3 X | C2 B2 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 4 | Black Palm | VII | 3.7 | 3.9 | 3.9 | 4.8 | 5.1 | |
| 4 | 4 | Black Palm | VII | 4.4 | 4.6 | 1.5 | 3.6 | 3.9 | |
| 4 | 5 | Black Palm | VII | 2.4 | | | 4.5 | | Dead |
| 4 | 6 | Black Palm | VII | 3.1 | 3.4 | 4.2 | 6.0 | 6.1 | |
| 4 | 7 | Black Palm | VII | 4.4 | | 3.0 | 3.0 | | Dead |
| 4 | 7 | Black Palm | VII | 3.7 | 4.0 | 4.2 | 5.4 | 5.5 | |
| 4 | 7 | Black Palm | VII | 2.5 | 2.9 | 1.2 | 3.0 | 3.3 | |
| 4 | 8 | Black Palm | VII | 2.5 | 2.7 | 1.2 | 3.3 | 3.5 | |
| 5 | 1 | Miconia | I | 3.0 | 3.0 | 3.3 | 5.4 | 5.9 | |
| 5 | 3 | Black Palm | VII | 3.7 | 4.0 | 3.9 | 5.7 | 5.8 | |
| 5 | 3 | Black Palm | VII | 3.7 | 3.9 | 4.2 | 6.0 | 6.3 | |
| 5 | 4 | Black Palm | VII | 3.1 | 3.3 | 4.5 | 4.8 | 5.1 | |
| 5 | 6 | Black Palm | VII | 3.7 | 3.9 | 4.5 | 5.4 | 5.7 | |
| 5 | 7 | Black Palm | VII | 3.1 | 3.5 | 4.2 | 4.8 | 5.2 | |
| 5 | 7 | Black Palm | VII | 3.1 | 3.2 | 1.8 | 4.5 | 4.9 | |
| 6 | 4 | Black Palm | VII | 3.7 | 4.0 | 2.8 | 3.6 | 4.0 | |
| 6 | 4 | Black Palm | VII | 3.1 | 3.4 | 4.5 | 5.1 | 5.3 | |
| 6 | 4 | Black Palm | VII | 3.7 | | 5.1 | 5.1 | | Dead |
| 6 | 5 | Black Palm | VII | 3.1 | 3.3 | 4.2 | 6.0 | 6.4 | |
| 6 | 6 | Luehea | I | 10.3 | 33.8 | 6.0 | 24.0 | 25.0 | |
| 6 | 6 | Black Palm | VII | 3.1 | 3.4 | 3.9 | 4.5 | 4.7 | |
| 6 | 6 | Black Palm | VII | 3.7 | 3.7 | 4.5 | 6.0 | 6.4 | |
| 6 | 6 | Black Palm | VII | 3.7 | 3.8 | 3.6 | 4.2 | 4.6 | |
| 6 | 6 | Black Palm | VII | 3.1 | 3.3 | 3.6 | 4.5 | 4.8 | |
| 6 | 7 | Black Palm | VII | 3.7 | 4.0 | 3.3 | 4.2 | 4.7 | |
| 1 | 1 | Piper | I | | 2.4 | | | 4.7 | |
| 5 | 1 | Annona | I | | 2.4 | | | 6.1 | |
| 6 | 6 | Black Palm | VII | | 3.2 | | | 4.0 | |
| 6 | 6 | Black Palm | VII | | 3.3 | | | 4.1 | |
| 6 | 6 | Black Palm | VII | | 3.0 | | | 4.3 | |
| 6 | 7 | Black Palm | VII | | 2.9 | | | 4.0 | |
| 6 | 7 | Black Palm | VII | | 2.6 | | | 3.9 | |
| 6 | 7 | Black Palm | VII | | 3.0 | | | 4.2 | |
| 6 | 7 | Black Palm | VII | | 3.4 | | | 5.0 | |
| 6 | 7 | Black Palm | VII | | 3.3 | | | 4.9 | |
| 6 | 7 | Black Palm | VII | 2.5 | 2.5 | 0.8 | 3.0 | 3.4 | |
| 7 | 3 | Anacardium | I | 61.0 | 100.3 | 12.0 | 34.0 | 34.5 | |
| 9 | 7 | | II | 3.6 | 3.3 | | 2.5 | 2.9 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 9[1]

| C4 B4 X | C3 B3 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | Hirtella | II | | 2.4 | 2.0 | 2.8 | 3.0 | Replacement |
| 0 | 3 | Chrysophyllum | I | 2.6 | 3.8 | 1.9 | 3.6 | 4.1 | |
| 1 | 4 | Anacardium | I | 8.5 | 10.2 | 3.3 | 6.6 | 7.5 | |
| 2 | 3 | Inga | I | 22.0 | 24.4 | 6.0 | 22.0 | 23.0 | |
| 3 | 0 | | III | 2.7 | 2.7 | 1.8 | 2.8 | 3.0 | |
| 3 | 7 | Rubiaceae | I | 3.4 | 5.3 | 0.7 | 4.2 | 4.7 | |
| 4 | 3 | | II | 2.8 | 2.7 | 0.7 | 2.5 | 3.0 | |
| 5 | 6 | Lafoensia | I | 5.2 | 6.1 | 2.5 | 7.6 | 8.7 | |
| 6 | 2 | Anacardium | I | 6.8 | 7.4 | 2.8 | 5.4 | 6.1 | |
| 6 | 9 | Anacardium | I | 12.7 | 14.0 | 3.0 | 12.5 | 13.3 | |
| 7 | 8 | Luehea | I | 68.3 | 77.5 | 14.0 | 28.0 | 29.0 | |
| 8 | 2 | | I | | 2.3 | | | 3.1 | |
| 8 | 5 | Palicourea | III | 3.0 | 3.0 | 2.5 | 5.4 | 5.9 | |
| 8 | 5 | Palicourea | III | | 2.5 | | | 5.6 | |

Plot 10[1]

| C5 B5 X | C4 B4 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | Lafoensia | I | 25.4 | 27.7 | 6.4 | 15.5 | 17.0 | |
| 0 | 1 | Andira | I | 4.4 | 4.6 | 2.5 | 5.1 | 6.0 | |
| 1 | 8 | | I | | 2.2 | | | 4.0 | |
| 2 | 5 | | I | 3.0 | 2.8 | 1.2 | 2.3 | 2.6 | |
| 3 | 9 | Luehea | I | 17.1 | 11.9 | 2.8 | 7.6 | 9.6 | |
| 4 | 1 | Randia | I | 3.0 | 3.0 | 0.8 | 4.2 | 4.8 | |
| 4 | 1 | Hirtella | II | 3.0 | 2.5 | 0.2 | 5.1 | 4.2 | |
| 5 | 2 | Alibertia | I | 1.8 | 2.1 | 0.7 | 3.3 | 3.0 | |
| 6 | 0 | | I | 3.0 | 2.8 | 2.0 | 4.5 | 5.0 | |
| 7 | 4 | Piper | I | | 2.1 | | | 4.1 | |
| 7 | 7 | Posequeria | II | 3.4 | 3.1 | 0.3 | 5.1 | 6.5 | |
| 8 | 1 | Piper | I | | 2.1 | | | 4.2 | |
| 8 | 4 | | VII | 3.1 | | 0.7 | 2.8 | | Dead |
| 8 | 4 | | VII | 2.5 | | 2.5 | 2.8 | | Dead |
| 9 | 6 | Black Palm | VII | 2.4 | 2.5 | 2.0 | 3.6 | 3.6 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 11[1]

| C6 B6 X | C5 B5 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 6 | Nectandra | II | 3.1 | 2.6 | | 3.6 | 4.0 | |
| 0 | 9 | | I | 5.8 | 6.4 | 3.0 | 5.4 | 5.7 | |
| 3 | 3 | Posequeria | II | 3.0 | 3.0 | | 2.8 | 3.2 | |
| 3 | 7 | Rubiaceae | I | 19.0 | 22.3 | 4.5 | 13.5 | 14.0 | |
| 4 | 8 | | II | | 2.4 | | | 3.9 | |
| 5 | 1 | Inga | I | 4.2 | 3.8 | 1.2 | 2.8 | 3.3 | Dying |
| 5 | 1 | Piper | I | | 2.2 | | | 3.0 | |
| 6 | 9 | | III | 12.4 | 12.7 | 7.0 | 12.5 | 13.2 | |
| 6 | 5 | Costus | VII | | 2.1 | | | 2.1 | |
| 8 | 5 | Costus | VII | | 2.3 | | | 3.2 | |

