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DIVISION 17

Recordings of Jungle Sounds

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OSRD No. 4704
February 17, 1945

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NATIONAL DEFENSE RESEARCH COMMITTEE

DIVISION 17

SECTION 17.3, ACOUSTICS

OSRD Report No. 4704

February 17, 1945

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RECORDINGS OF JUNGLE SOUNDS

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[illegible] (DATE)
A R Morrison

RUTGERS UNIVERSITY

Contract No. OEMsr-1335

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PREFACE

This report, Recordings of Jungle Sounds, covers part of the work undertaken by Rutgers University under Contract OEMsr-1335 with the Office of Scientific Research and Development.

The Field work back of this report was conducted in the Canal Zone as part of Project SC-105 under the general supervision of the Signal Officer, Panama Canal Department.

We were received by the Army in the Canal Zone with understanding and courtesy; the help needed was given effectively and without stint. In this connection we wish especially to mention Major General G. Ralph Meyer, Brigadier General Phillip E. Gallagher, Colonel George W. Morris, Colonel Franklin I. Pomeroy, Lieutenant Colonel Robert S. Waters, Major James J. Ainsworth, Major Edward M. Browder, Jr., Major Maynard H. Pettit, Major Arthur L. Seabury, Captain Robert A. Aubry, Captain Frederic A. Becker, Captain Willis P. Donkin, First Lieutenant Collins L. Cochran, First Lieutenant Victor M. Gelinas, Sergeant Harold R. Duckworth and to Corporals Roberts, King, Allen, Seip, Haycraft and Sergent who drove our vehicles and made themselves generally useful. Also we are very grateful to Dr. Thomas Barbour and James Zetek for courtesies extended in the use of the facilities on Barro Colorado Island.

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TABLE OF CONTENTS

Introduction 1

Types of jungle where sounds were recorded..... 2 - 6

The production of sound in the animal kingdom.. 6

Number of recordings made..... 7 - 9

Recording technique..... 9 - 10

Basis for selection of equipment..... 10

Characteristics of recording equipment..... 10 - 11

Truck installation..... 11 - 12

Laboratory installation..... 12

Methods of recording..... 12 - 14

Annotated list of the species recorded..... 15 - 33

Script and analysis of the two records accompanying the report..... 34 - 41

Titles and script to accompany the color film.. 42 - 46

List of illustrations..... 47 - 48

List of stations where jungle sounds were recorded, with map..... 49 - 50

Illustrations.....51 - 66

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THE AMBIENT SOUNDS OF THE JUNGLE

by A. A. Allen, P. P. Kellogg and D. G. Allen

I. Introduction

If one were to remain in a fixed spot in the jungle for a year with his ear attuned to the sounds about him, he could not help observing great changes from minute to minute, from day to day, week to week and month to month. The general level of sound would rise and fall, irrespective of its make-up. There would be certain periods of great volume; others of relative quiet. Some of these would be cyclical - others purely random. The object of this report is to offer an analysis of the sounds observed in the jungles of the Canal Zone between October 1944 and January 1945. This period includes the last of the rainy season and the beginning of the dry season.

In addition to the general statements offered, herewith, the report is illustrated with a phonograph record of the general sounds picked up by a microphone set at various times in different types of jungle areas. It is illustrated also by a phonograph record of the constituent parts of the conglomerate sound, picked up by a microphone usually set in a parabolic reflector and carefully aimed at the source of each sound. In each case it was ascertained that the source was close enough and loud enough to be readily identifiable above all other sounds. In each case the source of the sound was definitely traced - the creature making it definitely identified on the spot or collected (in the case of insects and amphibia) to be identified later by a specialist. The scientific names of all creatures recorded and identified accompany this report on pages 15-33; the names of the birds used are those found in Sturgis' "Field Book of the Birds of the Panama Canal Zone" except for those omitted from this book. For these the names are those found in Ridgway's "Birds of North and Middle America". Goldman's "Mammals of Panama" supplies the mammal names and Dunn's "Amphibia of Barro Colorado Island" the names of the amphibia. The insects were identified by Dr. James G. Rehn of the Academy of Natural Sciences of Philadelphia. In the discussion of the jungle types quotations are from Standley's "Flora of the Panama Canal Zone."

~~In classifying~~ jungle sounds, ~~we naturally~~ divide ~~them~~ into those of inanimate and those of animate origin. In some places and at certain times such inanimate sounds as wind or rain, the running water of streams, thunder, the falling of trees or branches, or even the sound of the

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falling leaves of palms or certain other jungle trees may completely outweigh the volume of sound from animate sources. In other places and at other times the inanimate sounds may be insignificant. In selecting places to record the animate sounds, effort was always made to avoid areas or periods where the inanimate sounds were of a high level although at times this was impossible and on the records these other sounds may be noticed in the background. Similarly an attempt was usually made to record only one species of animal at a time but this, also, was often impossible and on most of the records, weaker sounds emanating from sources other than that intended to be illustrated can be heard in the background. Usually, however, these do not interfere with the clarity of the record and merely add a touch of realism to it. It is unfortunate that the mechanical limitations of the microphone preclude an accurate transcription of such sounds as wind and rain, and that the nature of the 40 inch parabola is such as to emphasize sounds of high frequency and sometimes to give a metallic resonance to sounds of low frequency. In recording such sounds as the howling of monkeys, which were of sufficient volume, recordings were made both with and without the parabola. In recording insects and amphibia that could be approached to within a few inches, the parabola was likewise discarded.

II. The types of jungle where sounds were recorded

Except for the two periods (October 17 - November 8, and December 29 - January 16) spent at Barro Colorado Island, all recordings were made within twenty miles of our headquarters at Fort Clayton, Canal Zone. Since most of the trips were northward from Summit in the general region of the Madden Forest, it may be said that most of the recording was done on the Atlantic slope in spite of our headquarters being definitely on the Pacific side. In discussing the Flora of Panama Canal Zone, Standley* recognizes two distinct zones, the Atlantic and the Pacific slopes, the latter being much more arid. Some plants and trees are widespread through both regions, but each region has certain characteristic trees or plants not found in the other. "The high precipitation (on the Atlantic slope) produces a luxuriance of vegetation never equalled on the Pacific slope. The larger and denser trees tend to smother the more humble plants. It thus results that on the dry Pacific slope there is a lesser variety of trees, but a greater abundance of shrubs and a much greater profusion of small herbaceous species. - - - Because of varied physiographic conditions and the influence of human occupation the vegetation of the Atlantic slope is highly diversi-

*Flora of the Panama Canal Zone by Paul C. Standley. Contributions from the United States Herbarium Vol. 27.

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fied in appearance and composition. Comparatively little virgin vegetation remains - - Part of the land now covered with what seems to be untouched forest may have been at some time even under cultivation. Deep in the hills, in what appears to be primeval forest where one could easily believe oneself the first visitor, one often trips over a piece of barbed wire or stumbles upon a rusted tin can...(For over 400 years the area has been dominated by Europeans.) There are still limited tracts of forest within the Zone, notably on the hills near Frijoles, Gamboa and Obispo, where it is possible to form a good idea of what the primeval forest of the Isthmus was like. On Barro Colorado Island, nearly six square miles, chiefly of forest, have been set aside for permanent preservation - - -. A large number of the trees tower to a height of 100 feet or more, with proportionately thick trunks, which frequently are braced with bracketlike buttresses. Other trees, particularly the guarumos (Cecropia) and stilt palms (Iriartea), are strengthened by rigid prop roots, similar to those of maize. This rain forest is exceedingly dense and is composed of a great variety of species belonging to diverse families. Homogeneous forests, formed of one or a few species, rarely exist in tropical American lowlands, and nowhere in Central America is such a formation found in a humid coastal area.

"The trees of these wet Panama forests are so tall that it is difficult to determine their identity, except in the case of a few with distinctive foliage.- - -"In the wet forest there are distinct tiers of vegetation. Beneath the tallest trees lower ones of other kinds find space for expansion - - the palms, most of which find in the deep shade their favorite habitat. A few of the palms thrust their crowns above the forest roof, but most of them are of humbler stature.

"The diversity and relative abundance of palms and tree ferns is an excellent criterion for estimating the true nature of the forest - whether it has ever been cut or not. These, for the most part, are plants that cannot endure strong sunlight, and when the original forest is once cut over they do not soon reestablish themselves in the second growth that springs up immediately and outwardly simulates a true virgin forest.

"Beneath the trees are thickets of shrubs, representing a wide range of families - - -. The shrubs in the hilly forest frequently form only a sparse growth, but again they may be interlaced so intricately as to be almost impenetrable. In some localities one may traverse the forest almost at will without disturbing the bushes, but in others close by it is

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necessary to cut a trail with a machete almost every foot of the way, especially when the shrubbery is overgrown with such vines as Smilax.

"The herbaceous vegetation of the forest is relatively unimportant - - - -. Lianas, or coarse woody vines, form a picturesque element of the forest, and often a serious impediment to the explorer. Most of them have comparatively slender and flexible woody stems, quite naked below but climbing to the tops of the higher trees, where they expand their foliage and inflorescences. The stems seldom adhere closely to the tree trunks but more commonly dangle loosely from the branches.- -

"Epiphytes likewise contribute an important element to the forest vegetation. There is scarcely a single large tree which does not bear a heavy load of epiphytic plants clinging to its trunk and branches.- - - Certain bromeliads also attain an immense size.- - -The bromeliads are important because their leaves usually have enlarged or inflated bases in which water collects, thus affording breeding places for mosquitoes. Other animals also find shelter among the leaves. - - -

"One of the most characteristic features of these wet lowland forests is the absence of color other than green. Usually not a small showy flower is visible in any direction - -. If the trees have brilliant flowers they are borne on the upper part of the crown, so that only when a forested hillside is viewed from a distance are the flower-decked trees conspicuous----

- - -"Another distinct type of vegetation is that occupying land recently under cultivation but now abandoned. In the tierra caliente of tropical America the usual method of agriculture is to clear a tract of land, plant it for a few years until the soil is exhausted, then abandon it and clear a new field for cultivation. This practice is followed about the Canal Zone. Fallow fields soon are overgrown with coarse weedy shrubs and herbs - - -. In such places guarumo trees (Cecropia) form a dominant feature of the landscape."

That in general is the jungle as described by Paul Standley in the "Flora of the Panama Canal Zone". It might be added that a moderate change occurs in the general character of the jungle with the coming of the dry season. Certain of the largest jungle trees like the cuipo, bombax and bombacopsis shed their leaves and thereby admit much more light to the jungle floor. The dead leaves are not washed away as in the wet season so that a certain amount of litter accumulates. These changes naturally affect the background sounds but since they are not at all commensurate with the augmented volume of sound from species of insects and birds that start

calling in the dry season, any difference arising from the opening up of the jungle or the leaves on the jungle floor is not noticeable.

In making our recordings of the ambient sounds of the jungle we tried to keep in mind the diverse nature of the forest and visit all types with our recording equipment. Fortunately during the past three years the Army has greatly extended and improved the roads leading to various gun and searchlight positions and thereby made available to our sound truck (described below) all of the jungle types mentioned by Standley and many intermediate types. Indeed most of them were visited many times for altogether 50 trips were made with the sound truck for the purpose of recording in addition to the five weeks of almost continuous recording in the jungle of Barro Colorado Island. The roads to which we were largely confined by the truck have both advantages and disadvantages. Even where the roads have been cut through almost virgin timber, the admission of sunlight stimulates the growth of cecropias, heliconias and climbing bamboos and other second growth along the roadside so as to make an almost impenetrable thicket and hide from view the authors of the numerous sounds emanating from the main jungle. On the other hand, the jungle border always maintains a much higher concentration of bird and animal life than the middle of the jungle and this becomes available to the sound truck. It is not always possible, however, to judge the content of the jungle from what one can see from the road. Indeed the bird calls are often more indicative of the age of the jungle than the vegetation for certain species like the motmots, chestnut headed tinamou and Panama antthrush definitely belong to the deep jungle while others like the thrush tanager, Panama wren, tyrannine antshrike and black-crested antshrike are birds of the second growth just as the robins, blue tanagers mockingbirds, great-tailed grackles and ground doves are usually found about houses and gardens.

On the other hand, many species are rather adaptable and wander through jungles of all types or may be seen flying across open spaces to isolated trees which offer them food or resting places - such are the orioles of various species and especially the caciques and oropendulas, the parrots and even the toucans. The same is apparently true of the mammals - howling monkeys, tapirs, and ocelots are jungle species while armadillos, opossums, and coatis wander about rather indiscriminately. In the case of insects, also, certain species are widespread while some are confined to one type of habitat or one species of food tree.

There are certain other factors also which control the

amount of animate sound in the jungle. Many species are greatly affected by meteorological conditions and confine their calls largely to certain temperatures in the case of insects, or to certain degrees of humidity in the case of amphibia while heavy showers may cause all bird life to become inactive. Some species call entirely at night, some early in the morning and some only during the heat of the day. Some animals call from the ground, some from the tree tops and some only in flight; some consistently stay in one place while calling and others move about so that the resulting volume of sound at any one spot available to the microphone varies greatly from day to day or even minute to minute.

The songs of birds and the calls of insects and amphibia are primarily indications of the breeding season and, since this period is of comparatively short duration and for each individual occurs only once a year, the major sounds produced by them are distinctly cyclical. In the tropics, however, there is not the concentration of breeding seasons of many species into a few months that one finds in Northern latitudes. While the peak of the breeding season for birds for example, probably occurs in April there are some birds nesting every month of the year and the main period extends from February to July. In the case of amphibia, the breeding seasons and resulting calls seem even less regular than with birds and more dependent on water conditions. Even in one spot like Barro Colorado Island all individuals of one species do not seem to come into breeding activity at the same time, as they do in Northern latitudes, with the result that there will be feverish activity and lots of singing for a few days followed by a lapse of a week or more with no activity. This all helps to make the general picture of animate sound in the jungle rather complicated.

III. The production of sound in the animal kingdom is of two general types - mechanical and vocal. Insects (especially the Orthoptera) produce their sounds usually by rubbing together the inner margins of their wings which are provided with files and resonators to produce the characteristic sounds. Certain birds make drumming or rattling sound with their wings or beaks to supplement or replace song. The Panama crested curassow fans the air with his wings to produce a drumming sound. The manakins have the shafts of their wing feathers enlarged so that they strike one another in flight to produce a crackling sound. Most animate sounds, however, are produced by the vibration of membranes located in the respiratory system and often augmented by vocal sacs or other sounding board devices. With mammals the vocal chords are located in the larynx at the upper end of the

trachea and the howling monkeys have a curious development of the hyoid bones supporting the tongue which acts like a "loud speaker". With birds, on the other hand, the vibrating membranes are located in the syrinx at the lower end of the trachea and the membranes are controlled by a varying number of muscles. Most birds do not have definite resonance chambers though some do, and all birds have a great series of air chambers connecting with the trachea and located in every available space in the body. Amphibia produce their calls likewise with the aid of vocal sacs as resonators which may be located on the throat, sides of the neck, or even on the sides of the body. Since they have no muscles controlling the "vocal chords" their calls are relatively simple.

For many obvious reasons it has been impossible to secure records of the songs and calls of all the animals of Panama in the time alotted this project. Many of them do not call in the wet season - others are of local distribution and were not found in the area worked or their calls are so weak or so sporadic that they could be recorded only by chance. Unquestionably some of the recordings are much more representative of the species than others, but an effort was made to record all of the animate sounds available in the jungle and the jungle borders. No work was done, however, in the marshes or the savannas. Some species were recorded only once; others several times in an effort to improve on earlier recordings.

Altogether recordings have been made on 57 double faced records which will require 23 hours of constant playing time. These recordings represent 95 species of which 78 are birds, 4 are mammals, 9 are amphibia and 4 are insects. In addition of course, a small part of the recording is of the general background in different spots where work was done. Some of these recordings represent just a minute or so at daybreak or shortly thereafter; others represent a series of recordings made with the microphone at a definite spot during a 24 hour period. There will likewise be found on the discs recordings of a few inanimate sounds such as wind, rain, thunder and running water as well as airplanes, locomotives, motorboats, etc.

In the case of birds there are a few calls that have not been definitely identified although many efforts were made to find the author of the notes. It was not uncommon to record a distinctive song in the tree tops or in the thick jungle in a few minutes - and then spend several hours trying to see definitely the bird that produced the sound. In the case of the shrike-vireo several weeks elapsed before the bird was actually seen giving the notes that had been previously

recorded. This bird frequents the tops of the tallest jungle trees. Every effort has been made to eliminate errors but there is a possibility that in a few cases where a sound was heard only once or twice that our identification may be at fault.

Most of the insects recorded are night singers and while it was not difficult in most cases to approach within a few inches with the microphone and get the recording, it was often difficult with the flashlights to find the singer and catch him. The slightest disturbance of the vegetation would usually cause the singer to stop and then, likely as not, there would be several other insects in the vicinity any of which might be the author of the sound.

Attempts were made to cage the insects and get them to call in captivity and this was sometimes successful and resulted in specimens that could be definitely identified. Even with a daytime singer, such as the "petey-dink" cricket, the author of the call was a mystery for weeks after it had been recorded because it always calls from beneath a mat of ground vegetation and the slightest disturbance of this or even footsteps in the vicinity cause him to discontinue calling. The abundance and variety of insect calls during the wet season when we were working was remarkably low compared with those of the fall of the year in the Northern latitudes. This does not mean that there is any shortage of crickets and grasshoppers and katydids that make the September nights so resonant in the United States but merely that their breeding season had not arrived. Dozens of species were captured and caged in the hope that they might call but few did.

The same was more or less true of the amphibia; many specimens were captured that never gave voice to a note and the only successful recordings were made by waiting, microphone in hand, in the vicinity of a specimen that had been heard calling, until it called again. Sometimes this was on the floor of the jungle, sometimes at the edge of a pond, sometimes in the middle of a pond and one species was found in a "foxhole" he had dug for himself under the dense grass twenty feet from the margin of a pool.

With regard to mammals the majority of species call so infrequently that recording their voices outside of a zoological park would probably be impossible. Monkeys and especially howling monkeys are the exception and considerable time was spent recording their calls with and without the parabola. It was possible also to record the squeaky calls of coatis

on Barro Colorado Island as they quarreled about a feeding station, the chatters of the white faced monkeys and the shrill squeaks of the marmosets.

By far the greater part of our time was spent recording the songs and calls of birds. Since very few birds nest during the wet season, there was little activity during the first part of our stay, but by December more and more birds started singing so that we have a fair representation of the songs and calls of Panama birds. Some of the commonest species, however, like the Panama robin (Bonaparte's thrush) that have distinctive songs were not recorded for the reason that they do not sing until the advent of the breeding season and we left before that started.

Most of the singing of birds occurs between the hours of six and eight in the morning, and it is light enough to see birds by 6:15. Each morning, therefore, for over 50 of those spent in Panama we arose at 4:30 a.m. so as to be at our destination set up and ready to record by six. Usually singing had entirely stopped by 9:30 at which time we usually ceased our efforts and returned to headquarters. The afternoons were usually spent exploring for new places to record, photographing or repairing apparatus. Occasionally trips for recording were made in the late afternoon or evening for insects and night birds although the only night bird voices secured were those of the Parauque and the Spectacled Owl.

On Barro Colorado the recording apparatus was permanently installed in the laboratory during the period of our stay and the 700 feet of cable stretched out into the jungle so that recordings could be made at any time of the day or night. At Fort Clayton, however, we were dependent upon Army vehicles and drivers and while every consideration was given to our wishes we scarcely felt like keeping the drivers on a 24 hour schedule.

Recording technique

The Recording Medium was acetate-coated aluminum disks 16 inches in diameter, run at 33-1/3 or 78 r.p.m. The recording equipment consisted of a Presto 6-N recorder, a Presto 85-E amplifier with automatic equalization, a Presto 40-A preamplifier, Western Electric 630-A microphones, a forty inch diameter, ten inch focal length aluminum paraboloid, furnished by Sperry Gyroscope Corporation, 700 feet of shielded microphone cable on a reel, a primary power supply of twenty storage batteries, dc-ac converters, dry batteries and other

auxiliary equipment which will be described later.

Basis for Selection. Film and wire or tape recording were considered for the medium. Each had advantages. The film recording was rejected because of the probable difficulties with humidity and because of the length of time which would necessarily be required for processing and thus for learning if a recording had been satisfactorily made. Wire and tape were ruled out either because of the quality of available equipment or because high quality equipment was not yet developed to a state where it was dependable for use far from the home base. The factors which caused us to decide on Presto disc recording equipment were as follows, in their approximate order of importance:

1. Presto equipment has had wide distribution for many years and many of the difficulties inherent in recorders have been worked out: we felt that for this reason the equipment would probably run a better chance of standing up under the trying use to which we planned to put it.

2. Ability to hear immediately a recording while there was still a possibility of remaking it appealed to us strongly.

Characteristics of Recording Equipment. Overall frequency characteristics compare favorably with those achieved in modern broadcasts. The volume range is perhaps only about 40 decibels depending on the amount of noise tolerated.

Under carefully controlled laboratory conditions the frequency response is down only about 3 decibels at 10,000 cycles, and the volume range above the noise is at least that mentioned above. Under field conditions temperature and dust reduce the quality. Temperatures above 70°F definitely reduce the frequency response while the noise from dust particles which have settled on the disc cause a greater amount of noise at high frequencies and thus in effect limit the possibility of recording the higher frequencies. This same dust limits the amount of amplification on reproduction if the "scratch" noise is to be kept low, and thus reduces the volume range.

The forty inch parabola used primarily for recording bird voices at a distance, definitely favors the higher frequencies. With most birds and amphibians this distortion is not objectionable since it is unusual for a bird or amphibian to have a frequency range of as much as an octave, and in this small range the distortion is not more than a few decibels which is usually unnoticeable.

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When recording mammal voices such as the howling monkeys, the distortion caused by accentuating the high frequency components was very noticeable and gave a "tinny" quality to the recording. These and similar wide band sounds were recorded without the parabola.

The advantage of using a parabolic reflector was such that for most bird songs, a gain of from ten to twenty-five decibels resulted, depending on the frequency of the song. This made it possible to record the voice of a bird, under good conditions, when the singer was as much as 150 feet from the microphone. Without the reflector, most birds' voices at such a distance would be barely distinguishable above the other sounds of the jungle.

Arrangement of Equipment. Since maximum flexibility of arrangement was needed in order to permit us to record sounds remote from civilization, considerable attention was given to this problem.

TRUCK INSTALLATION. A primary installation for field work was made in a standard 1-1/2 ton Chevrolet Army truck with tarpaulin cover. Twenty six-volt, heavy duty storage batteries, 150 ah capacity were installed across the forward end of the load space of the truck. These were held in place by a wooden framework. Above the batteries on the starboard side were mounted two chargers of 12 battery capacity each. These chargers were designed to operate on 25 or 60 cycle, 110 volt alternating current. These chargers were connected to the batteries through a switch which made it a simple and convenient matter to charge the batteries whenever current was available. Usually this occurred every night but the drain was low enough so that the equipment could operate for twenty-four hours or more without recharging, which would suffice for about four days of normal operation.

The recorder and amplifier were mounted on a 27" wide shelf extending from the battery compartment to the rear of the truck on the port side. This shelf was supported with "Lord" shock insulating mounts which helped some in taking up the heaviest jolts.

Beneath the shelf were two eighteen inch square, three inch deep drawers for storing unused and used discs. There was also a smaller drawer for tools.

Seven hundred feet of two conductor, shielded, rubber-covered, heavy duty microphone cable was carried on an 18 inch metal reel permanently mounted near the rear on the starboard side of the truck.

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One mile of W-130 assault wire was carried on two reels just forward of the microphone cable reel. This wire could be used as a communication line between the microphone and the recorder, or it could be used to carry amplified signal between the pre-amplifier and the power amplifier as will be explained.

Over the batteries, midway between their tops and the roof, was a shelf used to carry the box containing spare parts, microphones and microscope. Other auxiliary equipment such as cameras was carried there.

A bench for the recording operator and a stool for the microphone man occupied the central part of the floor space in transit.

The parabolic reflector was carried inside the truck strapped to the ceiling. The tripod for the reflector was strapped into its socket near the cable reel.

Two army field telephones were carried for communication.

Two small portable "walkie-talkie" type radio sets were carried at times to aid in reconnaisance work but were not used.

LABORATORY INSTALLATION. In the work on Barro Colorado Island it was impractical to use the truck or to transport the heavy equipment over the rugged trails. Here the problem was solved by installing all of the equipment except the microphone and parabola in the laboratory where 110 volt, 60 cycle alternating current was available. The microphone could then be taken out in any direction for a distance of 700 feet and the work co-ordinated by field telephone. In event that it was necessary to work farther from the laboratory than 700 feet, it was planned to take the preamplifier into the jungle up to two miles, sending the signal back over a pair of W-130 wires. The preamplifier used this way would be operated directly from batteries and its gain of approximately 60 decibels is more than sufficient to send the signal without interference over several miles of line, especially in an area where electrical interference is low. (This, however, proved unnecessary) With the preamplifier close to the subject, and easily moved, a fifty foot microphone cable was sometimes used in place of the 700 foot cable.

How the Recording Equipment Was Used.

With the Truck. Since the hour of change from darkness to

daylight is usually accompanied by activity in the animal kingdom, we tried to be on the spot selected for recording, and ready to record, during this period. Usually this time of day is auspicious too because there is likely to be more song, while wind and man-made noises are likely to be at a minimum. In order to keep this appointment, the recording group usually arose at 0430 (fifth zone time) and tried to be on the road not later than 0500. We arrived at the chosen spot before 0600 and within ten minutes, were ready to record. Bright stars, such as Sirius and Betelgeux, were still visible at 0615 during November and December, but passing cars still burned headlights. The first bird voices were usually heard between 0600 and 0615.

The locations for recording were selected in advance by reconnaisance in a jeep. Effort was made to have all types of jungle represented and to return to each type spot until we felt that we had about exhausted its possibilities at that season.

In choosing a location, care had to be exercised to avoid naturally noisy situations, such as proximity to rushing streams or waterfalls, busy roads, road construction areas, practice firing ranges or beach areas with surf. The side of a hill sloping towards a noisy location, although the source of the noise might be several miles away, was found to be particularly unsuited to our purposes as the sounds had a tendency to travel up the hill, or so it seemed. Usually the spot selected was a wide place in some little used road such as a road leading to a gun position or searchlight. It was desirable to have trails leading from the road, near where the truck was parked, back into the jungle.

The usual recording crew consisted of three plus the driver. The equipment may be effectively operated by a crew of two, but there was a very distinct advantage in having three. This resulted from the fact that a bird singing close to the edge of the jungle was often recorded without ever being seen. The third man's responsibility was to follow this song, several hours if necessary until the singer was definitely seen and identified. When identification was doubtful, an effort was made to collect the bird.

Upon reaching the location selected for study, the truck was parked on the most level ground available. The parabolic reflector, the tripod and microphone were handed to the field man who took these three items and the end of the microphone cable from the reel on the back of the truck and walked to the most likely looking spot for picking up the sound in which

we were at the moment interested.

While the microphone was being placed and connected to the cable, the man in the truck unpacked the recording equipment, which had to be carefully secured and protected against the rough-riding characteristics of the truck, leveled the turntable by means of wedges and a level, started the converter which changed the 115 volts d.c. to 115 volts a.c., checked frequency, checked amplifiers, and connected the microphone cable to the preamplifier. The entire process of setting up the equipment from the time the truck stopped until we were ready to record required less than ten minutes.

Whenever the microphone was placed more than a few hundred feet from the recording truck, or whenever the truck could not be seen from the microphone, a standard army field telephone was used with W-130 assault wire connecting the two points.

For warning everyone to be quiet while a recording was being made, a signal flag on the truck was raised during the recording.

Recording from a Fixed Station. On a location such as Barro Colorado Island, it was impractical to take the heavy recording equipment into the jungle because of its weight and the rugged nature of the terrain. In this instance when it was desirable to record beyond 750 feet from the laboratory, it was planned to keep the recorder and main amplifier in the laboratory buildings and operate from the available 115 volt a.c. supply. The microphone, parabola, tripod and preamplifier were to be taken into the jungle and the preamplifier operated from dry batteries. A line of W-130 twisted pair assault wire was to be used to carry the output of the preamplifier to the laboratory. This wire could be easily carried on reels mounted on special pack boards which enabled it to be laid as the carrier walked along the trail. This plan, however, never went beyond the experimental stage. It was found to be practical but proved to be unnecessary as all of the jungle sounds were discovered within reach of the regular cable.

ANNOTATED LIST OF THE SPECIES OF

BIRDS, MAMMALS, AMPHIBIANS AND INSECTS

recorded under

OSRD Contract Number OEMsr-1335

and

Service Control Number S.C. 105

between

October 18, 1944 and January 20, 1945

Giving all references to the original recordings and the disks upon which the sounds were rerecorded in the laboratory.