Plot 12[1]

| C7 B7 X | C6 B6 Y | Species | Shape | DBH (cm) 1 Jan 1967 | DBH (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 4 | Miconia | I | 23.2 | | 1.5 | 20.0 | | Missing |
| 1 | 5 | Costus | III | 4.2 | | 2.5 | 3.6 | | Missing |
| 2 | 2 | Hirtella | I | 4.5 | 2.5 | 1.5 | 3.0 | 3.5 | |
| 2 | 6 | Costus | III | 4.0 | 2.5 | 2.5 | 3.3 | 3.5 | |
| 2 | 6 | | | 3.4 | | | | | Dead |
| 3 | 2 | | III | 2.7 | 2.7 | 3.3 | 4.2 | 4.5 | |
| 3 | 4 | Posequeria | | | | | | | Chopped Dead |
| 4 | 3 | | I | 4.2 | 3.9 | 0.8 | 3.3 | 3.5 | |
| 4 | 7 | Belotia | III | 5.7 | | | 12.0 | | Dead |
| 5 | 7 | Trema | III | 6.5 | | | 3.3 | | Dead |
| 5 | 7 | Costus | III | | 2.6 | | | 4.1 | |
| 5 | 7 | Costus | III | | 2.4 | | | 3.9 | |
| 5 | 7 | Costus | III | | 2.6 | | | 4.2 | |
| 5 | 7 | Costus | III | | 2.0 | | | 3.6 | |
| 5 | 8 | Miconia | III | 2.8 | 3.0 | 2.8 | 4.5 | 5.0 | |
| 5 | 8 | Belotia | III | 8.6 | 12.2 | 6.5 | 10.5 | 11.0 | |
| 5 | 8 | Croton | III | 2.7 | | 3.9 | 4.8 | | Dead |
| 5 | 9 | Belotia | III | 3.2 | | 8.5 | 11.5 | | Missing |
| 6 | 2 | Bursera | III | 14.3 | 15.7 | 6.0 | 8.0 | 8.8 | |
| 6 | 2 | Bursera | III | 12.5 | 13.2 | 6.0 | 10.0 | 11.2 | |
| 7 | 8 | Belotia | III | 6.2 | 7.6 | 9.0 | 10.0 | 1[illegible].8 | |
| 7 | 9 | Belotia | III | 9.0 | 11.4 | 7.0 | 13.0 | 13.7 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 12[1] (Continued)

| C7<br>B7<br>X | C6<br>B6<br>Y | Species[4] | Shape[2] | DBH[3] (cm)<br>1 Jan 1967 | DBH[3] (cm)<br>1 Dec 1969 | 1st Branch (m)<br>1967 | Height (m)<br>1 Jan 1967 | Height (m)<br>1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 8 | 5 | Costus | III | 2.4 | 2.5 | 1.2 | 1.9 | 2.2 | |
| 8 | 5 | Costus | III | 2.0 | 2.3 | 2.8 | 3.3 | 3.9 | |
| 8 | 5 | Costus | III | 2.0 | 2.1 | 3.0 | 3.6 | 3.8 | |
| 8 | 6 | | III | 2.5 | 2.8 | 1.2 | 3.6 | 3.9 | |
| 9 | 5 | Heliconia | V | | 2.6 | | | 3.9 | |
| 9 | 5 | Heliconia | V | | 2.8 | | | 4.0 | |
| 9 | 5 | Heliconia | V | | 2.4 | | | 3.9 | |
| 9 | 9 | Annona | II | 3.4 | 4.0 | 0.2 | 5.1 | 7.0 | |

Plot 13[1]

| D2<br>C2<br>X | D1<br>C1<br>Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | Annona | II | 2.4 | 2.5 | | 4.2 | 5.1 | |
| 0 | 4 | Anacardium | IV | 19.4 | 20.3 | 3.9 | 14.0 | 15.0 | |
| 0 | 7 | Anacardium | III | 12.5 | 13.9 | 7.0 | 14.0 | 14.9 | |
| 0 | 8 | | VII | 3.7 | | 0.8 | 3.6 | | Missing |
| 1 | 7 | Palm | VII | 3.7 | 3.9 | 1.2 | 3.6 | 3.9 | |
| 1 | 9 | Palm | VII | 2.5 | 2.7 | 0.8 | 2.0 | 3.0 | |
| 1 | 9 | Palm | VII | 3.7 | 3.8 | 4.2 | 6.0 | 6.5 | |
| 1 | 9 | Palm | VII | 3.2 | 3.4 | 6.0 | 6.4 | 6.7 | |
| 2 | 7 | | III | 15.9 | 16.0 | 1.8 | 11.5 | 12.0 | |
| 2 | 9 | Oenocarpus | VII | 3.6 | 3.8 | 7.2 | 8.4 | 8.9 | |
| 3 | 2 | Croton | IV | 3.2 | 3.2 | 0.3 | 4.5 | 4.9 | |
| 3 | 4 | Posequeria | III | 8.6 | 8.6 | 4.5 | 6.6 | 7.0 | |
| 3 | 7 | Palm | VII | 3.7 | 3.7 | 4.2 | 5.7 | 5.8 | |
| 3 | 7 | Palm | VII | 3.7 | 3.8 | 1.8 | 4.2 | 4.7 | |
| 3 | 7 | Palm | VII | 3.7 | 3.8 | 1.5 | 3.9 | 3.9 | |
| 3 | 8 | Palm | VII | 3.7 | 4.0 | 1.2 | 3.9 | 3.9 | |
| 3 | 8 | Palm | VII | 4.4 | 4.5 | 5.7 | 8.2 | 8.4 | |
| 3 | 8 | Palm | VII | 3.7 | 3.9 | 3.6 | 4.5 | 4.7 | |
| 5 | 0 | | I | 2.4 | 2.5 | 0.8 | 3.6 | 3.9 | |
| 5 | 1 | | I | 2.4 | 2.6 | 0.5 | 4.2 | 5.0 | |
| 5 | 3 | | III | 2.6 | 2.9 | 0.8 | 1.2 | 2.0 | |
| 5 | 7 | | I | 4.6 | 4.6 | 1.8 | 4.5 | 4.9 | |
| 5 | 8 | | VII | 3.7 | 3.9 | 4.2 | 5.4 | 5.6 | |
| 5 | 9 | Black Palm | VII | 3.7 | 3.7 | 4.5 | 6.0 | 6.3 | |
| 6 | 0 | | I | 2.0 | 2.4 | 0.8 | 3.6 | 3.8 | |

## TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 13[1] (Continued)

| D2 C2 X | D1 C1 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 8 | Luehea | IV | 36.5 | 40.3 | 6.6 | 16.0 | 16.5 | Chopped |
| 6 | 9 | Black Palm | VII | 3.7 | 3.9 | 1.8 | 3.6 | 3.9 | |
| 7 | 2 | | IV | 2.8 | | | 3.6 | | Missing |
| 7 | 5 | Alibertia | III | 1.8 | 2.1 | 3.0 | 4.2 | | Chopped |
| 7 | 5 | Palicouria | I | 2.6 | 2.6 | 0.5 | 3.9 | 4.2 | |
| 7 | 5 | | | | | | | | Missing |
| 8 | 1 | Pittoniotis | I | 2.8 | 2.9 | 0.3 | 4.5 | 4.8 | |
| 8 | 2 | Anacardium | I | 2.4 | 2.5 | 0.8 | 3.6 | 4.2 | |
| 8 | 6 | Miconia | I | 3.6 | 3.7 | 3.6 | 4.5 | 4.7 | |
| 8 | 7 | Miconia | I | 2.8 | 3.0 | 1.8 | 5.4 | 5.7 | |
| 8 | 7 | Psychotria | IV | 1.6 | 3.7 | 3.0 | 3.6 | 5.7 | |
| 9 | 0 | | I | 3.4 | 3.4 | 2.8 | 3.9 | 4.2 | |
| 9 | 1 | | III | 1.8 | 2.0 | 0.3 | 3.9 | 4.3 | |
| 9 | 3 | Pittoniotis | IV | 3.4 | 3.5 | 3.0 | 6.0 | 6.0 | |

Plot 14[1]

| D3 C3 X | D2 C2 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | Psychotria | | | | | | | Dead |
| 2 | 0 | | VII | 5.0 | | 3.6 | 5.1 | | Missing |
| 2 | 0 | | VII | 2.5 | | 1.2 | 3.3 | | Missing |
| 2 | 0 | Apocynaceae | I | 4.5 | 4.6 | 1.5 | 4.2 | 4.7 | Chopped |
| 2 | 2 | Palm | VII | 2.8 | 2.8 | 0.3 | 0.8 | 1.0 | Chopped |
| 3 | 0 | Palm | VII | 2.5 | 2.7 | 0.3 | 3.6 | 4.0 | |
| 3 | 0 | Palm | VII | 3.1 | 3.1 | 3.6 | 4.2 | 4.5 | |
| 3 | 0 | Palm | VII | 2.5 | 2.6 | 3.6 | 4.2 | 4.7 | |
| 3 | 0 | Palm | VII | 2.5 | 2.6 | 1.2 | 3.3 | 3.7 | |
| 3 | 6 | Alibertia | II | 2.0 | 2.3 | 0.8 | 2.8 | 3.2 | Dying |
| 3 | 8 | | VII | 4.4 | 4.6 | 3.9 | 5.7 | 6.0 | |
| 3 | 8 | | VII | 3.7 | 3.8 | 3.6 | 4.5 | 4.7 | |
| 3 | 8 | | VII | 5.0 | 5.0 | 4.5 | 6.4 | 6.8 | |
| 3 | 8 | | VII | 3.1 | 3.8 | 3.6 | 4.5 | 4.7 | |
| 3 | 8 | | VII | 5.0 | 5.0 | 4.5 | 6.4 | 6.8 | |
| 3 | 8 | | VII | 3.1 | 3.3 | 6.0 | 7.6 | 7.9 | |
| 3 | 9 | Flacourtiaceae | III | 4.8 | 5.2 | 4.5 | 6.0 | 6.5 | |
| 4 | 5 | Alibertia | I | 2.2 | 2.5 | 1.2 | 3.6 | 4.1 | Dying |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 14[1] (Continued)

| D3 C3 X | D2 C2 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 8 | Palm | VII | 3.7 | 4.0 | 5.4 | 7.6 | 7.7 | |
| 4 | 8 | Palm | VII | 3.1 | 3.3 | 1.2 | 3.0 | 3.5 | |
| 4 | 8 | Palm | VII | 3.7 | 3.7 | 5.4 | 6.9 | 7.1 | |
| 4 | 8 | Palm | VII | 3.1 | 3.2 | 3.9 | 4.5 | 4.8 | |
| 5 | 6 | Black Palm | VII | 2.5 | 2.9 | 3.9 | 4.5 | 4.7 | |
| 5 | 7 | Black Palm | VII | 3.7 | 4.0 | 3.9 | 5.4 | 5.5 | |
| 6 | 1 | | IV | 2.0 | 2.4 | 0.8 | 4.2 | 4.7 | |
| 6 | 1 | | I | 2.2 | 2.4 | 1.2 | 3.6 | 3.7 | |
| 6 | 4 | Hirtella | II | 2.2 | 2.5 | 0.3 | 1.5 | 2.5 | |
| 6 | 5 | Black Palm | VII | 1.2 | 2.0 | 0.3 | 2.8 | 3.0 | |
| 6 | 5 | Black Palm | VII | 3.7 | 4.0 | 3.6 | 4.2 | 4.3 | |
| 6 | 6 | Black Palm | VII | 3.1 | 3.3 | 3.9 | 4.5 | 4.7 | |
| 6 | 6 | Black Palm | VII | 2.5 | 2.8 | 5.4 | 6.6 | 6.9 | |
| 6 | 6 | Black Palm | VII | 2.5 | 2.9 | 2.5 | 3.6 | 3.8 | |
| 7 | 3 | | IV | 2.2 | 2.6 | 1.5 | 3.9 | 4.0 | |
| 7 | 5 | Black Palm | VII | 1.2 | 2.1 | 4.2 | 6.0 | 6.2 | |
| 7 | 5 | Black Palm | VII | 5.0 | 5.1 | 4.5 | 6.0 | 6.3 | |
| 7 | 5 | Black Palm | VII | 2.5 | 3.0 | 1.2 | 4.2 | 4.5 | |
| 7 | 6 | Black Palm | VII | 4.4 | 4.6 | 4.5 | 5.1 | 5.5 | |
| 8 | 0 | Pittoniotis | I | 3.4 | 3.5 | 1.8 | 4.2 | 4.7 | |
| 8 | 1 | | I | 2.1 | 2.1 | 1.9 | 3.9 | 4.2 | |
| 8 | 1 | | I | 2.4 | 2.4 | 1.5 | 3.9 | 4.3 | |
| 8 | 7 | Palm | VII | 2.5 | 2.6 | 0.3 | 2.8 | 3.0 | |
| 8 | 8 | Palm | VII | 3.7 | 4.0 | 4.2 | 6.0 | 6.3 | |

Plot 15[1]

| D4 C4 X | D3 C3 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | Lauraceae | IV | 3.1 | 3.1 | 0.8 | 3.9 | 4.2 | |
| 0 | 3 | Alibertia | I | 2.4 | 2.5 | 1.2 | 3.9 | 4.5 | |
| 3 | 7 | Chrysophyllum | I | 3.0 | 3.0 | 1.5 | 4.2 | 4.8 | |
| 3 | 8 | Spondias | I | 64.8 | 69.3 | 14.0 | 26.5 | 27.0 | |
| 3 | 8 | Palm | VII | 3.4 | 3.5 | 4.2 | 5.4 | 6.0 | |
| 3 | 8 | Palm | VII | 4.4 | 4.6 | 2.8 | 4.5 | 5.3 | |
| 3 | 9 | Flacourtiaceae | I | 2.6 | 2.6 | 2.5 | 3.9 | 4.2 | |
| 6 | 0 | Copaifera | I | 8.0 | 8.4 | 4.5 | 6.9 | 8.0 | |
| 8 | 2 | Annona | I | 3.4 | 4.0 | 2.5 | 4.2 | 4.2 | |
| 8 | 8 | Palm | VII | 2.5 | | 3.0 | 3.0 | 4.0 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 15[1] (Continued)

| D4 C4 X | D3 C3 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 8 | 8 | Palm | VII | 3.1 | | 2.5 | 2.5 | | Dead |
| 8 | 8 | Palm | VII | 3.7 | | 3.3 | 4.5 | | Dead |
| 8 | 8 | Palm | VII | 3.1 | | 2.8 | 3.6 | | Dead |
| 9 | 4 | | I | 3.0 | 3.2 | 2.8 | 4.8 | 5.8 | |

Plot 16[1]

| D5 C5 X | D4 C4 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | Croton | | 2.9 | 3.0 | 2.0 | | 3.3 | |
| 1 | 4 | Palicourea | I | 3.0 | 3.1 | 1.2 | 4.5 | 4.8 | |
| 2 | 3 | Cordia | III | 10.9 | 11.2 | 10.0 | 14.0 | 15.1 | |
| 2 | 6 | Alibertia | I | 2.6 | 2.6 | 1.8 | 3.3 | 3.5 | |
| 3 | 3 | | I | 2.7 | 2.8 | 1.2 | 3.3 | 3.4 | |
| 3 | 4 | Ardesia | I | 3.0 | 2.9 | 0.8 | 1.8 | 2.0 | |
| 5 | 5 | Palm | VII | 3.7 | 3.7 | 1.8 | 4.2 | 4.5 | |
| 5 | 7 | Alibertia | I | 2.8 | 3.0 | 1.5 | 2.8 | 3.8 | |
| 6 | 6 | Palm | VII | 3.4 | 3.4 | 1.8 | 3.6 | 3.9 | |
| 6 | 6 | Palm | VII | 3.7 | 3.7 | 0.8 | 2.8 | 3.0 | |
| 7 | 0 | Phoebe | I | 35.1 | 35.6 | 11.5 | 26.0 | 27.0 | |
| 7 | 6 | Anacardium | I | 19.0 | 30.4 | 6.0 | 20.1 | 21.5 | |
| 8 | 6 | Inga | I | 9.9 | 10.1 | 6.0 | 12.0 | 11.0 | Dying |
| 8 | 6 | Inga | I | 8.2 | 8.2 | 6.0 | 10.0 | 1.9 | Chopped |
| 9 | 2 | Chrysophyllum | I | 6.8 | 6.9 | 3.3 | 6.9 | 8.1 | |

Plot 17[1]

| D6 C6 X | D5 C5 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | Copaifera | III | 5.8 | | 2.8 | 6.0 | | Missing |
| 0 | 6 | | I | 13.6 | 15.2 | 7.0 | 10.0 | 10.0 | Three |
| 0 | 6 | | I | 2.4 | 2.4 | 3.3 | 5.7 | 2.3 | Stems |
| 1 | 6 | | I | 13.5 | 14.0 | 8.0 | 11.0 | 11.2 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 17[1] (Continued)

| D6<br>C6<br>X | D5<br>C5<br>Y | Species[4] | Shape[2] | DBH[3] (cm)<br>1 Jan 1967 | DBH[3] (cm)<br>1 Dec 1969 | 1st Branch (m)<br>1967 | Height (m)<br>1 Jan 1967 | Height (m)<br>1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 5 | Anacardium | I | 23.2 | 26.7 | 3.6 | 12.5 | 14.0 | |
| 7 | 1 | Sapindaceae | I | 15.1 | 15.3 | 7.0 | 12.5 | 12.8 | |
| 7 | 7 | | III | 6.0 | | 5.4 | 6.0 | 7.0 | |
| 8 | 0 | Spondias | I | 12.1 | 12.7 | 6.0 | 9.5 | 11.8 | |
| 8 | 5 | Ficus | I | 71.3 | 127.0 | 6.4 | 26.5 | 28.0 | |