Chestnut-headed Tinamou
Tinamus major castaneiceps, Salvadori
Range: Southwestern Costa Rica and Pacific slope of Panama to Darien.
Habitat: Terrestrial in deep jungle.
Rerecorded on to disk number 77, cuts 1 to 5.
Quality: Good to fair.
Original recordings made at Station 12, January 8, 1945

Pileated Tinamou "Perdiz de Rastrogo"
Crypturellus soui panamensis (Cabanis)
Range: Canal Zone to Darien; Pearl Islands
Habitat: Edge of jungle - terrestrial.
Rerecorded on to disk number 77, cuts 6 & 7;and 78, cuts 1 & 2
Quality: 3 excellent, 1 good
Original recordings made at Station 14, November 24, 1944 and at Station 6, December 15, 1944

Crested Guan. "Pavon"
Penelope purpurascens aequatorales (Linnaeus)
Range: Nicaragua south along the Pacific coast of Colombia to Ecuador
Habitat: Large trees of the jungle
Rerecorded on to disk number 78, cut 3 and 79, cuts 1 to 3.
Quality: Excellent
Original recordings made at Station 12, November 8, 1944

Gray-headed Guan. Chachalaca. "Faisana"
Ortalis garrula cinereiceps (Gray)
Range: Southern Costa Rica south and east to Darien: Pearl Islands
Habitat: Edge of the jungle and second growth.
Rerecorded on to disk number 80, cuts 1 to 3.
Quality: Excellent
Original recordings made at Station 2, December 17, 1944 and at Station 13, January 16, 1945

Scaled Pigeon. "Paloma de Montaña"
Columba speciosa (Gmelin)
Range: Tropical America, Vera Cruz to Peru, eastern Bolivia, Matto Grosso and Santa Catharina
Habitat: Forests, usually seen in tree tops or flying over.
Rerecorded on to disk number 80, cuts 4 and 5.
Quality: Fair
Original recordings made at Station 3, November 29, 1944

Blue Ground Dove "Cococha"
Claravis pretiosa (Ferrari-Perez)
Range: Southeastern Mexico to Peru, Bolivia, N.Argentina and S. Brazil.
Habitat: Second growth jungle and plantations
Rerecorded on to disk number 80, cut 6
Quality: Good
Original recordings made at Station 5, December 13, 1944

Verreaux's Dove "Paloma Rabiblanca"
Leptotila verreauxi verreauxi (Bonaparte)
Range: Southwestern Nicaragua to northern Colombia and Venezuela.
Habitat: Second growth jungle and roadsides.
Rerecorded on to disk number 80, cuts 7 & 8.
Quality: Fair
Original recordings made at Station 4, December 1, 1944.

Spectacled Owl
Pulsatrix perspicillata Chapmani (Latham)
Range: Eastern Costa Rica to western Ecuador
Habitat: Mature jungle.
Rerecorded on to disk number 81, cut 1
Quality: Good
Original recordings made at Station 12, January 12, 1945

Tovi Parrakeet. "Perice"
Brotogeris j. jugularis (Müller)
Range: Arid tropical zone of Southwestern Mexico to N. Colombia
Habitat: Second growth jungle and vicinity of habitations.
Rerecorded on to disk number 81, cuts 2 and 3.
Quality: Good
Original recordings made at Station 6, November 2 and December 9, 1944.

Plain-colored Parrot. "Loro"
Amazona farinosa inornata (Salvadori)
Range: Panama and Northwestern South America, Ecuador & Venezuela
Habitat: Largely tree tops of mature jungle.
Rerecorded on to disk number 81, cut 4.
Quality: Excellent
Original recordings made at Station 12, January 10, 1945

Blue-headed Parrot. "Casanga"
Pionus menstruus (Linnaeus)
Range: Southeastern Costa Rica to Peru, Bolivia, Matto Grosso and Trinidad
Habitat: Tree tops - mostly of mature jungle
Rerecorded on to disk number 81, cuts 5 and 6
Quality: Fair
Original recordings made at Station 12, November 8 and January 12.

Great Rufous Motmot
Baryphthengus martii semirufa (Sclater)
Range: Eastern Nicaragua to northwestern Ecuador
Habitat: Lower story of the mature jungle
Rerecorded on to disk number 82, cut 2
Quality: Good
Original recordings made at Station 12, January 2, 1945

Lesser Broadbilled Motmot
Electron platyrhynchus minor (Hartert)
Range: Eastern Nicaragua to Panama
Habitat: Lower story of mature jungle
Rerecorded on to disk number 81, cuts 7 & 8 and 82 cut 1.
Quality: Excellent
Original recordings made at Station 12, January 7, 1945

Parauque
Nyctidromus albicollis albicollis (Gmelin)
Range: Tropical Central and South America from W. Guatemala and Honduras to Peru and Brazil
Habitat: Edge of the jungle
Rerecorded on to disk number 82, cuts 3 & 4.
Quality: Excellent.
Original recordings made at Station 10, December 16, 1944 and Station 6, January 18, 1945

Graceful Trogon
Trogonurus curucui tenellus (Cabanis)
Range: Southeastern Honduras to Panama
Habitat: Mature and second growth jungle
Rerecorded on to disk number 83 cuts 1 and 2
Quality: Excellent
Original recordings made at Station 7, November 20, 1944 and Station 12, January 4, 1945

Gartered Trogon
Chrysotrogon caligatus (Gould)
Range: Southeastern Mexico to Northern Peru
Habitat: Mature and second growth jungle.
Rerecorded on to disk number 83, cuts 3, 4 and 5.
Quality: Excellent.
Original recordings made at Station 5, December 12, 1944

White-tailed Trogon
Trogon strigilatus chionurus (Sclater and Salvin)
Range: Eastern Panama to Western Ecuador
Habitat: Middle growth of mature jungle and jungle borders.
Rerecorded on to disk number 84, cuts 1 and 2
Quality: Good
Original recordings made at Station 12, January 10, 1945.

Large-tailed Trogon
Curucujus malanurus macrourus (Gould)
Range: Eastern Panama and Colombia
Habitat: Mature jungle and jungle borders
Rerecorded on to disk number 84, cut 3.
Quality: Good
Original recordings made at Station 13, December 9, 1944

Massena Trogon
Curucujus massena massena (Gould)
Range: Southeastern Mexico to Panama
Habitat: Mature jungle, middle growth
Rerecorded on to disk number 85, cut 1
Quality: Good
Original recordings made at Station 8, December 7, 1944.

Short-keeled Toucan
Rhamphastos piscivorus brevicarinatus (Gould)
Range: Southern Honduras to Venezuela and Trinidad
Habitat: Treetops of mature jungle.
Rerecorded on to disk number 85 cuts 2 and 3.
Quality: Excellent
Original recordings made at Station 12, November 1, 1944 and January 12, 1945.

Swainson's Toucan
Rhamphastos swainsonii Gould
Range: Southern Honduras to Ecuador and Venezuela
Habitat: Tree tops of mature jungle
Rerecorded on to disk number 85, cuts 4, 5 and 6.
Quality: Good
Original recordings made at Station 12, October 30 and November 9, 1944 and January 13, 1945.

Collared Aracari Toucan
Pteroglossus torquatus torquatus (Gmelin)
Range: Southeastern Mexico to Panama
Habitat: Tree tops of mature and second growth jungle.
Rerecorded on to disk number 86, cuts 3 and 4.
Quality: Fair
Original recordings made at Station 12, January 4 and 12, 1945.

Pucheran's Woodpecker
Tripsurus pucherani pucherani (Malherbe)
Range: Southeastern Honduras to Central and Western Ecuador
Habitat: Jungle borders
Rerecorded on to disk number 86, cut 5.
Quality: Fair
Original recordings made at Station 6, December 15, 1944

Malherbe's Woodpecker
Scapaneus malherbii (Gray)
Range: Panama, Colombia and Venezuela
Habitat: Mature jungle and about clearings.
Rerecorded on to disks number 86, cuts 6 & 7 and 87, cut 1
Quality: Fair
Original recordings made at Station 12, November 1; Station 4, December 1, 1944 and Station 12, January 6, 1945

Panama Pileated Woodpecker
Ceophlaeus lineatus mesorhynchus (Cabanis and Heine)
Range:. Central and southern Costa Rica to the Santa Marta district of Colombia.
Habitat: Mature jungle and edge of clearings.
Rerecorded on to disk number 87, out 2
Quality: Fair
Original recordings made at Station 9, December 4, 1944

Fasciated Antshrike
Cymbilaimus lineatus fasciatus Ridgway
Range: Nicaragua to Northern Peru
Habitat: Undergrowth of jungle edges and roadsides
Rerecorded on to disk number 87, cut 3
Quality: Fair
Original recordings made at Station 6, December 19, 1944

Black-crested Antshrike
Thamnophilus doliatus nigricristatus (Lawrence)
Range: Panama and Caribbean coast of Colombia
Habitat: Edge of jungle and roadside in the undergrowth
Rerecorded on to disk number 87, cuts 4 and 5.
Quality: Good
Original recordings made at Station 5, November 27, 1944 and December 12, 1944

Slaty Antshrike
Thamnophilus punctatus atrinuchus (Salvin and Godman)
Range: British Honduras to Western Ecuador
Habitat: Undergrowth of jungle borders and clearings.
Rerecorded on to disk number 87, cut 7.
Quality: Excellent
Original recordings made at Station 6, December 15, 1944

Tyrannine Antbird
Cercomacra tyrannine rufiventris
Range: Panama to Northern Brazil
Habitat: Undergrowth of jungle edges and clearings
Rerecorded on to disk number 87, cut 7 and 88,cut 1
Quality: Excellent
Original recordings made at Station 13, November 23, 1944 and Station 7, December 21, 1944

White-bellied Antbird
Myrmeciza longipes panamensis Ridgway
Range: Panama to Northeastern Colombia
Habitat: Floor of second growth jungle
Rerecorded on to disk number 88, cuts 2 and 3.
Quality: Excellent
Original recordings made at Station 15, November 21, 1944 and Station 5, November 27, 1944

Sclater's Antbird
Myrmeciza exsul exsul Sclater
Range: Panama, Costa Rica and Nicaragua
Habitat: Floor of mature jungle
Rerecorded on to disk number 88, cut 4 & 5 and 89, cut 1
Quality: Excellent
Original recordings made at Station 8, December 7, 1944 and
Station 12, October 25, 1944

Panama Antthrush
Formicarius analis panamensis Ridgway
Range: Panama and Colombia
Habitat: Floor of mature jungle
Rerecorded on to disk number 89, cuts 4 & 5
Quality: Excellent
Original recordings made at Station 12, October 28, 1944

Lawrence's Antpitta
Hylopezus perspicillatus perspicillatus (Lawrence)
Range: Panama
Habitat: Floor of mature jungle
Rerecorded on to disk number 89, cuts 2 & 3
Quality: Excellent
Original recordings made at Station 10, December 2, 1944

Lineated Xenicopsis
Xenicopsis (Xenoctistes) subalaris lineatus (Lawrence)
Range: Costa Rica and Panama
Habitat: Lower growth of mature jungle
Rerecorded on to disk number 90, cuts 1 to 4
Quality: Good
Original recordings made at Station 9, January 15, 1944.

Panama Ruddy Dendrocincla (not definitely identified)
Dendrocincla homochroa ruficeps (Sclater and Salvin)
Range: Panama
Habitat: Tree trunks of mature jungle
Rerecorded on to disk number 91, cut 1.
Quality: Fair
Original recordings made at Station 12, January 7, 1945

Streaked-headed Woodhewer (Some question as to identification)
Lepidocolaptes albolineatus albolineatus (Lawrence) =
Picolaptes lineaticeps lineaticeps Lafresnaye of Ridgway
Range: Eastern Panama
Habitat: Tree trunks of mature jungle
Rerecorded on to disk number 91, cut 2.
Quality: Good
Original recordings made at Station 7, November 16, 1944

Riker's Yellow-crowned Tyrannulet
Tyrannulus elatus reguloides (Ridgway)
Range: Panama to the Peru and the Amazon Valley
Habitat: Second growth and about habitations
Rerecorded on to disk number 91, cut 3
Quality: Good
Original recordings made at Station 12, November 1, 1944

Colombian Flycatcher
Myiozetetes similis columbianus (Cabanis and Heine)
Range: Honduras to Eastern Peru
Habitat: Jungle borders and roadsides
Rerecorded on to disk number 91, cuts 4, 5 and 6.
Quality: Fair
Original recordings made at Station 12, November 6, 1944.

Noble Flycatcher.
Myiodynastes maculatus nobilis (Sclater)
Range: Costa Rica to Ecuador
Habitat: Jungle borders and clearings
Rerecorded on to disk number 91, cut 7.
Quality: Poor
Original recordings made at Station 13, December 9, 1944

Boat-billed Flycatcher
Megarhynchus pitangua mexicanus (Lafresnaye)
Range: Southeastern Mexico to Panama
Habitat: Jungle borders and roadsides
Rerecorded on to disk number 91, cut 8.
Quality: Poor
Original recordings made at Station 13, December 9, 1944

Short-legged Wood Pewee
Myiochanes brachytarsus brachytarsus (Sclater)
Range: Southeastern Mexico to Argentina
Habitat: Jungle and jungle borders
Rerecorded on to disk number 92, cuts 1 and 2
Quality: Fair
Original recordings made at Station 14, November 23, 1944

Red-headed Manakin
Pipra mentalis ignifera Bangs
Range: Costa Rica and Panama
Habitat: Lower growth of mature jungle
Rerecorded on to disk number 92, cuts 3 and 4
Quality: Good
Original recordings made at Station 12, January 4, 1945

Sharp-tailed Manakin
Chiroxiphia lanceolata Sclater
Range: Panama to Venezuela and Trinidad
Habitat: Low jungle, second growth
Rerecorded on to disk number 92, cut 5.
Quality: Fair
Original recordings made at Station 3, November 29, 1944.