Plot 18[1]

| D7<br>C7<br>X | D6<br>C6<br>Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | Nectandra | II | 2.6 | | | 3.6 | | Missing |
| 1 | 4 | Hirtella | II | 3.4 | 3.5 | | 3.9 | 4.2 | |
| 1 | 9 | Anacardium | I | 20.8 | 23.6 | 8.5 | 10.0 | 15.0 | |
| 3 | 0 | | II | 1.8 | 2.0 | | 2.8 | 3.5 | |
| 3 | 3 | Nectandra | I | 4.8 | | 3.6 | 5.4 | | Missing |
| 3 | 3 | | I | 5.6 | | 2.8 | 4.5 | | Dead or Dying |
| 4 | 0 | Hirtella | II | 3.0 | 3.0 | | 3.9 | 4.5 | |
| 4 | 5 | Conostegia | II | 3.0 | 3.2 | 2.8 | 4.2 | 4.8 | |
| 5 | 1 | Belotia | III | 10.1 | 12.5 | 6.0 | 12.0 | 14.5 | |
| 5 | 2 | Miconia | I | 1.8 | | 3.3 | 6.0 | 4.0 | |
| 5 | 6 | Belotia | III | 18.9 | 21.1 | 6.3 | 12.0 | 15.5 | |
| 5 | 6 | Conostegia | I | 1.8 | | 0.4 | 1.8 | | Chopped |
| 7 | 0 | Croton | I | 5.6 | | 1.8 | 2.0 | | Dead or Dying |
| 8 | 3 | Andira | I | 9.4 | 10.1 | 4.5 | 6.9 | 10.5 | |
| 8 | 3 | | I | 3.2 | 3.3 | 2.8 | 3.6 | 3.8 | |

Plot 19[1]

| E2<br>D2<br>X | E1<br>D1<br>Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | Palm | III | | 2.5 | 5.4 | | 5.6 | Replaced |
| 0 | 8 | Anacardium | | 32.1 | 43.9 | 4.5 | | 18.0 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 19[1] (Continued)

| E2 D2 X | E1 D1 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | Palm | VII | | 2.7 | | | 3.1 | |
| 1 | 2 | Palm | VII | 4.4 | 4.4 | 4.5 | 6.0 | 6.2 | |
| 1 | 3 | Palm | VII | 3.4 | 3.6 | | 4.2 | 4.1 | |
| 1 | 3 | Palm | VII | | 2.7 | | | 3.0 | |
| 1 | 6 | Palm | VII | 3.1 | 3.2 | 0.5 | 1.8 | 2.3 | |
| 1 | 9 | Chrysophyllum | I | 2.3 | 2.5 | 0.8 | 3.9 | 4.3 | |
| 2 | 2 | | | 3.4 | | | 1.5 | | Dead |
| 2 | 5 | Palm | VII | 2.7 | 2.9 | 4.2 | 6.0 | 6.3 | |
| 2 | 7 | Palm | VII | 3.7 | 3.8 | 5.1 | 5.1 | 5.8 | |
| 2 | 7 | Palm | VII | 3.7 | | 1.5 | 2.0 | | Dead |
| 2 | 7 | Palm | VII | 3.1 | 3.3 | 5.7 | 5.7 | 5.7 | |
| 3 | 1 | Palm | VII | 2.7 | 2.7 | 1.8 | 3.6 | 4.0 | |
| 3 | 1 | Palm | VII | 3.7 | 4.0 | 4.2 | | | |
| 3 | 1 | Palm | VII | 3.1 | 3.3 | 4.2 | 4.5 | 4.9 | |
| 3 | 2 | Palm | VII | 3.1 | | | 5.4 | | Dead |
| 3 | 2 | Palm | VII | 3.7 | 4.0 | 4.2 | 6.0 | 6.3 | |
| 3 | 3 | Palm | VII | 3.4 | 3.4 | 6.0 | 7.6 | 7.9 | |
| 3 | 7 | Palm | VII | 3.4 | 3.6 | 0.7 | 3.6 | 3.8 | |
| 3 | 8 | Palm | VII | 3.7 | 3.8 | 3.9 | 6.0 | 6.4 | |
| 4 | 1 | Palm | VII | 3.7 | 3.7 | 5.1 | 6.0 | 6.5 | |
| 4 | 7 | Palm | VII | 3.1 | 3.2 | 0.5 | 3.6 | 3.9 | |
| 4 | 8 | Alibertia | I | 2.3 | 2.5 | 0.5 | 3.6 | 3.9 | |
| 5 | 0 | Palm | VII | 3.7 | 3.8 | 1.7 | 3.6 | 4.0 | |
| 5 | 1 | | | | | | | | Missing |
| 5 | 5 | Palm | VII | 2.7 | 2.9 | | 1.5 | 2.3 | |
| 5 | 5 | Palm | VII | 3.4 | 3.4 | 0.8 | 1.8 | 2.5 | |
| 5 | 6 | Palm | VII | 2.1 | 2.5 | 0.5 | 1.8 | 2.5 | |
| 5 | 6 | Palm | VII | 3.7 | 3.9 | 0.7 | 1.8 | 2.4 | |
| 6 | 0 | Palm | VII | 3.7 | 3.7 | 3.9 | 4.5 | 5.0 | |
| 6 | 1 | Palm | VII | 3.7 | 3.8 | 4.2 | 5.7 | 5.9 | |
| 6 | 1 | Palm | VII | 4.4 | 4.4 | 6.0 | 8.2 | 8.4 | |
| 6 | 5 | Genipa | III | 14.3 | 16.5 | 4.2 | 17.5 | 17.5 | |
| 7 | 1 | Palm | VII | 5.0 | 4.1 | 2.8 | 4.2 | 4.8 | |
| 8 | 6 | | IV | 1.9 | 2.0 | 0.3 | 1.8 | 2.2 | |
| 9 | 4 | Rubiaceae | IV | 3.6 | 3.6 | 0.4 | 4.2 | 4.5 | |
| 9 | 5 | | I | 6.2 | 6.2 | 1.2 | 6.0 | 6.3 | |
| 9 | 6 | | I | 1.8 | | 1.2 | 1.5 | | Dying Chopped |
| 9 | 7 | | III | 21.0 | 22.3 | 13.0 | 17.5 | 17.8 | |
| 9 | 7 | | III | 22.0 | 23.8 | 12.0 | 21.5 | 22.9 | Stems |
| 9 | 7 | Annona | I | 1.8 | 2.0 | 0.5 | 0.8 | 1.5 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 20[1]

| E3 D3 X | E2 D2 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 7 | Inga | I | 21.0 | 22.1 | 5.4 | 14.0 | 16.5 | |
| 1 | 6 | Annona | I | 19.0 | 18.5 | 4.5 | 16.0 | 20.0 | |
| 5 | 1 | Palm | VII | 3.4 | 3.6 | 3.6 | 4.2 | 4.4 | |
| 5 | 2 | Palm | VII | 3.7 | 3.7 | 6.4 | 7.2 | 7.1 | |
| 5 | 2 | Palm | VII | 3.7 | 3.8 | 3.9 | 4.5 | 4.7 | |
| 5 | 2 | Palm | VII | 4.0 | 4.0 | 3.6 | 5.4 | 5.6 | |
| 5 | 2 | Palm | VII | 4.0 | 4.1 | 4.5 | 6.0 | 6.0 | |
| 5 | 2 | Palm | VII | 4.0 | 3.9 | 1.2 | 3.6 | 3.7 | |
| 6 | 1 | Palm | VII | 3.7 | 3.8 | 3.9 | 5.4 | 5.6 | |
| 6 | 2 | Palm | VII | 3.1 | 3.3 | 6.0 | 7.6 | 8.1 | |
| 6 | 2 | Palm | VII | 3.7 | 3.9 | 5.4 | 6.6 | 6.9 | |
| 6 | 3 | Palm | VII | 3.4 | 3.7 | 6.0 | 6.9 | 7.2 | |
| 6 | 3 | Palm | VII | 3.7 | 3.8 | 6.0 | 7.2 | 7.5 | |
| 6 | 3 | Palm | VII | 3.1 | 3.4 | 5.7 | 6.9 | 7.4 | |
| 6 | 3 | Palm | VII | 4.4 | 4.3 | 4.8 | 6.0 | 6.5 | |
| 6 | 3 | Palm | VII | 3.7 | 3.8 | 6.0 | 6.9 | 7.3 | |
| 6 | 3 | | II | 5.5 | 5.5 | 4.5 | 6.0 | 6.4 | |
| 6 | 4 | Palm | VII | 5.0 | 5.1 | 1.2 | 3.6 | 3.9 | |
| 7 | 2 | Palm | VII | 3.1 | 3.3 | 4.5 | 6.0 | 6.5 | |
| 7 | 3 | Luehea | III | 43.2 | 48.2 | 13.0 | 23.0 | 35.0 | |
| 8 | 8 | Lafoensia | I | 78.4 | 83.8 | 11.0 | 36.0 | 37.3 | |
| 9 | 6 | Posequeria | I | | 6.0 | | | 6.2 | |