Sclater's Attila
Attila spadicens sclateri Lawrence =
Attila citreopygus citreopygus (Bonaparte) of Ridgway
Range: Eastern Nicaragua to Eastern Ecuador
Habitat: Treetops of the mature jungle
Rerecorded on to disk number 93, cuts 1 to 3.
Quality: Good
Original recordings made at Station 8, January 19, 1945 and December 7, 1944

Purple-throated Fruit Crow
Querula purpurata (Müller)
Range: Costa Rica to Eastern Peru
Habitat: Tree tops of mature jungle
Rerecorded on to disk number 93, cuts 4 to 6
Quality: Fair
Original recordings made at Station 12, November 6, 1944; Station 9, November 28, 1944 and Station 12, January 12, 1945

Panama Wren
Thryophilus modestus elutus Bangs
Range: Panama
Habitat: Second growth brush - jungle borders and roadsides
Rerecorded on to disk number 93, cut 7.
Quality: Fair
Original recordings made at Station 4, December 11, 1944

Panama Black-billed (bellied) Wren
Pheugopedius fasciato-ventris albigularis (Sclater)
Range: Panama and N. Colombia to Santa Marta
Habitat: Undergrowth of the jungle and jungle border
Rerecorded on to disk number 93, cut 8 and 94, cuts 1 & 2.
Quality: Good
Original recordings made at Station 15, November 21, 1944

Tawny-bellied Wren
Pheugopedius hyperythrus (Salvin and Godman)
Range: Western Costa Rica and Panama
Habitat: Undergrowth of jungle
Rerecorded on to disk number 94, cuts 3 & 4
Quality: Fair
Original recordings made at Station 2, November 26, 1944

Panama House Wren
Troglodytes musculus inquietus (Baird)
Range: Panama
Habitat: Vicinity of habitations
Rerecorded on to disk number 94, cut 7
Quality: Poor
Original recordings made at Station 1, January 14, 1945

Sclater's Wood Wren
Henicorhina p. prostheleuca (Sclater)= H.p.pittieri (Cherrie) of Ridgway
Range: Costa Rica to Panama
Habitat: Undergrowth of jungle
Rerecorded on to disk number 94, cut 5
Quality: Good
Original recordings made at Station 9, November 28, 1944

Lawrence's Musician Wren
Leucolepis phaeocephalus lawrencei (Sclater) =
L. lawrencii (Sclater) of Ridgway
Range: Southeastern Honduras to Panama
Habitat: Floor of the jungle
Rerecorded on to disk number 94, cut 8; and 95, cuts 1 & 2.
Quality: Good
Original recordings made at Station 6, December 27, 1944

Mockingbird
Mimus gilvus columbianus (some doubt as to this subspecies)
Range: Costa Rica to Colombia
Habitat: Vicinity of habitations
Rerecorded on to disk number 95, cuts 3 & 4
Quality: Excellent
Original recordings made at Station 2, December 10 and 24, 1944.

Yellow-green Vireo
Vireosylva flavoviridis flavoviridis Cassin
Range: Northern Mexico to Bolivia
Habitat: Tree tops of second growth jungle and roadsides
Rerecorded on to disk number 95, cut 5
Quality: Fair
Original recordings made at Station 1, November 30, 1944

Panama Shrike Vireo
Vireolanius pulchellus viridiceps
Range: Veragua to Panama
Habitat: Tree tops of the jungle
Rerecorded on to disk number 95, cuts 6 & 7.
Quality: Excellent
Original recordings made at Station 6 December 27 and 15, 1944.

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Yellow-green Pachysylvia
Pachsylvia viridiflava (Lawrence)
Range: Veragua to Panama
Habitat: Second growth jungle
Rerecorded on to disk number 96, cut 1.
Quality: Fair
Original recordings made at Station 1, January 14, 1945

Sclater's Warbler
Basileuterus rufifrons mesochrysus (Sclater)
Range: Panama and Colombia
Habitat: Undergrowth of jungle border and roadsides
Rerecorded on to disk number 96, cut 2
Quality: Fair
Original recordings made at Station 6, December 19, 1944.

Buff-rumped Warbler
Basileuterus fulvicauda veraguensis (Sharpe)
Range: Panama and southwestern Costa Rica
Habitat: The borders of jungle streams
Rerecorded on to disk number 96, cuts 3, 4, 5 and 6
Quality: Good
Original recordings made at Station 9, January 15, 1945 and
Station 6, January 17, 1945.

Panama Blue Grosbeak
Cyanocompsa cyanoides cyanoides (Lafresnaye)
Range: Panama
Habitat: Thickets at edge of jungle or roadsides
Rerecorded on to disk number 96, cuts 7 & 8 and 97, cut 1.
Quality: Fair
Original recordings made at Station 13, January 16, 1945 and
Station 5, December 26, 1944.

Lesser Rice Grosbeak
Oryzoborus funereus Sclater
Range: Southern Mexico to western Ecuador
Habitat: Thickets at edge of jungle and roadsides
Rerecorded on to disk number 97, cut 2.
Quality: Good
Original recordings made at Station 2, November 19, 1944

Slate-colored Seed-eater
Sporophila grisea schistacea
Range: Panama
Habitat: Forest borders
Rerecorded on to disk number 97, cuts 3 and 4.
Quality: Fair
Original recordings made at Station 6, December 26, 1944.

CONFIDENTIAL

Hicks' Seedeater
Sporophila aurita (Bonaparte)
Range: Guatemala to W. Colombia
Habitat: Forest borders
Rerecorded on to disk number 97, cut 5
Quality: Good
Original recordings made at Station 5, December 20, 1944.

Slate-colored Grosbeak
Pitylus grossus saturatus Todd
Range: Nicaragua to W. Ecuador and E. Brazil
Habitat: Treetops of jungle
Rerecorded on to disk number 97, cut 6 and 98, cut 1.
Quality: Excellent
Original recordings made at Station 11, December 2, 1944.

Panama Buff-throated Saltator
Saltator (magnoides) intermedius (Lawrence)
Range: Panama
Habitat: Second growth jungle - thickets
Rerecorded on to disk number 98, cuts 2, 3 & 4.
Quality: Very good
Original recordings made at Station 4, December 11, 1945

Lafresnaye's Sparrow
Arremonops striaticeps striaticeps (Lafresnaye) =
A. conirostris conirostris (Bonaparte) of Ridgway
Range: Panama and Colombia
Habitat: Thickets - at edge of jungle and roadsides
Rerecorded on to disk number 98, cut 6 and 99, cuts 1 & 2.
Quality: Excellent
Original recordings made at Station 5, November 27, 1944; Station 14, November 24, 1944 and Station 5, January 20, 1945.

Mexican Bananaquit
Coereba mexicana mexicana (Sclater)
Range: Southern Mexico to Ecuador
Habitat: Flowering trees and banana plantations
Rerecorded on to disk number 99, cuts 3 and 4
Quality: Fair
Original recordings made at Station 12, November 9, 1944 and November 1, 1944

Thick-billed Euphonia
Tanagra crassirostris (Sclater)
Range: Costa Rica to Ecuador
Habitat: Tree tops of flowering and fruiting trees
Rerecorded on to disk number 99, cut 5.
Quality: Fair to poor
Original recordings made at Station 5, December 22, 1944

Blue Tanager. Azulejo
Thraupis cana diaconus Ridgway and Nutting
Range: Mexico to N. Peru
Habitat: Edge of jungle and about habitations
Rerecorded on to disk number 98, cut 5.
Quality: Poor
Original recordings made at Station 12, October 15, 1944

Panama Crimson-backed Tanager. "Sangre de Toro"
Ramphocelus dimidiatus isthmicus Ridgway
Range: Panama
Habitat: Second growth and edge of jungle
Rerecorded on to disk number 99, cuts 6, 7 and 8
Quality: Fair
Original recordings made at Station 3, November 28, 1944 and Station 5, December 15, 1944

Summer Tanager
Piranga rubra rubra (Linnaeus)
Range: Eastern U.S. in summer, Central and Northern South America in winter.
Habitat: Edge of the jungle and second growth
Rerecorded on to disk number 99, cut 9
Quality: Very poor
Original recordings made at Station 12, November 9, 1944.

Dusky-tailed Ant Tanager
Phoenicothraupis fuscicauda Cabanis
Range: Southern Nicaragua to northern Colombia
Habitat: Second growth jungle.
Rerecorded on to disk number 100, cut 1.
Quality: Fair
Original recordings made at Station 1, January 14, 1945

Panama Thrush Tanager
Rhodinocichla rosea eximia Ridgway
Range: Southern Costa Rica and Panama
Habitat: Thick brush of second growth jungle
Rerecorded on to disk number 100, cuts 2, 3, 4 and 5, 107, cut 6, and 108, cut 1.
Quality: Excellent
Original recordings made at Station 5, December 14, 1944 and Station 6, December 16 and 18, 1944.

Wagler's Oropendula
Zarhynchus wagleri wagleri (Gray)
Range: Nicaragua to N.W. Peru
Habitat: Large trees of jungle or jungle border - often near roads, streams or clearings.
Rerecorded on to disk number 101, cuts 1 and 2
Quality: Good
Original recordings made at Station 13, January 16, 1945.

Lawrence's Cacique
Cacicus vitellinus Lawrence
Range: Panama and N. Colombia
Habitat: Often associated with Wagler's Oropendulas - of similar habits.
Rerecorded on to disk number 101, cuts 3 and 4.
Quality: Good
Original recordings made at Station 5, November 27, 1944 and January 20, 1945.

Small-billed Cacique
Cacicus microrhynchus (Sclater and Salvin)
Range: Nicaragua to N. Colombia
Habitat: Large trees of jungle or jungle border
Rerecorded on to disk number 101, cuts 5 and 6.
Quality: Fair
Original recordings made at Station 6, December 16 and 15, 1944.

Prevost's Cacique
Amblycercus holosericeus centralis Todd
Range: S.E.Mexico to Ecuador
Habitat: Thickets of second growth jungle
Rerecorded on to disk number 102, cut 1.
Quality: Fair
Original recordings made at Station 2, November 26, 1944.

Giraud's Oriole
Icterus giraudi Cassin
Range: Southern Mexico to N. Colombia
Habitat: Edge of jungle, plantations and roadsides
Rerecorded on to disk number 102, cuts 2, 3, 4, 5 and 6.
Quality: Good
Original recordings made at Station 4, December 1, 1944; Station 5, November 27, 1944; Station 13, November 22, 1944.

Great-tailed Grackle
Megaquiscalus major assimilis (Sclater)
Range: S. Texas to Colombia
Habitat: Open country, vicinity of habitations or marshes.
Rerecorded on to disk number 103, cuts 1 and 2.
Quality: Poor
Original recordings made at Station 2, December 3 and 24, 1944.

Caracara
Polyborus cheriway auduboni Cassin
Range: Florida and Texas to Panama
Habitat: Edge of the jungle and open country.
Rerecorded on to disk number 103, cuts 3 and 4
Quality: Fair
Original recordings made at Station 1, January 14, 1945.

MAMMALS

Black Howling Monkey
Alouatta palliata inconsonans Goldman
Range: S. Mexico to Panama
Habitat: Mature jungle
Rerecorded on to disk number 74, cuts 1 & 2 and 75, cuts 1 to [illegible].
Quality: Excellent to good.
Original recordings made at Station 12, November 8, 1944, January 1, 1945 and November 3, 1944.

White-faced Monkey
Cebus capucinus capucinus
Range: Mexico to Brazil
Habitat: Mature jungle
Rerecorded on to disk number 103, cut 6.
Quality: Fair
Original recordings made at Station 12, November 1944.

Marmoset
Ateles geoffrayi
Range: Mexico to Panama
Habitat: Mature and second growth jungle.
Rerecorded on to disk number 103, cut 7.
Quality: Poor
Original recordings made at Station 6, January 18, 1945

Coati Mundi
Nasua narica panamensis Allen
Range: S. Mexico to Colombia
Habitat: Mature and second growth jungle
Rerecorded on to disk number 104, cuts 1 and 2.
Quality: Fair to poor.
Original recordings made at Station 12, October 19 and 22, 1944.

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AMPHIBIA

Giant Toad
Bufo marinus
Range: Mexico, Central America and tropcial South America
Habitat: Nocturnal. Calls from the margins of ponds in open country at close of rainy season.
Rerecorded on to disk number 104, cut 3.
Quality: Excellent
Original recordings made at Station 10, November 17, 1944.

"Jungle Toad"
Bufo typhonius
Range: Panama and tropical South America
Habitat: Nocturnal - calls from the margins of pools in jungle stream in rainy season.
Rerecorded on to disk number 104, cuts 4, 5 and 6.
Quality: Very good
Original recordings made at Station 12, October 19, 1944, December 20, 1944 and October 29, 1944

"Panama Narrow Mouthed Toad"
Engystomops pustulosus
Range: Mexico to Venezuela
Habitat: Nocturnal.Calls from small temporary pools at edge of jungle in rainy season.
Rerecorded on to disk number 105, cuts 1, 2 and 3.
Quality: Excellent
Original recordings made at Station 3, November 30, 1944, Station 12, October 20, 1944 and Station 10, November 17, 1944.

"Dik-Dik-tree toad"
Phyllobates flotator
Range: Panama
Habitat: Terrestrial and diurnal on the jungle floor in the rainy season.
Rerecorded on to disk number 105, cuts 4 (dud) and 5.
Quality: Good to fair
Original recordings made at Station 12, October 24, 1945

"Panama Peeper"
Eleutherodactylus diastema
Range: Costa Rica, Panama and tropical South America.
Habitat: Jungle and jungle border. Terrestrial and nocturnal in its calls in the rainy season.
Rerecorded on to disk number 105, cuts 6 & 7.
Quality: Fair
Original recordings made at Station 12, November 6 and October 12, 1944.

"Cave frog"
Leptodactylus labialis
Range: Mexico and Antilles to Panama
Habitat: Moist ground, digs small cave beneath grass from which it calls at night in rainy season.
Rerecorded on to disk number 105, cut 8 and 106, cut 4.
Quality: Good
Original recordings made at Station 12, November 17, 1944.

"Katydid tree toad"
Hyla microcephala
Range: Costa Rica and Panama
Habitat: Nocturnal - calls from bushes or other vegetation in ponds during rainy season
Rerecorded on to disk number 106, cut 2.
Quality: Excellent
Original recordings made at Station 12, November 17, 1944.

"Gray tree toad"
Hyla gabii
Range: Costa Rica and Panama
Habitat: Nocturnal - calls from margins of running streams at the end of rainy season.
Rerecorded on to disk number 106, cut 3.
Quality: Good
Original recordings made at Station 3, November 30, 1944.

"Green-faced Hyla"
Hyla phaeota
Range: Panama and Colombia
Habitat: Nocturnal - calls from the margin of ponds at beginning of dry season.
Rerecorded on to disk number 106, cut 4.
Quality: Fair
Original recordings made at Station 12, January 5, 1945.

INSECTS

"Burrowing" Cricket
Anurogryllus muticus
Range: Southern New Jersey to Central Argentina
Habitat: Lives in burrow in sod and calls from the entrance - nocturnal.
Rerecorded on to disk number 108, cut 6.
Quality: Poor
Original recordings made at Station 12, October 19, 1944

"Petey-Dink" Cricket
Luzara minor
Range: Panama and northern Colombia
Habitat: Under matted vegetation along roadsides. Diurnal as well as nocturnal.
Rerecorded on to disk number 108, cut 7.
Quality: Good
Original recordings made at Station 5, November 25, 1944

"Fort Clayton" Tree Cricket
Paroecanthus annulatus
Range: Guatemala to Colombia
Habitat: On lower vegetation at edge of jungle - nocturnal.
Rerecorded on to disk number 108, cut 8.
Quality: Excellent
Original recordings made at Station 2, November 16, 1944.

"Summit Garden" cricket
Gryllodes sigillatus
Range: Widely distributed in Old and New World tropics.
Habitat: Crevices in rocks, etc.
Rerecorded on to disk number 109, cut 1.
Quality: Fair
Original recordings made at Station 3, November 30, 1944.

UNIDENTIFIED BIRDS AND INSECTS

Trogonlike
Rerecorded on to disk number 107, cut 3.
Quality: Poor
Original recordings made at Station 12, October 24, 1944

Ovenbird-like
Rerecorded on to disk number 107, cut 4.
Quality: Poor
Original recordings made at Station 6, December 28, 1944

Chatterer (Thrush Tanager?)
Rerecorded on to disk number 107, cut 1.
Quality: Fair to poor
Original recordings made at Station 6, December 22, 1944.

Pipe factory triller (flycatcher?)
Rerecorded on to disk number 107, cut 2
Original recordings made at Station 2, December 3, 1944.

Cicada "Buzz saw"
Rerecorded on to disk number 108, cut 2.
Quality: Very good
Original recordings made at Station 9, January 15, 1945

Cricket?
Rerecorded on to disk number108, cut 4
Quality: Poor
Original recordings made at Station 12, January 4, 1945.

"Tinkle Bell tree cricket"
Rerecorded on to disk number 109, cut 2
Quality:Good, but overloaded.
Original recordings made at Station 10, December 16, 1944

Cricket. "Anthill"
Rerecorded on to disk number 108, cut 5
Quality: Excellent
Original recordings made at Station 10, December 16, 1944.

"Small Fort Clayton" tree cricket
Anaxipha sp?
Rerecorded on to disk number 108, cut 9.
Quality: Fair
Original recordings made at Station 2, November 16, 1944.

Script and analysis of the two records accompanying the report on Jungle Acoustics:

Record 1 - Part 1. Recordings from the jungle

Sounds from the Jungle

Recorded between October 1944 and mid-January 1945 by Dr. Arthur A. Allen, Dr. Paul Kellogg and David G. Allen in the forests and forest borders of Panama. These recordings were made under the direction of Dr. Carl F. Eyring for the Division of Acoustical Research of Rutgers University under OSRD Contract Number OEMsr-1335 and Service Control Number S.C. 105. The two disks represent a sample of the sounds recorded and are a part of the final report on this project known as "jungle acoustics".

Part one - This record is designed to reproduce some of the commonest sounds of the jungle that are likely to occur at any time and register on other recordings.

First - rain in the jungle. This was taken from original record 15A, 2nd cut, 10-30 seconds.

Second - dripping water after a rain or heavy dew. This was taken from original record 17B, 8th cut, 1 min.-1 min.20 sec.

Third - running water of a small stream. This was taken from original record 26B, 1st cut, .0-15 sec.

Fourth - wind at the edge of the jungle. This was taken from original record 34B, 5th cut, 1 min.30 sec - 1 min. 50 sec.

Fifth - wind in the palms. This was taken from original record 44A, 1st cut, 3 min.20 sec.- 3 min.50 sec.

Sixth - a toad chorus (Bufo typhonius). This was taken from original record 46B, 3rd cut, 30-50 sec.

Seventh - an insect chorus - crickets and tree crickets. This was taken from original record 35A, 5th cut, 20-40 sec.

Eighth - a bird chorus - Lawrence's Cacicque, Verreaux Dove, Lafresnaye's Sparrow, Ant Shrike, Parrakeet. This was taken from original record 39A, 6th cut, 0-25 sec.

Additional sounds that may be heard in the background of each recording.

1. When raindrops actually hit the covering of the microphone they cause heavy thumps.

2. Single calls of a "peeper" (Eleutherodactylus diastema) and repeated notes of a"dick-dick tree frog" (Phyllobates flotator) can be heard in the distance.

3. Numerous tree crickets can be heard faintly in addition to two louder but short hisses caused by imperfections in the record.

4. One "peeper" (Eleutherodactylus diastema) can be heard faintly.

5. There seems to be no background audible other than the wind

6. There is considerable noise from the running water of the stream in the background although the toads were calling in a quiet pool.

7. There is a distant motor of a plane or car audible on this record. The crickets sing continuously, the tree crickets intermittently.

8. The bird calls appear in this order. Verreaux Dove, La Fresnaye's Sparrow, Lawrence's Cacique, Black-crested Antshrike, Verreaux Dove, Tovi Parrakeet; In addition there is a weak cricket sound.

Record 1 - Part 2 - Recordings from the jungle

Jungle Acoustics - part two

This record is designed to show some of the variations which occur in the general background sounds of the jungle at different times of day in the wet and in the dry season.

First we will listen at dawn in the wet season (monkeys and birds predominate). This was taken from original record 15B, 1st cut, 60 sec.-1 min.25 sec.

Second - Midday in the wet season. A distant stream and a terrestrial amphibian can be heard. This was taken from original record 18B, 5th cut, 30-55 sec.

Third - Dusk in the wet season. Dripping water, tree toads and an owl. This was taken from original record 18A, 1st cut, 30-55 sec.

Fourth - Night in the wet season. Dripping water, tree toads and an owl. This was taken from original record 18A, 4th cut, 0-25 sec.

Now we will change to the dry season.

It is dawn...the bird chorus is louder. This was taken from original record 41A, 7th cut, 3 min. 30 sec.- 3 min.55 sec.

Mid-day in the dry season. The cicadas have taken over. This was taken from original record 57A, 1st cut, 5 min. - 5 min.25 sec.

Dusk in the dry season..the insect level is higher than in the wet season. This was taken from original record 46B, 3rd cut, 6 min.-6 min.25 sec.

Night in the dry season...again the insect level is higher. This was taken from original record 49B, 10 min-10 min.20 sec.

Additional sounds that may be heard in the background of each recording.

1. In addition to the Black Howling Monkeys that make

the most noise, a Panama Antthrush whistles and a Short-keeled Toucan squeaks. More faintly a "peeper" (Eleutherodactylus diastema) can be heard; a small flycatcher (probably the Short-legged Pewee) and dripping water.

2. In addition to a distant stream there can be heard in this record a small terrestrial amphibian (Phyllobates flotator) giving his oft repeated dick-dick-dick note.

3. The tree toad is the "peeper" (Eleutherodactylus diastema). The tinamou is the Chestnut-headed Tinamou. Dripping water can also be heard.

4. The sharp call of the "peeper" and the thumping of the drops of water can be heard in addition to a single hoot of an owl (probably the Spectacled Owl).

5. The first squeaky notes are those of the Short-keeled Toucan followed by the low hoots of two Rufous Motmots answering one another and interrupted by the explosive whistle of a Laurence's Woodhewer. A continuous but weak, high pitched insect sound is audible.

6. A distant plane can be heard behind the loud calls of the cicadas and a faint call from an ant bird.

7. In addition to the insects, a Lawrence's Antthrush can be heard, also some sharp notes from a Woodhewer(?); and calls from two amphibians Bufo typhonius and Hyla gabii.

8. A Howling Monkey can be heard in the distance and also the explosive note of Hyla gabii but most of the sound is from the insects.

Record 2 - Part 3 - Recordings from the jungle

Jungle Acoustics - part three

This record is designed to give a sample of the common sounds that may be heard in a Panama jungle from daybreak until dusk at the beginning of the dry season.

1. First the morning awakening of a Black Howling Monkey. This was taken from original record 18A, 8th cut, 3 min. 5 sec.- 3 min.35 sec.

2. Second - the Swainson's Toucan. This was taken from original record 52A, 2nd cut, 1 min.20 sec.- 1 min.35 sec.

3. Third - The Great Rufous Motmot. This was taken from original record 46A, 2nd cut, 55 sec.- 1 min. 15 sec.

4. Now a Plain-colored Parrot. This was taken from original record 48B, 2 min.-2 min.15 sec.

5. Next a Panama Antthrush. This was taken from original record 14B, 3rd cut, 7 sec.-35 sec.

6. A Giraud's Oriole. This was taken from original record 26B, 6th cut, 10-32 sec.

7. A group of Wagler's Oropendulas. This was taken from original record 54B, 1st cut, 6 min.- 6 min.20 sec.

8. A pair of Black-billed Wrens. This was taken from original record 21B, 4th cut, 25-45 sec.

9. A flock of Crested Guans greet a thunder storm. This was taken from original record 19A, 1st cut, 6 min.-6min.30 sec.

10. Finally the evening calls of a Chestnut-headed Tinamou. This was taken from original record 58A, 10th cut, 15-40 sec.

Additional sounds that may be heard in the background of each recording.

1. In addition to the Howlers, a distant stream and dripping water can be heard. Likewise a tree cricket

and a "peeper" (Eleutheradactylus disstema) call intermittently and a Lawrence's Woodhewer is audible in the distance.

2. The Howling Monkeys continue into this record. Also the "peeper" and there is a faint insect background. A small flycatcher, probably the Short-legged Pewee also calls.

3. The only other sound on this record is a slight rush which may be defined as a non-identifiable sound from recording equipment and faint background noises recorded when the desired sound is distant or weak.

4. A Short-keeled Toucan can be heard in the distance.

5. There is a slight rush (see No. 3) in the background

6. A few chips and a distant song from a Lesser Rice Grosbeak can be heard - also a distant call from a White-breasted Antthrush.

7. The sharp scolding note is the female oropendula; the liquid sound followed by a crashing or stick breaking noise is the male. A weak insect call is audible.

8. A pair of wrens sing together the two phrases on this record. In the interval between the wren songs a Tyrannine Antshrike calls. The two loud chips at the end were not identified.

9. In addition to the "pavo" calls of the guans and the thunder, the shrill notes of a "peeper" are audible.

10. While waiting for the tinamou to call, a Swainson's Toucan can be heard and Howling Monkeys in the dim distance. There is considerable "rush" on this record as it was recorded at a high level.

Record 2 - Part 4 - Recordings from the jungle

Jungle Acoustics - part four

A Night in the Jungle

The recordings begin at nightfall at the edge of the Panamanian jungle during the wet season. All is quiet except for a few insects and a chorus of amphibians calling from a nearby pond and stream.

The largest and loudest of the amphibians is the Giant Toad - Bufo marinus (Linne). This was taken from original record 20B, 7th cut, 3 min-3min.25 sec.

A chorus of smaller toads will now be heard - Bufo typhonius (Linne). This was taken from original record 8A, 7th cut, 0-20 sec.

The next sound is made by a narrow mouthed toad Engystomops pustulosus (Cope). This was taken from original record 26A, 12th cut, 0-20 sec.

A small tree toad sitting in a bush over the water now calls. This is Hyla microcephala Cope. This was taken from original record 21A, 3rd cut, 1 min. 35 sec.- 2 min.5 sec.

Two larger tree toads follow, both rather infrequent in their calls - first the gray tree toad - Hyla gabbii Cope. This was taken from original record 59A, 4th cut 12-37 sec.

Next a larger tree toad Hyla phaeota Cope. This was taken from original record 46A, 4th cut, 3 min. 10 sec. - 3 min.32 sec.

During the wet season few of the night birds are calling but shortly after dusk and just before daybreak we hear the Paurauque. This was taken from original record 55B, 3rd cut, 0-20 sec.

And lastly we hear the low notes of the Spectacled Owl. This was taken from original record 51B, 10 min. 55 sec. - 11 min.25 sec.

Additional sounds that may be heard in the background of each recording.

1. The toad was calling from a pond where there were other amphibians. The principal competitors are a burrowing frog Leptodactylus labialis and the more nasal voiced narrow mouthed toad Engystomops pustulotus. A weak cricket noise is barely audible.

2. There is a faint insect sound in the background and a "peeper" calls once.

3. There is a slight record noise on this recording and the explosive notes of Hyla gabii can be heard in the distance.

4. The burrowing frog (Leptodactylus labialis) and the Grant Toad both call before the Hyla. The narrow mouthed toad(Engystomops pustulotus) also calls but the squeaky Hyla notes are quite distinctive.

5. This tree toad was calling from a stone wall near the outlet of a small pond and the falling water can be heard in the background. Also a faint insect sound and a squeaky Hyla microcephala in the distance.

6. Running water can be heard in the background and a faint cricket but no other amphibians.

7. A tree cricket can be heard in the background but there was remarkably little other sound when this bird was recorded.

8. A fairly high insect level mars this record, a Wood hewer calls once and also Hyla gabii.

SCRIPT TO ACCOMPANY THE COLOR FILM
WHICH IS A PART OF THE
REPORT ON RECORDING JUNGLE SOUNDS

Titles and explanatory notes for the 400 foot 16 mm. color film accompanying the report on recording jungle sounds.

The film is designed to show the nature of the Panamanian jungle during the rainy season when most of the recordings were made as well as to show the method used in recording the jungle sounds. It likewise shows a few of the birds and animals whose voices can be heard on the accompanying phonograph records.

Titles

1. Voice of the Jungle
   (This is a cartoon by Mrs. D. W. Thomas)

2. Photographed in Panama by A. A. Allen, Professor of Ornithology at Cornell University

   Professor Allen was in charge of the recording project. Most of the recording was done between daylight (6 a.m.) and 10 a.m. or in the late afternoons and evening, leaving much of the day free for exploration and photography.

3. This film is designed to accompany the report on recording jungle sounds

   The two phonograph records will undoubtedly mean much more to the listener after he has viewed this film and seen the nature of the jungle - the rain - and the wild life.

4. The jungle in the rainy season

   The rainy season in Panama begins in April and lasts until January, tapering off in December. Field work on this project lasted from October to January. The first two shots under this title were made from a searchlight position looking down on the roof of the jungle with the low clouds drifting by. The last two of the jungle from the side were made during one of the frequent showers, from the laboratory porch on Barro Colorado Island.

5. An Anteater gets caught in a shower

   The anteater is searching the larger branches of a tree near the laboratory on Barro Colorado Island for termites whose covered runways can be seen on some of the branches. It was sprinkling when the picture was started and it rained very hard during the exposure. The camera was on a covered second floor porch which protected the long focus lens from the rain. At the close of the picture

the Anteater does considerable scratching as though some of the "ants got in his pants".