Plot 21[1]

| E4 D4 X | E3 D3 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | | III | 2.0 | | 3.0 | 3.5 | | Missing |
| 0 | 3 | | III | 2.6 | | 3.7 | 40.0 | | Cut |
| 0 | 9 | Anacardium | I | 98.0 | 96.5 | 4.3 | 30.0 | 32.0 | |
| 0 | 9 | | II | 2.0 | | | 3.0 | | Missing |
| 1 | 5 | | III | 4.0 | 4.8 | 3.5 | 4.5 | 4.9 | |
| 3 | 5 | Annona | IV | 17.7 | 19.9 | 4.0 | 7.0 | 10.9 | |
| 3 | 5 | Annona | IV | 9.5 | 9.8 | 3.0 | 5.5 | 5.8 | |
| 3 | 6 | | IV | 2.3 | 2.4 | 1.0 | 2.5 | 3.0 | |
| 3 | 7 | Alibertia | III | 3.7 | 3.7 | 2.5 | 5.0 | 5.2 | |
| 4 | 2 | Palicourea | I | 2.8 | 2.8 | 1.0 | 3.0 | 3.0 | |
| 4 | 4 | | I | 2.5 | 2.5 | 1.0 | 3.0 | 3.0 | |
| 5 | 7 | Posequeria | | | 4.2 | | | 7.0 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 21[1] (Continued)

| E4<br>D4<br>X | E3<br>D3<br>Y | Species[4] | Shape[2] | DBH[3] (cm)<br>1 Jan<br>1967 | <br>1 Dec<br>1969 | 1st Branch<br>(m)<br>1967 | Height (m)<br>1 Jan<br>1967 | <br>1 Dec<br>1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 6 | Palicourea | IV | 1.8 | 2.0 | 1.0 | 2.5 | 2.8 | |
| 8 | 1 | Annona | I | 3.4 | 3.8 | 3.0 | 4.5 | 4.9 | |
| 9 | 3 | Anacardium | I | 3.1 | 3.2 | 1.0 | 3.0 | 3.9 | |

Plot 22[1]

| E5<br>D5<br>X | E4<br>D4<br>Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 8 | Posequeria | I | 5.6 | 5.9 | 1.3 | 4.5 | 4.7 | |
| 1 | 5 | | I | | 2.6 | 1.0 | | 4.0 | Replaced |
| 3 | 6 | | | 9.7 | | 2.0 | 2.5 | | Dead |
| 4 | 5 | | IV | 2.0 | 2.2 | 1.0 | 2.5 | 2.7 | |
| 5 | 0 | Palm | VII | 3.7 | 3.8 | 1.0 | 3.0 | 3.5 | |
| 5 | 1 | Palm | VII | 3.1 | 3.3 | 1.0 | 2.5 | 2.8 | |
| 5 | 2 | Palm | VII | 5.0 | 5.0 | 4.3 | 1.0 | 1.5 | |
| 5 | 3 | Palm | VII | 4.4 | 4.6 | 1.3 | 2.5 | 2.7 | |
| 5 | 3 | Palm | VII | 4.0 | 4.3 | 4.5 | 6.0 | 6.3 | |
| 6 | 3 | Palm | VII | 2.7 | 2.8 | 1.0 | 2.0 | 2.9 | |
| 6 | 3 | Palm | VII | 2.8 | 2.9 | 2.5 | 4.5 | 4.8 | |
| 6 | 3 | Palm | VII | 3.7 | 3.7 | 3.5 | 5.5 | 5.7 | |
| 6 | 4 | Palm | VII | 2.5 | 2.7 | 1.0 | 2.0 | 2.5 | |
| 7 | 7 | Alibertia | I | 2.8 | 2.8 | 1.0 | 3.0 | 3.4 | |
| 8 | 5 | Hirtella | I | 2.2 | 2.4 | 2.0 | 3.5 | 3.7 | |
| 9 | 7 | Spondias | III | 25.0 | 26.0 | 11.0 | 15.0 | 16.0 | Dead |

Plot 23[1]

| E6<br>D6<br>X | E5<br>D5<br>Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 8 | | II | 3.6 | 3.6 | 0.5 | 2.0 | 2.6 | |
| 1 | 8 | | VII | | | | | | Dead |
| 2 | 3 | Annonaceae | I | 12.1 | 13.0 | 8.0 | 16.5 | 16.7 | |
| 4 | 9 | Heliconia | V | 3.0 | 3.0 | 1.0 | 3.5 | 4.1 | |
| 5 | 9 | Heliconia | V | 3.0 | 3.0 | 1.0 | 3.5 | 4.2 | |
| 6 | 3 | Inga | I | 19.0 | 19.4 | 8.0 | 12.0 | 12.8 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 23[1] (Continued)

| E6<br>D6<br>X | E5<br>D5<br>Y | Species[4] | Shape[2] | DBH[3] (cm)<br>1 Jan 1967 | <br>1 Dec 1969 | 1st Branch (m)<br>1967 | Height (m)<br>1 Jan 1967 | <br>1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 5 | Inga | I | 16.1 | 16.9 | 3.5 | 13.0 | 13.4 | |
| 9 | 4 | Luehea | I | 7.0 | 6.8 | 1.0 | 5.5 | 7.0 | |

Plot 24[1]

| E7<br>D7<br>X | E6<br>D6<br>Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | Belotia | III | 4.9 | 6.4 | 4.5 | 6.5 | 6.8 | |
| 1 | 5 | Heliconia | V | 3.6 | 3.6 | 1.8 | 3.5 | 3.9 | |
| 1 | 5 | Heliconia | V | 4.0 | 4.0 | 2.0 | 3.5 | 3.8 | |
| 1 | 5 | Heliconia | V | 3.6 | | 3.3 | 3.3 | | Dead |
| 1 | 5 | Heliconia | V | 3.1 | 3.2 | 1.8 | 3.6 | 3.9 | |
| 1 | 6 | Heliconia | V | 2.3 | 2.5 | 1.5 | 2.7 | 3.0 | |
| 2 | 5 | Heliconia | V | 3.4 | | 1.8 | 3.0 | | Dead |
| 2 | 6 | Heliconia | V | 3.7 | | 2.0 | 4.2 | | Dead |
| 2 | 6 | Heliconia | V | 3.4 | | 2.0 | 2.0 | | Dead |
| 3 | 1 | Belotia | III | 6.7 | 7.7 | 3.0 | 8.4 | 8.7 | |
| 3 | 2 | | I | 6.7 | 7.7 | 3.0 | 8.4 | 8.7 | |
| 3 | 7 | Cavanillesia | VI | 70.1 | 76.2 | 18.0 | 24.0 | 25.0 | |
| 3 | 7 | Cecropia | I | 10.1 | 16.7 | 10.0 | 15.0 | 16.3 | |
| 4 | 4 | Heliconia | V | 3.6 | | 1.5 | 3.3 | | Dead |
| 4 | 4 | Heliconia | V | 3.3 | 3.4 | 1.2 | 3.2 | 3.7 | |
| 4 | 4 | Heliconia | V | 3.2 | 3.2 | 1.5 | 3.3 | 3.8 | |
| 5 | 0 | Belotia | III | 5.7 | 6.6 | 3.5 | 7.2 | 8.0 | |
| 5 | 3 | Cecropia | III | 9.5 | 12.4 | 14.0 | 14.5 | 15.0 | |
| 5 | 3 | Belotia | III | 3.2 | 3.5 | 4.5 | 6.0 | 7.1 | |
| 6 | 4 | Croton | III | 3.0 | 3.0 | 2.0 | 5.6 | 6.0 | |
| 8 | 8 | Annona | I | 22.3 | 23.8 | 4.4 | 16.5 | 17.0 | Dying |
| 3 | 8 | | | | | | | | Missing |

Plot 25[1]

| F2<br>E2<br>X | F1<br>E1<br>Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | Luehea | III | 25.6 | | 8.0 | 12.0 | | Dead |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 25[1] (Continued)

| F2 E2 X | F1 E1 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 1 | | I | 2.2 | 2.4 | 1.5 | 3.9 | 4.2 | |
| 4 | 5 | | IV | 2.2 | 2.3 | 0.3 | 3.6 | 3.9 | |
| 5 | 5 | Palm | VII | 1.0 | 2.0 | 0.9 | 2.8 | 3.2 | |
| 5 | 5 | Palm | VII | 1.4 | 2.3 | 2.8 | 3.6 | 3.8 | |
| 5 | 1 | Anacardium | I | 6.6 | 7.3 | 3.3 | 6.6 | 7.0 | |
| 5 | 6 | Palm | VII | 1.0 | 2.1 | 2.0 | 3.6 | 3.9 | |
| 6 | 1 | | I | 4.4 | 4.5 | 1.2 | 4.2 | 4.7 | |
| 7 | 6 | Piper | III | 3.0 | 4.4 | 3.3 | 5.4 | 5.7 | |
| 8 | 1 | Alibertia | II | 5.0 | 5.1 | | 6.0 | 6.6 | |
| 8 | 7 | Chrysophylum | I | 4.8 | 5.2 | 3.0 | 6.0 | 6.4 | |
| 7 | 0 | Palm | VII | | | | | 2.9 | No Stem |

Plot 26[1]

| F3 E3 X | F2 E2 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 5 | Luehea | I | 7.0 | 7.3 | 2.5 | 7.6 | 7.2 | |
| 1 | 3 | Anacardium | IV | 8.4 | 8.9 | 1.9 | 6.5 | 6.5 | |
| 2 | 5 | Anacardium | I | 9.4 | | 2.0 | 6.0 | | Dead |
| 2 | 5 | Anacardium | I | 21.3 | 22.8 | 2.8 | 5.5 | 6.0 | Chopped |
| 4 | 9 | Palm | VII | 4.4 | 4.4 | 1.8 | 3.3 | 3.5 | |
| 4 | 9 | Palm | VII | 3.7 | 3.8 | 1.5 | 2.8 | 2.8 | |
| 4 | 9 | Palm | VII | 3.7 | 3.7 | 0.8 | 2.5 | 2.5 | |
| 5 | 6 | Cecropia | III | 22.6 | 24.4 | 20.0 | 25.0 | 27.0 | |
| 5 | 9 | Palm | VII | 4.4 | 4.4 | 3.3 | 5.4 | 5.5 | |
| 6 | 0 | Spondias | I | 25.0 | 26.4 | 3.9 | 14.5 | 16.2 | Dying |
| 6 | 4 | | I | 3.0 | | 1.3 | 3.0 | | Dead |
| 6 | 5 | | I | 3.6 | | 1.8 | 3.3 | | Dead |
| 6 | 9 | Palm | VII | 4.4 | 3.1 | 0.8 | 3.9 | 3.3 | Replaced |
| 7 | 0 | Anacardium | I | 21.3 | 22.6 | 3.9 | 16.5 | 18.0 | |
| 9 | 7 | | I | 19.6 | 20.3 | 11.0 | 15.1 | 15.4 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 27[1]

| F4 E4 X | F3 E3 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 4 | | III | 2.6 | 2.7 | 0.8 | 3.0 | 3.6 | |
| 2 | 0 | | VII | 1.8 | | 0.8 | 2.8 | | Dead |
| 2 | 0 | | VII | 1.8 | | 0.8 | 3.6 | | Chopped |
| 3 | 6 | Flacourtiaceae | I | 6.3 | 8.1 | 1.8 | 6.9 | 7.0 | |
| 8 | 2 | | III | 2.0 | | 1.5 | 2.5 | | Dead |
| 8 | 3 | Cordia | III | 12.4 | 14.9 | 6.5 | 12.5 | 12.8 | |
| 8 | 6 | | I | 2.4 | | 1.5 | 4.5 | | Dead |
| 9 | 8 | | I | 3.0 | 4.4 | 1.9 | 6.0 | 6.1 | |
| 1 | 1 | Ardesia | I | | 2.2 | | | 3.2 | |
| 2 | 3 | | I | | 2.5 | | | 4.0 | |
| 6 | 0 | Ardesia | I | | 2.0 | | | 2.6 | |
| 9 | 7 | Miconia | I | | 2.6 | | | 4.2 | |
| 9 | 7 | Piper | I | | 2.4 | | | 3.2 | |
| 5 | 5 | Heliconia | V | | 3.3 | | | 3.9 | |
| 9 | 1 | Piper | I | | 2.8 | | | 4.1 | |

Plot 28[1]

| F5 E5 X | F4 E4 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 6 | Luehea | II | 5.4 | 5.6 | 1.8 | 2.8 | 4.0 | Two Stems |
| 1 | 6 | Luehea | II | 4.6 | 4.7 | 2.8 | 4.8 | 5.1 | |
| 2 | 8 | Ficus | I | 6.3 | 6.8 | 2.8 | 4.5 | 4.9 | |
| 4 | 7 | Posequeria | I | 5.4 | 5.9 | 1.8 | 4.5 | 4.7 | |
| 6 | 3 | Anacardium | I | 17.5 | 18.5 | 4.5 | 19.0 | 16.0 | Leaning |
| 6 | 6 | Inga | I | 22.4 | 24.0 | 2.8 | 13.5 | 19.0 | |
| 8 | 9 | | I | 15.1 | | 1.8 | 11.0 | | Dead |
| 9 | 9 | Annona | I | | 16.4 | | | 9.0 | |
| 8 | 2 | | I | | 2.6 | | | 5.6 | |
| 9 | 2 | | I | | 2.4 | | | 2.5 | |
| 9 | 4 | Ardesia | I | | 2.5 | | | 4.0 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 29[1]

| F6 E6 X | F5 E5 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 7 | Cecropia | III | 24.4 | 36.4 | 23.0 | 32.C | 32.1 | |
| 1 | 7 | Andira | II | 4.9 | 5.1 | 0.5 | 7.6 | 8.0 | Four |
| 1 | 7 | Andira | II | 8.2 | 8.2 | 0.5 | 7.6 | 8.0 | Stems |
| 1 | 7 | Andira | II | 6.3 | 6.5 | 0.5 | 7.6 | 8.0 | |
| 2 | 7 | Andira | II | 3.0 | 3.1 | 0.5 | 7.6 | 8.0 | |
| 2 | 7 | | II | | 2.6 | 0.5 | | 4.2 | Replaced |
| 3 | 5 | | III | 5.2 | | 2.0 | 3.0 | | Dead |
| 3 | 5 | | IV | 3.4 | | 0.8 | 3.6 | | Dead |
| 3 | 0 | Belotia | III | 4.7 | 9.5 | 4.2 | 6.0 | 11.2 | |
| 4 | 6 | Piper | I | 2.4 | 2.5 | 1.5 | 2.5 | 4.9 | |
| 6 | 3 | Copaifera | III | 4.7 | 5.3 | 5.4 | 6.9 | 7.0 | |
| 6 | 5 | | IV | 2.8 | 3.0 | 0.7 | 4.2 | 4.9 | |
| 6 | 6 | | I | 2.4 | 2.5 | 0.8 | 3.3 | 3.8 | |
| 7 | 2 | Spondias | I | 3.6 | 3.6 | 2.8 | 4.8 | 5.0 | |
| 7 | 5 | Heliconia | V | 2.8 | 3.0 | 2.0 | 3.0 | 3.5 | |
| 7 | 5 | Heliconia | V | 4.1 | 4.1 | 2.0 | 3.9 | 4.3 | |
| 7 | 5 | Heliconia | V | 4.4 | 4.4 | 2.8 | 6.0 | 6.3 | |
| 8 | 5 | Heliconia | V | 4.0 | 4.1 | 2.8 | 5.4 | 5.9 | |
| 8 | 5 | Heliconia | V | 3.0 | 3.2 | 1.2 | 3.0 | 3.4 | |
| 9 | 8 | Nectandra | II | 4.2 | 4.2 | | 3.9 | 4.2 | |
| 2 | 1 | Piper | I | | 2.5 | | | 5.0 | |

Plot 30[1]

| F7 E7 X | F6 E6 Y | Species | Shape | DBH (cm) 1 Jan 1967 | DBH (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 4 | | II | 4.4 | | 0.9 | 0.9 | | Chopped |
| 0 | 5 | Nectandra | I | 2.8 | 2.8 | 1.2 | 3.9 | 4.5 | |
| 1 | 1 | Anacardium | I | 4.4 | 5.3 | 2.0 | 5.4 | 6.1 | |
| 1 | 7 | Hirtella | I | 2.8 | | 1.5 | 2.5 | | Dead |
| 2 | 9 | Croton | IV | 4.1 | 4.1 | 0.5 | 3.6 | 4.3 | |
| 2 | 0 | Heliconia | V | 2.5 | | 1.2 | 2.0 | 2.5 | |
| 2 | 0 | Heliconia | V | 2.3 | | 2.5 | 3.0 | 3.2 | |
| 3 | 0 | Rubiaceae | III | 6.2 | 6.2 | 3.9 | 6.4 | 6.9 | |
| 3 | 3 | Sapindaceae | I | 28.5 | 30.2 | 2.5 | 20.0 | 20.0 | |
| 3 | 6 | Posequeria | III | 5.0 | 5.0 | 2.0 | 4.5 | 4.9 | |
| 5 | 2 | Anacardium | I | 5.0 | 5.1 | 2.0 | 3.3 | 4.5 | |
| 5 | 8 | Pittoniotis | I | 5.3 | | 1.7 | 3.9 | | Dead |
| 6 | 3 | | I | 9.6 | 11.1 | 1.9 | 9.0 | 9.8 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 30[1] (Continued)

| F7<br>E7<br>X | F6<br>E6<br>Y | Species[4] | Shape[2] | DBH[3] (cm)<br>1 Jan 1967 | DBH[3] (cm)<br>1 Dec 1969 | 1st Branch (m)<br>1967 | Height (m)<br>1 Jan 1967 | Height (m)<br>1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 9 | 7 | Cecropia | III | 24.4 | 26.0 | 23.0 | 32.0 | 32.8 | |
| 9 | 8 | | IV | 2.5 | 2.5 | 0.8 | 2.5 | 2.8 | |