6. Inside the jungle - Black Howlers and a Boa.

This is a posed picture to show a bit of typical jungle and a comparison of the jungle suit as worn by Professor Kellogg and the regular khaki worn by David Allen. Kellogg has been watching some Black Howling Monkeys and points them out to David Allen who has been cutting his way through the jungle with a machete unaware of the presence of Kellogg or the monkeys. The monkey shown has discovered a Boa constrictor in the tree and is howling in characteristic manner. He is joined by other members of his troop which are nearby but do not show in the picture. (It would be appropriate at this point to play Record 2 - the morning awakening of a Black Howling Monkey). Black Howlers are medium sized monkeys, about the size of springer spaniels, do not survive in captivity and so are seldom seen in zoological parks.

7. White faced Monkey and marmosets

This is a more familiar type of monkey often seen in zoological parks. He is eating almendro nuts. The marmosets or squirrel monkeys are likewise often kept in captivity and make engaging pets.

8. Blue-headed Parrot - Toucans and a Crested Guan

These are short shots of typical tropical birds in the tree tops taken with a long focus lens. Parrots are extremely noisy and conspicuous on the wing but quiet and difficult to see after alighting in the dense foliage. The Blue-headed Parrot is one of the common medium-sized parrots found from Costa Rica to Peru. The next shot is that of an Aracari Toucan with its enormous bill and parti-colored breast of red, yellow and black. Following is a more distant shot of a larger short-keeled toucan - black with a yellow throat. The fourth shot is of a crested guan in the top of the mangabé tree, in which the toucans are also perched, feeding on the small berries. Guans take the place of turkeys in the New World tropics but they are more arboreal. This bird would probably weigh six or eight pounds.

9. Jungle flowers - passion flower, poroporo and Erythrina

There are very few flowers in the jungle and one may

travel far without finding either the scarlet passion flower or the Erythrina. The poroporo, however, is a second growth tree (Cochlospermum) common at the edge of the jungle or on bushy hillsides.

10. Recording the song of a trogon

This sequence is designed to show the "sound truck" in action along a jungle road. Professor Allen and David Allen carry the parabola with its microphone and the telephone from the truck into the jungle where the trogon has been heard calling. The parabola is aimed at the bird like a gun and the trogon is seen calling from a branch overhead. David receives instructions by telephone from Professor Kellogg in the truck when all is in readiness and silence must be maintained. Professor Kellogg is then seen in the truck with the canopy drawn back - recording the song on the phonograph disk with the Presto recorder.

11. Hanging nests of Wagler's Oropendulas

The nests are about 3 feet long, beautifully woven from fibers and hung to the tips of the branches of tall jungle trees usually about clearings or where the nests hang free from any vegetation beneath. The birds are somewhat larger than the common crow blackbird, blackish brown in color with bright yellow tails and curiously swollen bills. Their remarkable songs, which can be heard on record 2, are a mixture of liquid burps and crashing sounds like the breaking of brush. There were 30 nests in this tree including one of a Lawrence's Cacique which was similar in construction.

12. Coatis rob a bird feeding station

Ripe bananas were hung with wire hooks on a bunch of green bananas to attract fruit-eating birds (Giraud's Orioles and blue tanagers are seen in the picture). Coatis, however, which were numerous on Barro Colorado Island where this picture was taken stole the bananas almost as fast as they were put out. The coati is a long-nosed raccoon. This sequence closes with a group of coatis that came from the jungle each evening to the back door of the laboratory for a "hand-out".

13. A black-throated hummingbird feeds her young

The camouflaged hummer's nest (about the size of a walnut) was on the dead branch of a fallen tree at the

edge of Gatun Lake. The young ones are only a few days old and still have short bills. They are fed on the nectar of flowers and tiny insects by a curious injection method which looks much more precarious than it really is. The photograph was made at a distance of five feet from a blind placed near the nest the day before.

14. Parrakeets and Tanagers in the flame tree

The succulent petals of these scarlet flowers are very attractive to tanagers, honey creepers and parrakeets. In this picture a couple of blue tanagers join the tovi parrakeets at the tip of a branch of the Honduran flame tree in the Summit Botanical Gardens. The tree is not a native of Panama but the birds are common and widespread. The parrakeets are the smallest of the parrots and are about the size of robins.

15. A three-toed sloth

One of the most unusual animals of the jungle. It is not properly built for walking and so seldom descends to the ground but spends its day high up in jungle trees where it feeds entirely on the foliage and buds. It moves very slowly and is easily mistaken at a distance for a termites nest. The animal in the picture was discovered descending a cecropia tree and induced to cross the road and then to climb a dead branch held by the driver of the jeep while Professor Allen photographed it. The greenish color is due to an alga which grows in the wet hair during the rainy season. Sloths are related to the anteaters and armadillos and are of a low Order (Edentata) in the classification of mammals just above the marsupials or pouched animals.

16. Identifying night sounds

Considerable difficulty was encountered tracing down with flashlights the authors of night sounds and catching them for identification after they had been recorded. Here a tree toad is being captured.

17. Night callers: Two tree toads and a spectacled owl

The tree toads are *Hyla phaeota* and *Hyla gabii* respectively whose voices as well as that of the spectacled owl can be heard on the second record.

LIST OF ILLUSTRATIONS

Figure

1. Map of the Canal Zone and the stations where jungle sounds were recorded

2. P. P. Kellogg and the recording equipment set up in the laboratory on Barro Colorado Island.

3. The recording equipment installed in the 1-1/2 ton Army truck.

4. Locating the author of a night sound.

5. Cages in which insects and amphibians were confined to isolate and identify their calls.

6. The recording group at Station 5.

7. Dr. Carl F. Eyring, director of the project; and the parabolic reflector.

8. Station 11 - at the edge of Madden Jungle.

9. At the second bridge on the Chiva Chiva Road.

10. Station 8 - at Las Cruces Trail.

11. Solid bank of vegetation along the Madden Highway near Las Cruces Trail. Wm. Nastuck and the generator used in producing sounds.

12. A stop at the ruins of Old Panama. Extraneous sounds made sound recording impossible.

13. The jungle bordering Gatun Lake. View from the laboratory on Barro Colorado Island.

14. The top of the mature jungle on Barro Colorado Island.

15. Inside the mature jungle - characteristic lianas, buttressed trunks and prop roots.

16. A fresh clearing in second growth jungle.

17. A clearing reverting to second growth jungle.

18. Two of the original trees left standing - a cuipo (on the right) and a Panama tree. The clearing is fast reverting to second growth jungle.

LIST OF ILLUSTRATIONS - 2

19. Cecropia trees (second growth) bordering the mature jungle.

20. False bananas (Heliconias) bordering the jungle.

21. A thicket of Heliconias at the edge of the jungle.

22. Coatis travel in groups and use their voices sufficiently often so that recording them is possible.

23. Agoutis are solitary animals and seldom call so that recording proved impossible.

24. Opossums were numerous but were never heard to utter a sound.

25. A zorro or wooly opossum that lived near the laboratory but whose voice was never heard.

26. The authors of this report in their jungle suits with the parabola that made most of the recording feasible.

27. Jungle suits render one less conspicuous in the jungle. P. P. Kellogg in the spotted suit, David Allen in the regular Khaki uniform.

28. A. A. Allen pointing the parabola in the jungle.

29. The senior author photographing a Slaty Seed-eater's nest 15 feet up in a climbing bamboo. This vine was almost impenetrable without a machete.

30. Road through the jungle near Station 10; a few mature trees left standing close to the road.

31. Undergrowth of palms in the mature jungle on Barro Colorado Island. These are seldom found in second growth jungles.

32. A cuipo tree in the dry season after shedding its leaves. An appreciable number of the jungle trees lose their leaves in January and affect the general appearance of the forest.

33. Road through the jungle with second growth cecropias, balsas and poroporas rapidly covering the roadside clearing.

LIST OF STATIONS WHERE JUNGLE SOUNDS WERE RECORDED

The location of each station is indicated on the accompanying map. (Many of the names were given by us as a matter of convenience and will not be found on other maps).

1. Patillo Point
2. Fort Clayton
3. Summit Garden
4. Oil Dump Road
5. Third Bridge on the Chiva Chiva Road
6. Chiva Chiva Triangle
7. Chiva Chiva Crossover
8. Las Cruces Trail
9. Mile beyond Las Cruces Trail
10. Madden Field
11. Madden Field jungle
12. Barro Colorado
13. Back road to Chorera
14. Camp Butler
15. Gamboa Cut off.

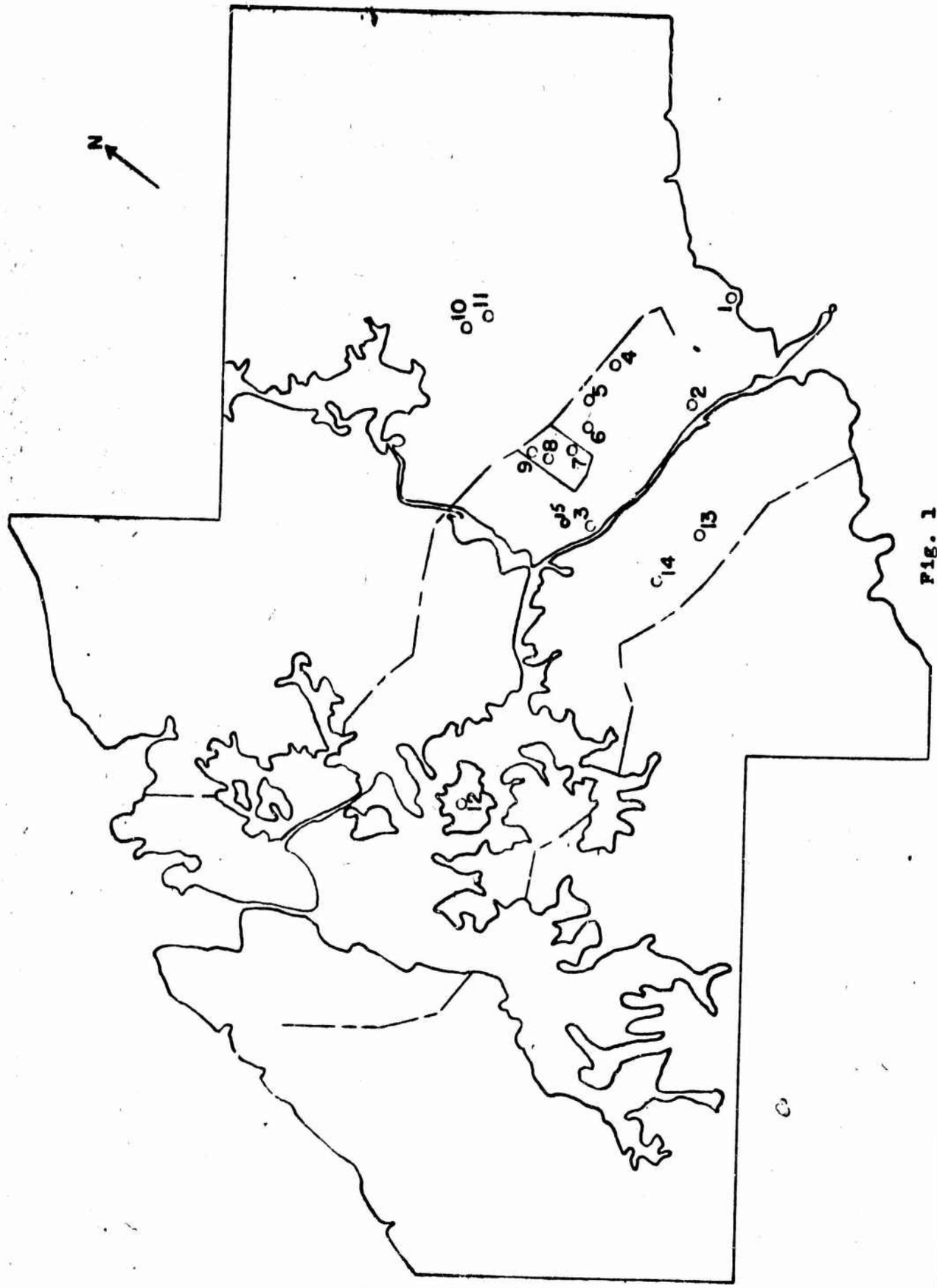

Fig. 1

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Fig. 2

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Fig. 3

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Fig. 4

Fig. 5

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Fig. 6

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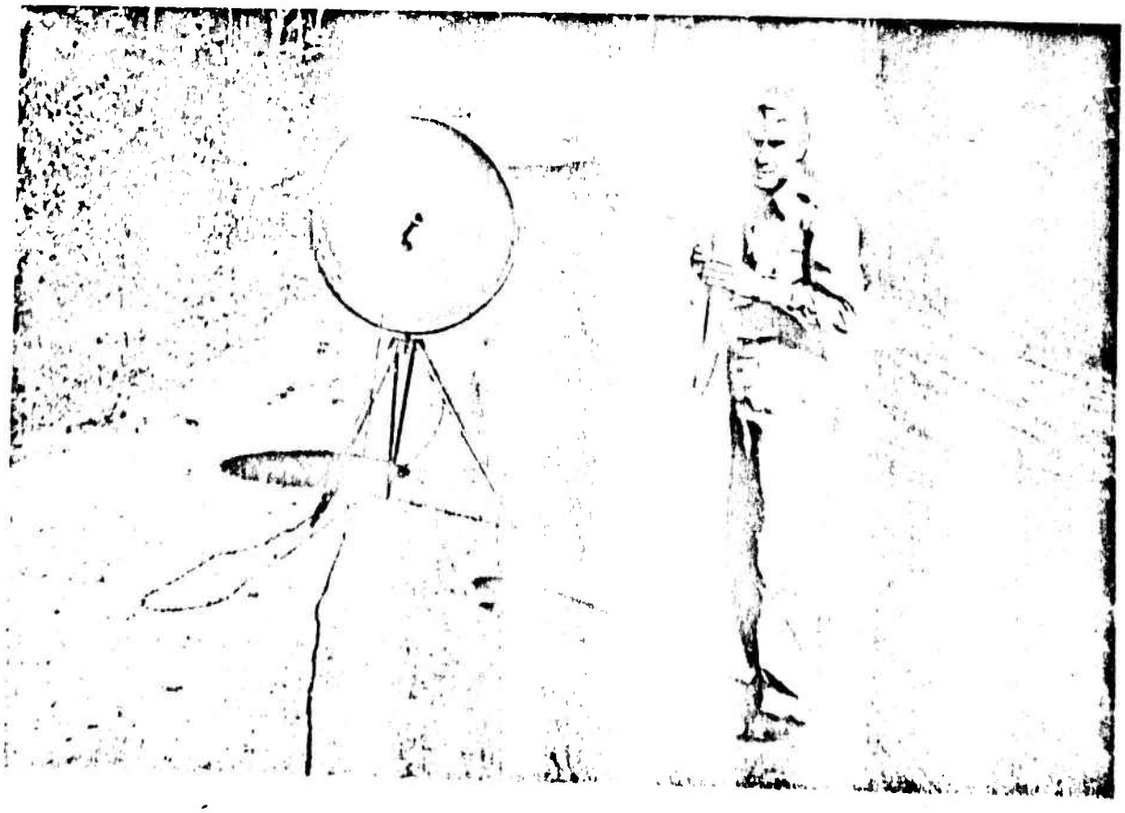

Fig. 7

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Fig. 8

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Fig. 10

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Fig. 11

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Fig. 12

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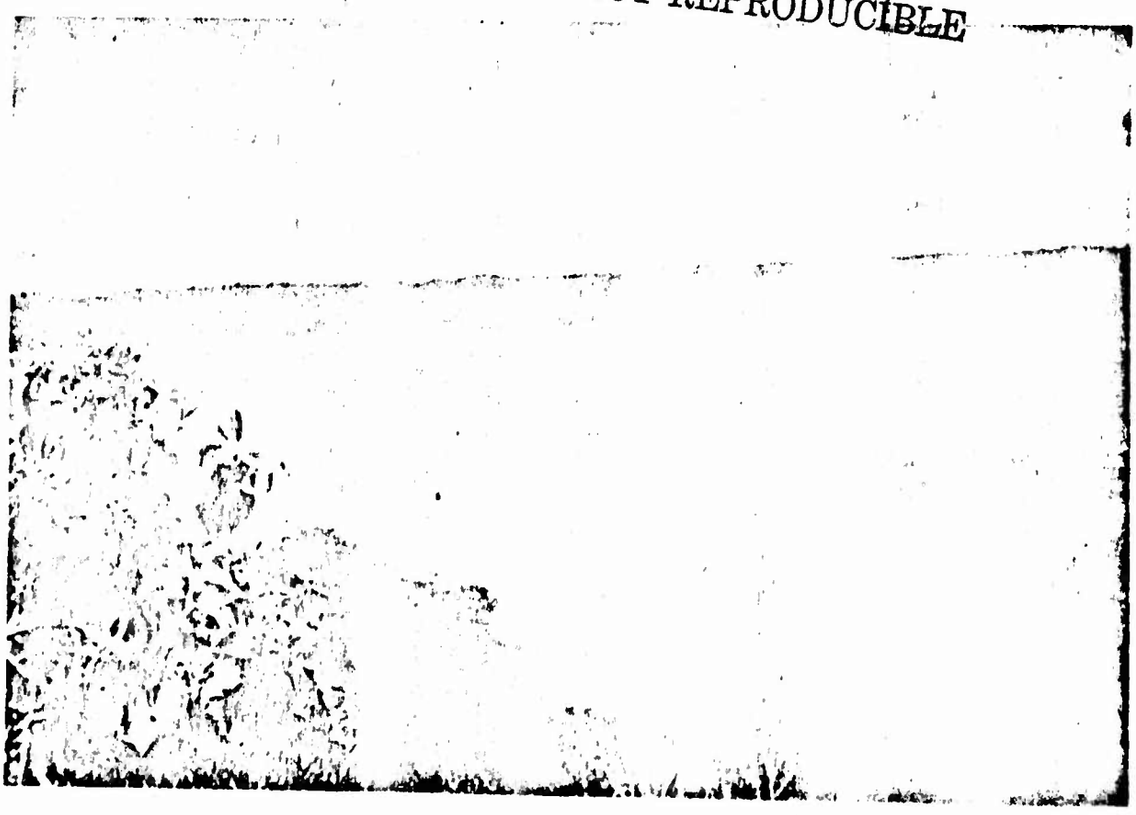

Fig. 13

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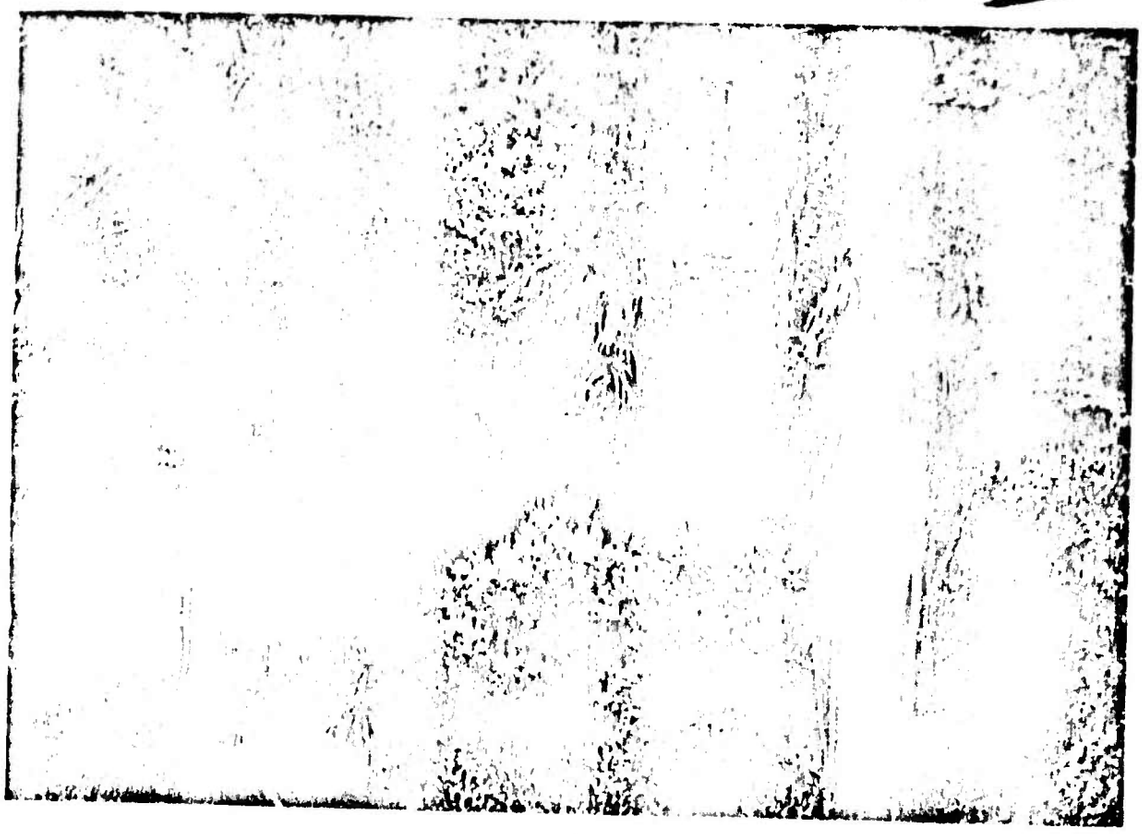

Fig. 14

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Fig. 15

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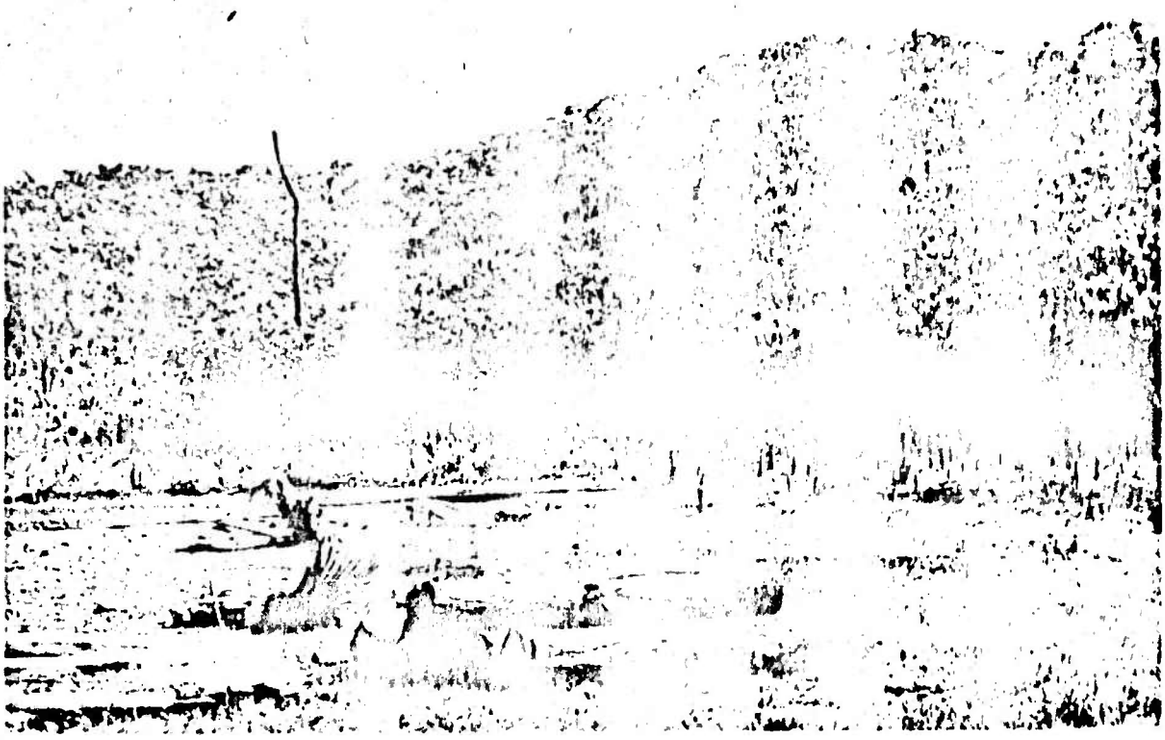

Fig. 16

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Fig. 17

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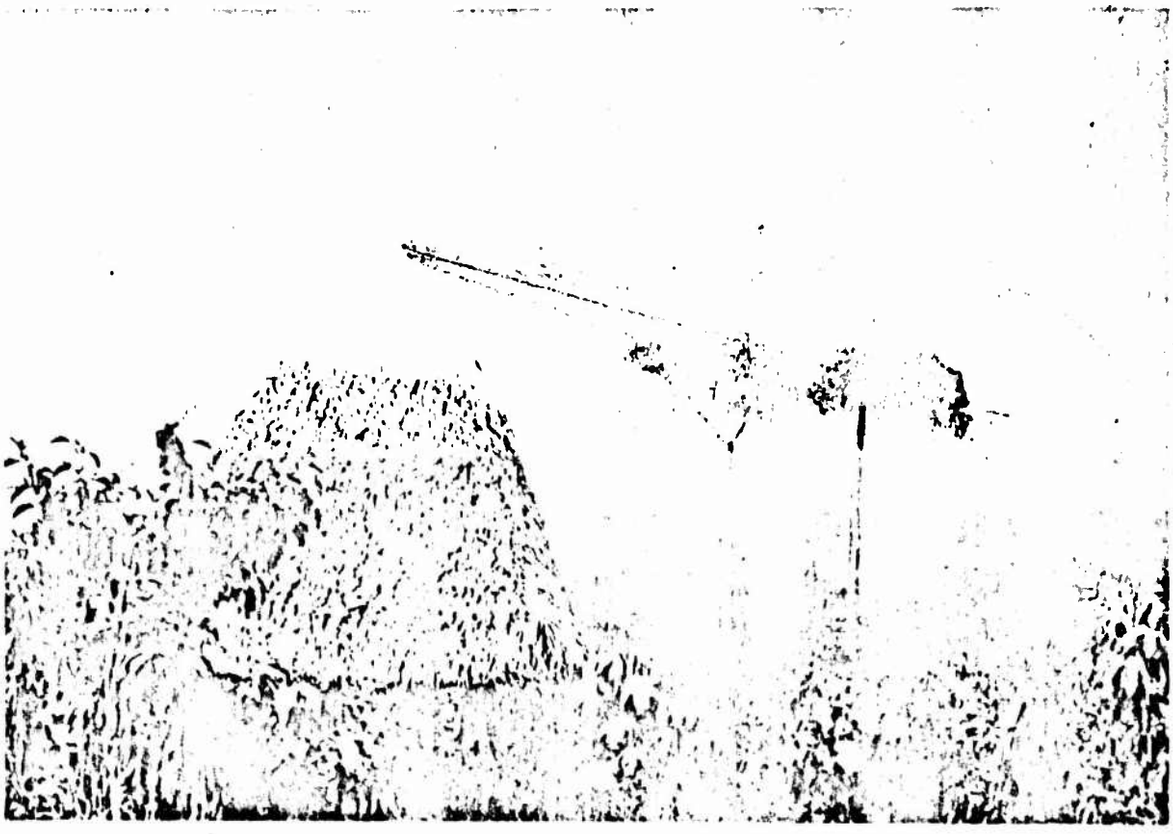

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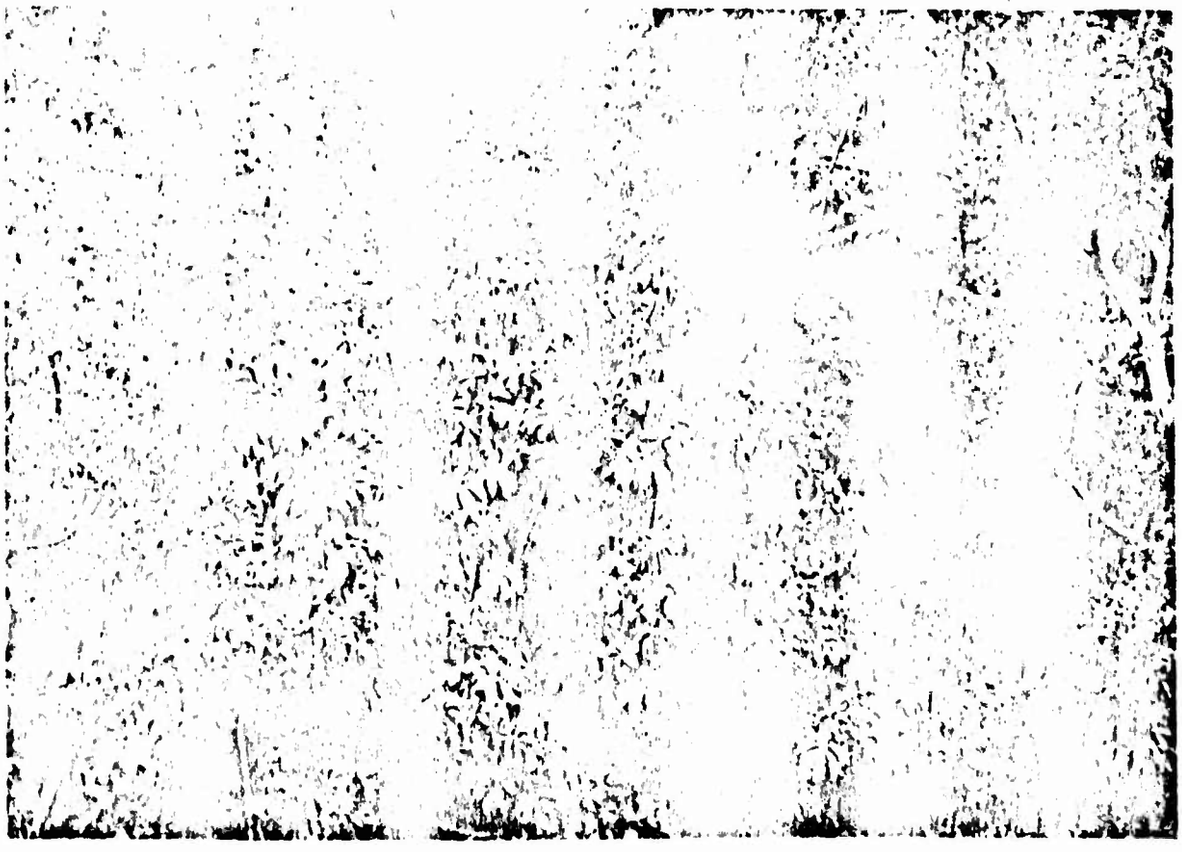