Plot 31[1]

| G2<br>F2<br>X | G1<br>F1<br>Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 9 | Piper | I | 2.0 | 2.2 | 1.2 | 3.0 | 3.5 | |
| 1 | 2 | | I | 2.3 | 3.2 | 1.5 | 3.9 | 4.1 | |
| 2 | 1 | Chrysophyllum | I | 2.6 | 3.0 | 0.8 | 3.6 | 5.9 | |
| 2 | 4 | | I | 50.3 | 54.8 | 13.0 | 23.0 | 23.0 | |
| 2 | 7 | Miconia | III | 3.6 | 3.8 | 5.1 | 6.3 | 6.9 | |
| 2 | 7 | | | | | | | | Missing |
| 2 | 9 | | I | 2.0 | 2.1 | 0.8 | 3.3 | 3.8 | |
| 4 | 8 | Miconia | I | 7.8 | 7.8 | 4.8 | 7.6 | 7.9 | |
| 7 | 3 | Posequeria | III | 5.0 | 4.9 | 2.8 | 4.5 | 4.8 | |
| 7 | 7 | Chrysophyllum | I | 3.0 | 3.3 | 1.8 | 4.5 | 4.9 | |
| 8 | 3 | Solanum | III | 8.4 | 10.1 | 3.6 | 6.0 | 9.0 | |
| 8 | 5 | Annona | I | 29.9 | 31.4 | 8.0 | 15.0 | 16.0 | |
| 0 | 5 | Hirtella | II | | 2.0 | | | 4.1 | |
| 3 | 4 | Chrysophyllum | I | | 2.5 | | | 5.1 | |
| 3 | 5 | Hirtella | II | | 1.8 | | | 4.2 | |
| 8 | 3 | | II | | 5.1 | | | 6.1 | |
| 7 | 6 | Chrysophyllum | I | | 3.0 | | | 8.2 | |
| 8 | 8 | | I | | 2.4 | | | 5.0 | |

Plot 32[1]

| G3<br>F3<br>X | G2<br>F2<br>Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | Helicteres | II | 3.0 | 3.0 | | 2.5 | 3.2 | |
| 0 | 5 | | IV | 3.6 | 3.7 | 0.8 | 2.3 | 3.1 | |
| 0 | 7 | Flacourtiaceae | III | 2.2 | 2.4 | 1.8 | 2.8 | 4.2 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 32[1] (Continued)

| G3 F3 X | G2 F2 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 9 | | I | 4.0 | 5.1 | 0.7 | 6.0 | 6.3 | |
| 1 | 1 | Cecropia | III | 15.1 | 15.2 | 13.5 | 18.5 | 19.0 | |
| 1 | 7 | Palicourea | I | 9.5 | | 1.2 | 6.0 | | Missing |
| 2 | 5 | Annonaceae | III | | 7.6 | 5.0 | | 6.5 | Replaced |
| 2 | 9 | Piper | I | | 2.5 | 1.2 | | 4.1 | Replaced |
| 3 | 1 | Posequeria | II | 4.6 | 5.1 | 1.8 | 3.0 | 3.2 | |
| 3 | 2 | Palm | VII | 5.0 | 5.0 | 1.2 | 2.8 | 3.0 | |
| 3 | 2 | Palm | VII | 4.7 | 4.8 | 3.6 | 5.4 | 5.4 | |
| 4 | 1 | Palm | VII | 3.4 | 3.6 | 5.1 | 6.0 | 6.3 | |
| 4 | 1 | Palm | VII | 3.7 | 3.9 | 2.5 | 5.4 | 5.7 | |
| 4 | 2 | Palm | VII | 3.7 | 3.7 | 0.8 | 3.3 | 3.7 | |
| 4 | 2 | Palm | VII | 4.7 | 4.8 | 1.8 | 4.2 | 4.5 | |
| 6 | 9 | Miconia | II | 3.7 | 4.2 | 0.3 | 4.2 | 6.0 | |
| 4 | 5 | | II | 2.7 | 2.7 | | 2.5 | 2.9 | |
| 5 | 0 | Palm | VII | 5.0 | 5.1 | 1.2 | 3.6 | 4.0 | |
| 5 | 0 | Palm | VII | 4.4 | 4.4 | 2.8 | 3.6 | 4.0 | |
| 5 | 0 | Palm | VII | 3.4 | 3.6 | 4.5 | 4.5 | 4.7 | |
| 5 | 1 | Palm | VII | 2.1 | 2.2 | 1.8 | 2.7 | 2.9 | |
| 5 | 7 | Hirtella | II | 2.8 | 2.9 | 1.8 | 3.9 | 4.0 | |
| 6 | 0 | Palm | VII | 3.7 | 3.7 | 4.5 | 6.0 | 6.5 | |
| 6 | 0 | Palm | VII | 4.4 | 4.5 | 6.0 | 7.6 | 7.9 | |
| 6 | 4 | Hirtella | II | 4.0 | 4.0 | | 3.6 | 4.1 | |
| 7 | 0 | | VII | 4.4 | | 4.2 | 6.0 | | Dead |
| 8 | 8 | Annona | I | 22.2 | 25.4 | 6.0 | 10.0 | 11.2 | |
| 7 | 9 | Miconia | I | 1.9 | 2.1 | 1.2 | 4.2 | 4.5 | |
| 7 | 9 | Psychotria | IV | 2.5 | 2.6 | 1.8 | 3.6 | 3.9 | |
| 8 | 0 | | VII | 4.4 | | 1.5 | 3.0 | | Dead |
| 8 | 9 | Piper | III | 2.6 | 3.3 | 1.8 | 3.6 | 5.9 | |
| 9 | 9 | Hirtella | I | 2.2 | 2.5 | 1.5 | 2.8 | 3.1 | |

Plot 33[1]

| G4 F4 X | G3 F3 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | Piper | III | | 2.5 | | | 5.0 | Replaced |
| 1 | 8 | Heliconia | V | 4.7 | 4.6 | 2.5 | 3.6 | 3.9 | |
| 1 | 9 | Heliconia | V | 4.7 | 4.7 | 2.1 | 4.8 | 5.3 | |
| 1 | 9 | Heliconia | V | 4.2 | 4.3 | 1.8 | 5.1 | 5.4 | |
| 2 | 2 | Heliconia | V | | 4.1 | | | 5.0 | |

**TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)**

Plot 33[1] (Continued)

| G4 F4 X | G3 F3 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 8 | Croton | III | 4.8 | 5.1 | 5.7 | 6.9 | 7.0 | |
| 2 | 7 | Heliconia | V | 4.1 | 4.2 | 2.0 | 5.4 | 5.7 | |
| 3 | 2 | Piper | III | | 3.3 | | | 6.5 | |
| 3 | 4 | | III | 2.5 | | 1.2 | 2.8 | | Missing |
| 3 | 6 | Flacourtiaceae | III | 6.2 | 8.4 | 3.6 | 6.6 | 6.9 | |
| 4 | 5 | Heliconia | V | 4.7 | | 1.5 | 5.4 | | Dead |
| 4 | 6 | Heliconia | V | 3.1 | | 2.5 | 2.2 | | Dead |
| 4 | 6 | Heliconia | V | 3.0 | | 1.8 | 3.3 | | Dead |
| 4 | 8 | Ficus | III | 4.5 | 5.0 | 2.8 | 4.5 | 5.2 | |
| 5 | 0 | Flacourtiaceae | IV | 3.2 | 3.3 | 1.2 | 4.5 | 4.9 | |
| 5 | 0 | Banara | I | 5.1 | 5.1 | 5.4 | 5.9 | | |
| 5 | 3 | Cordia | III | 3.2 | 4.4 | 1.8 | 4.8 | 5.3 | |
| 5 | 4 | Heliconia | V | 4.0 | 4.0 | 1.8 | 3.9 | 4.0 | |
| 5 | 5 | Heliconia | V | 2.4 | 2.6 | 1.5 | 3.6 | 3.9 | |
| 5 | 5 | Heliconia | V | 4.5 | 4.5 | 3.0 | 5.7 | 5.8 | |
| 5 | 6 | Heliconia | V | 3.7 | 3.9 | 2.0 | 3.9 | 4.2 | |
| 5 | 7 | Heliconia | V | 3.3 | 3.4 | 2.8 | 4.5 | 4.9 | |
| 5 | 7 | | II | | 4.2 | | | 7.3 | |
| 5 | 9 | Heliconia | V | 3.0 | 3.3 | 2.1 | 5.1 | 5.4 | |
| 5 | 9 | Heliconia | V | 4.0 | 4.2 | 2.1 | 5.1 | 5.4 | |
| 6 | 0 | | III | 3.7 | 3.9 | 4.5 | 4.5 | 4.9 | |
| 7 | 0 | Cecropia | III | | 4.4 | | | 8.0 | |
| 7 | 4 | Ardesia | I | 6.0 | 6.0 | 0.9 | 2.5 | 4.6 | Chopped but Living |
| 7 | 9 | Miconia | I | 3.4 | 5.8 | 3.0 | 6.4 | 7.0 | |
| 8 | 2 | | I | 2.5 | | 1.2 | 2.5 | | Dead |
| 8 | 8 | Cordia | I | 5.6 | 8.4 | 2.5 | 4.2 | 10.5 | |
| 9 | 8 | | II | 2.0 | 2.4 | 0.8 | 3.6 | 3.9 | |

Plot 34[1]

| G5 F5 X | G4 F4 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 | Inga | I | 11.9 | | 3.6 | 6.9 | | Dead |
| 1 | 7 | | VII | 3.2 | | 3.6 | 4.5 | | Missing |
| 1 | 7 | | VII | 3.2 | | 3.0 | 5.7 | | Missing |
| 1 | 8 | Palm | VII | 3.7 | 3.8 | 3.6 | 4.5 | 5.1 | |
| 1 | 8 | Palm | VII | 4.4 | 4.4 | 3.9 | 6.0 | 6.4 | |
| 1 | 8 | Palm | VII | 3.4 | 3.6 | 4.5 | 5.7 | 6.2 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 34[1] (Continued)

| G5 F5 X | G4 F4 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | Palm | VII | 3.1 | 3.3 | 4.8 | 6.0 | 6.3 | |
| 2 | 0 | | I | 5.0 | 6.3 | 5.4 | 6.4 | 7.0 | |
| 2 | 7 | Palm | VII | 3.1 | 3.4 | 1.5 | 2.8 | 3.2 | |
| 2 | 7 | Palm | VII | 3.7 | 3.9 | 4.3 | 0.5 | 4.9 | |
| 2 | 8 | Palm | VII | 3.1 | 3.4 | 4.5 | 5.7 | 5.9 | |
| 2 | 8 | Palm | VII | 3.4 | 3.5 | 4.8 | 6.0 | 6.4 | |
| 2 | 8 | Palm | VII | 3.7 | 3.7 | 4.8 | 6.0 | 6.5 | |
| 2 | 8 | Palm | VII | 3.7 | 3.9 | 3.3 | 4.8 | 5.3 | |
| 2 | 9 | Palm | VII | 3.1 | 3.4 | 4.5 | 5.7 | 6.0 | |
| 3 | 2 | Pittoniotis | I | 5.6 | 5.6 | 1.8 | 4.8 | 5.4 | |
| 3 | 7 | Palm | VII | 3.7 | 3.8 | 1.2 | 3.0 | 3.4 | |
| 3 | 8 | Palm | VII | 3.7 | 3.9 | 0.8 | 2.8 | 3.5 | |
| 3 | 8 | Palm | VII | 3.7 | 3.9 | 4.8 | 6.0 | 6.3 | |
| 3 | 8 | Palm | VII | 4.0 | 4.2 | 2.8 | 4.5 | 4.8 | |
| 3 | 9 | Palm | VII | 2.7 | 3.0 | 4.2 | 5.7 | 5.9 | |
| 3 | 9 | Palm | VII | 3.7 | 3.8 | 4.5 | 5.4 | 5.9 | |
| 3 | 9 | Palm | VII | 4.7 | 4.7 | 5.4 | 6.4 | 6.3 | |
| 4 | 9 | Palm | VII | 3.7 | 4.0 | 1.8 | 3.6 | 4.1 | |
| 5 | 1 | | IV | 2.4 | | 0.8 | 2.0 | | Dead |
| 6 | 1 | Cupania | III | 4.1 | | 2.5 | 4.5 | | Dead |
| 6 | 2 | Posequeria | IV | 3.5 | 3.4 | 0.4 | 2.8 | 3.2 | Bent |
| 6 | 7 | Heliconia | V | 4.0 | 4.0 | 1.5 | 3.9 | 4.5 | |
| 6 | 7 | Heliconia | V | 3.0 | | 1.8 | 1.8 | | Dead |
| 6 | 8 | Heliconia | V | 3.4 | 3.4 | 1.8 | 4.2 | 4.7 | |
| 7 | 5 | Heliconia | V | 2.5 | 3.0 | 1.2 | 2.0 | 2.8 | |
| 7 | 5 | Heliconia | V | | | | | | Missing |
| 7 | 7 | Heliconia | V | 3.2 | 3.5 | 1.5 | 1.5 | 2.4 | |
| 7 | 7 | Heliconia | V | 4.0 | 4.1 | 2.1 | 4.5 | 5.0 | |
| 7 | 7 | Heliconia | V | 4.6 | 4.5 | 2.1 | 4.5 | 4.9 | |
| 7 | 7 | Heliconia | V | 4.0 | 4.1 | 2.1 | 4.5 | 5.0 | |
| 7 | 8 | Heliconia | V | 4.2 | | 1.9 | 4.5 | | Dead |
| 7 | 8 | Heliconia | V | 4.0 | | 2.0 | 4.8 | | Dead |
| 7 | 8 | Heliconia | V | 4.0 | | 2.1 | 4.5 | | Dead |
| 7 | 9 | Heliconia | V | 3.7 | | 2.0 | 4.5 | | Dead |

Plot 35[1]

| G6 F6 X | G5 F5 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 8 | Tabebuia | I | 5.0 | 5.6 | 2.5 | 3.9 | 4.9 | |

TABLE A-2. VEGETATION INVENTORY AT ALBROOK FOREST SITE (Cont.)

Plot 35[1] (Continued)

| G6 F6 X | G5 F5 Y | Species[4] | Shape[2] | DBH[3] (cm) 1 Jan 1967 | DBH[3] (cm) 1 Dec 1969 | 1st Branch (m) 1967 | Height (m) 1 Jan 1967 | Height (m) 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | Guazuma | IV | 19.0 | 12.7 | 8.0 | 16.5 | 17.0 | |
| 3 | 7 | Anacardium | I | 8.4 | 9.6 | 3.0 | 6.9 | 7.2 | |
| 5 | 2 | Annona | I | 27.2 | 28.8 | 5.4 | 20.5 | 22.0 | |
| 6 | 2 | Anacardium | I | 17.5 | 20.9 | 3.6 | 15.0 | 16.0 | |
| 6 | 7 | Sapindaceae | I | 9.5 | 10.2 | 3.6 | 9.0 | 10.1 | |
| 6 | 8 | | I | 6.3 | 7.8 | 3.0 | 6.6 | 7.5 | |
| 9 | 1 | Luehea | I | 12.3 | 13.9 | 3.0 | 11.0 | 12.1 | |
| 9 | 5 | | I | | 37.3 | | | 20.5 | Replaced |
| 9 | 8 | Anacardium | I | 86.7 | 94.2 | 10.0 | 33.5 | 33.5 | |

Plot 36[1]

| G7 F7 X | G6 F6 Y | Species | Shape | DBH 1 Jan 1967 | DBH 1 Dec 1969 | 1st Branch 1967 | Height 1 Jan 1967 | Height 1 Dec 1969 | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | Cecropia | III | 20.0 | 32.7 | 12.5 | 16.0 | 16.5 | |
| 0 | 3 | Belotia | III | 5.5 | 10.7 | 3.8 | 6.0 | 7.2 | |
| 1 | 3 | Croton | | | | | | | Chopped |
| 2 | 1 | | II | 3.3 | | 0.8 | 0.8 | | Dead |
| 2 | 3 | | | | | | | | Chopped |
| 3 | 3 | Heliconia | V | 3.7 | 3.9 | 2.0 | 4.2 | 4.5 | |
| 3 | 3 | Heliconia | V | 3.7 | 4.1 | 2.0 | 4.2 | 4.3 | |
| 3 | 7 | | I | 4.8 | 5.1 | 2.5 | 3.6 | 4.2 | |
| 4 | 2 | Croton | IV | 2.7 | | 1.2 | 4.5 | | Dead |
| 5 | 7 | Anacardium | I | | 53.3 | 8.0 | 20.0 | 21.5 | |
| 9 | 4 | Phoebe | III | 4.4 | 4.4 | 3.9 | 5.4 | 6.4 | |
| 9 | 4 | Phoebe | I | 41.6 | 42.9 | 2.9 | 22.0 | 22.5 | |

1. Plots are numbered in order from right to left ascending (see figure A-1).
2. Shape (of the seven representative shapes shown in figure A-7) which most closely resembled the inventoried plant.
3. Diameter at breast height.
4. A blank indicates that the plant species could not be identified.

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## APPENDIX III. GLOSSARY

| | | |
|---|---|---|
| ARPA | = | Advanced Research Projects Agency |
| °C | = | degrees centigrade |
| cm | = | centimeter(s) |
| COH | = | coefficient of haze |
| $CO_2$ | = | carbon dioxide |
| DBH | = | diameter at breast height |
| E | = | east |
| Fe | = | iron |
| °F | = | degrees Fahrenheit |
| km | = | kilometer |
| m | = | meter |
| max | = | maximum |
| mb | = | milibar(s) |
| MDARS | = | Meteorological Data Acquisition and Recording Systems |
| Min | = | minimum |
| mm | = | millimeter(s) |
| Mn | = | manganese |
| mph | = | miles per hour |
| N | = | north |
| NE | = | northeast |
| No. | = | number |
| NW | = | northwest |
| OCRD | = | Office of Chief of Research and Development |
| ppm | = | parts per million |
| RDTE | = | Research, Development, Test, and Evaluation |
| S | = | south |
| SE | = | southeast |
| Sur | = | surface |
| Sq | = | square |
| SW | = | southwest |
| USATTC | = | United States Army Tropic Test Center |
| Var | = | variable |
| W | = | west |
| WES | = | US Army Waterways Experiment Station |
| % | = | percent |
| " | = | inch(es) |