Fig. 19

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Fig. 20

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Fig. 21

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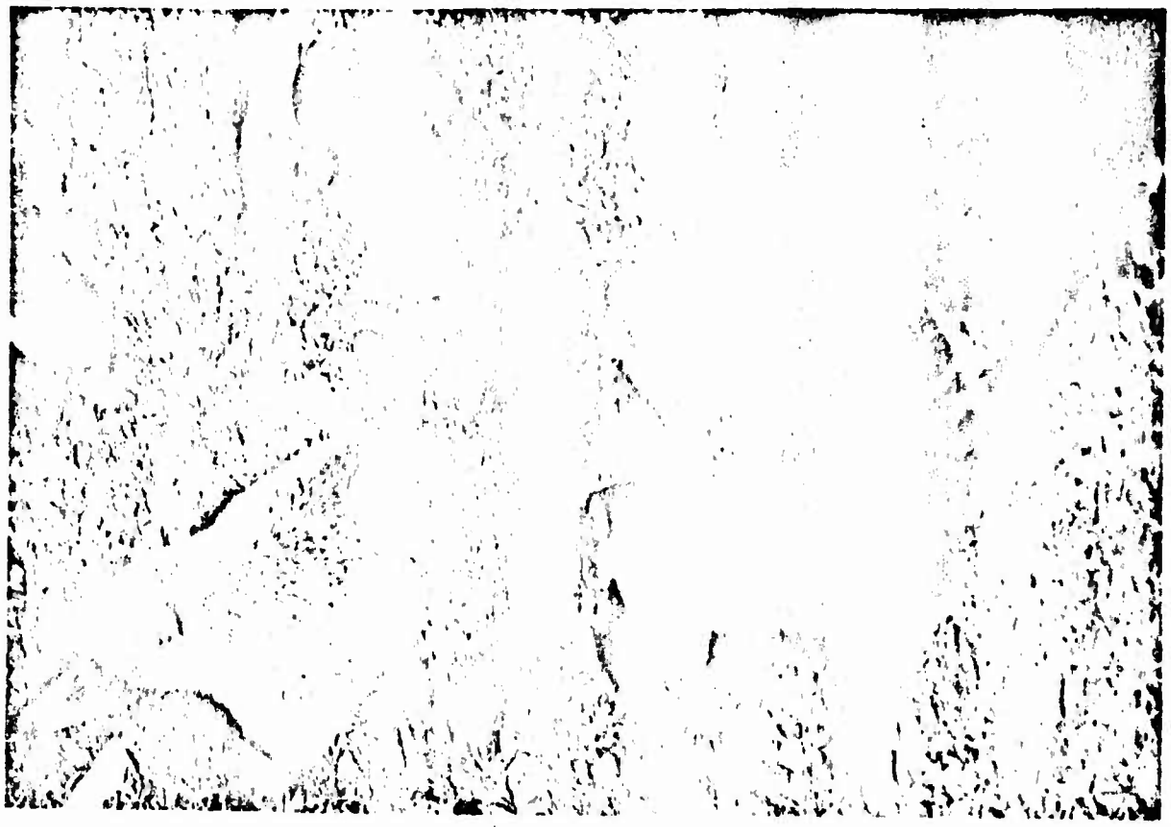

Fig. 22

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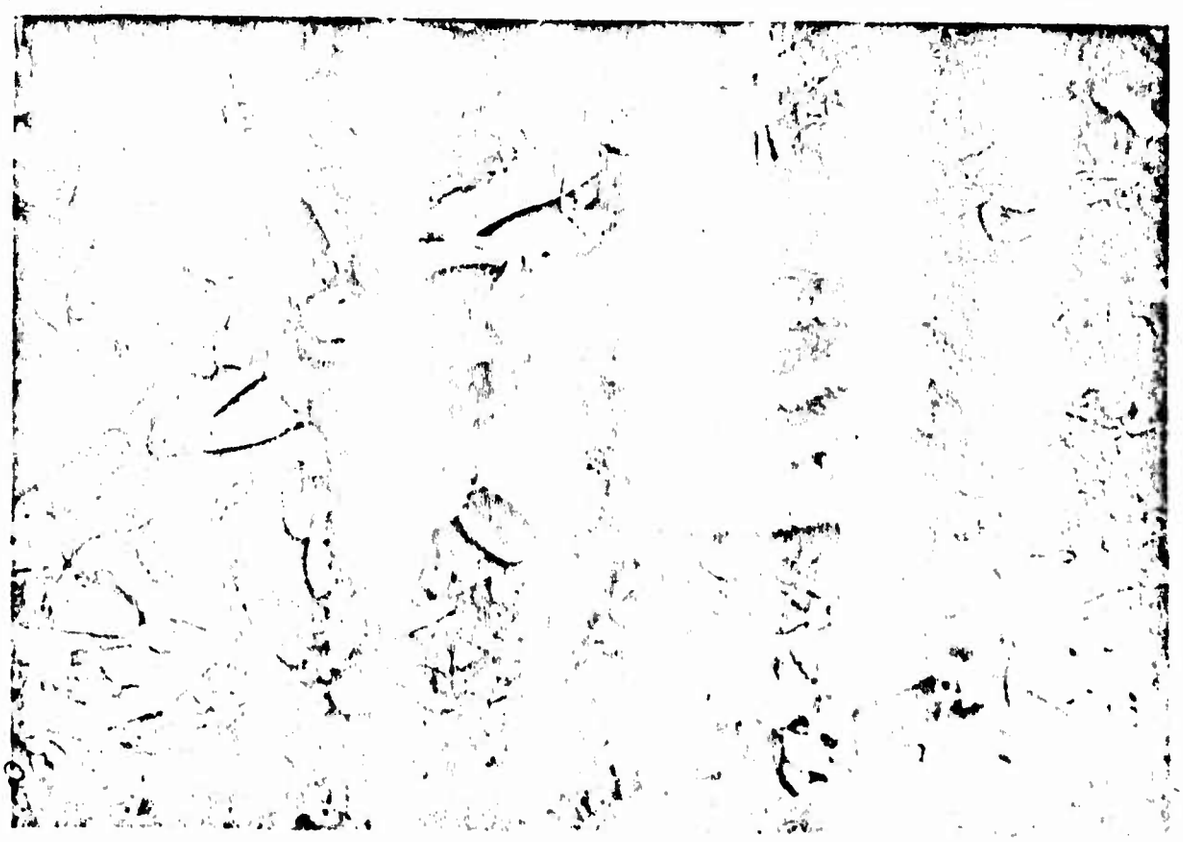

Fig. 23

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Fig. 24

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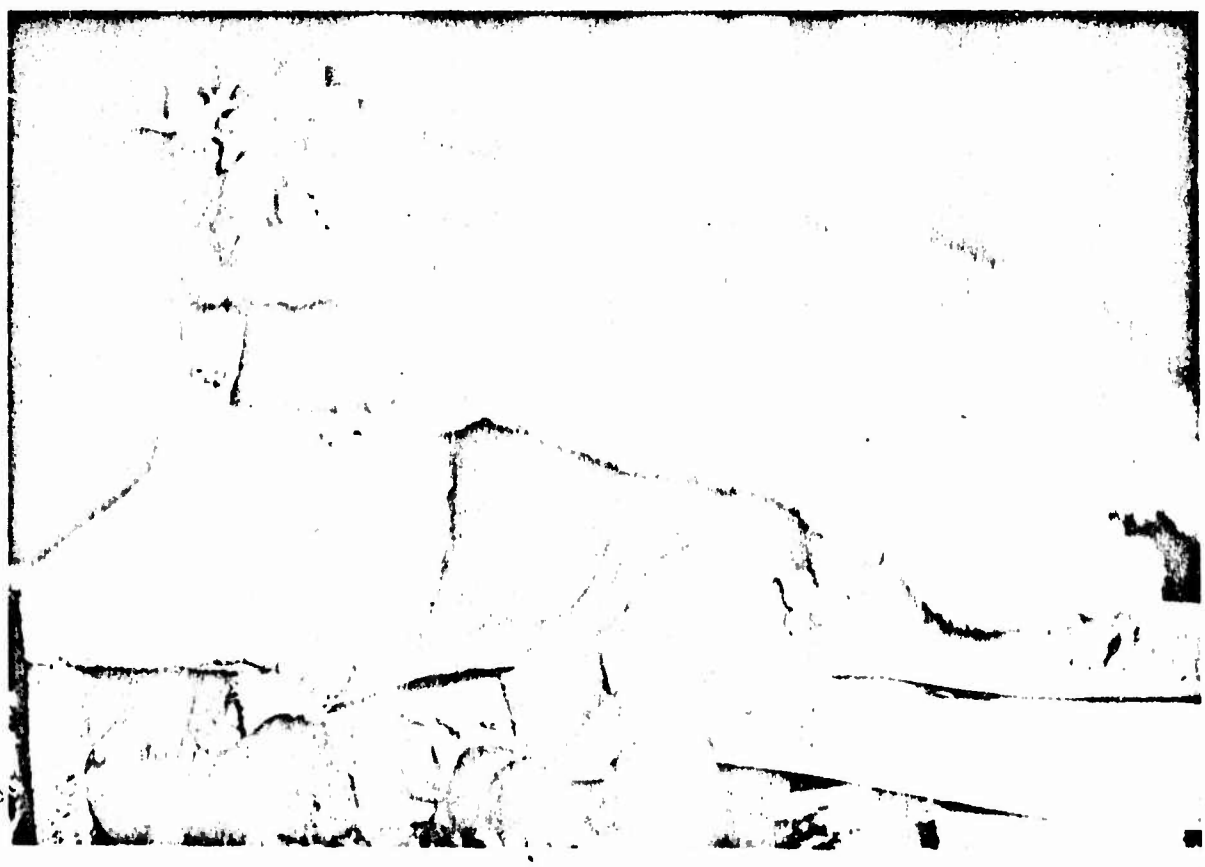

Fig. 25

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Fig. 27

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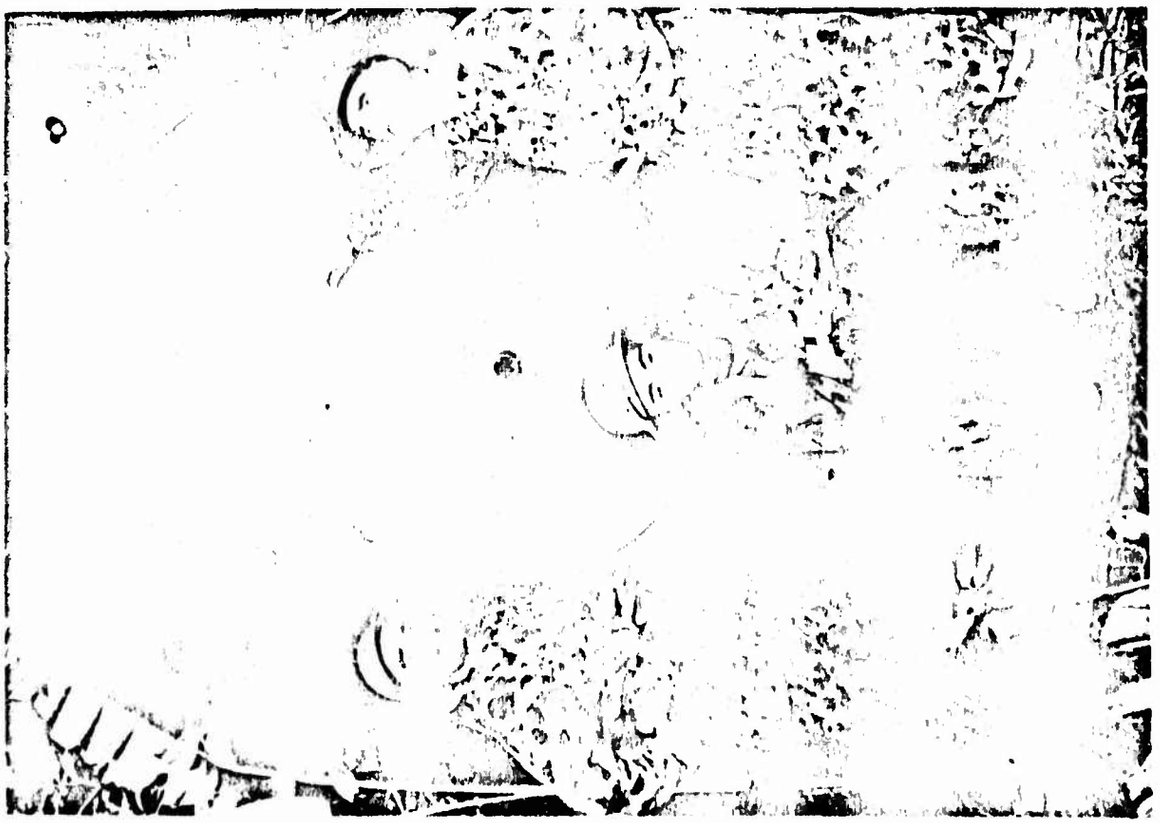

Fig. 26

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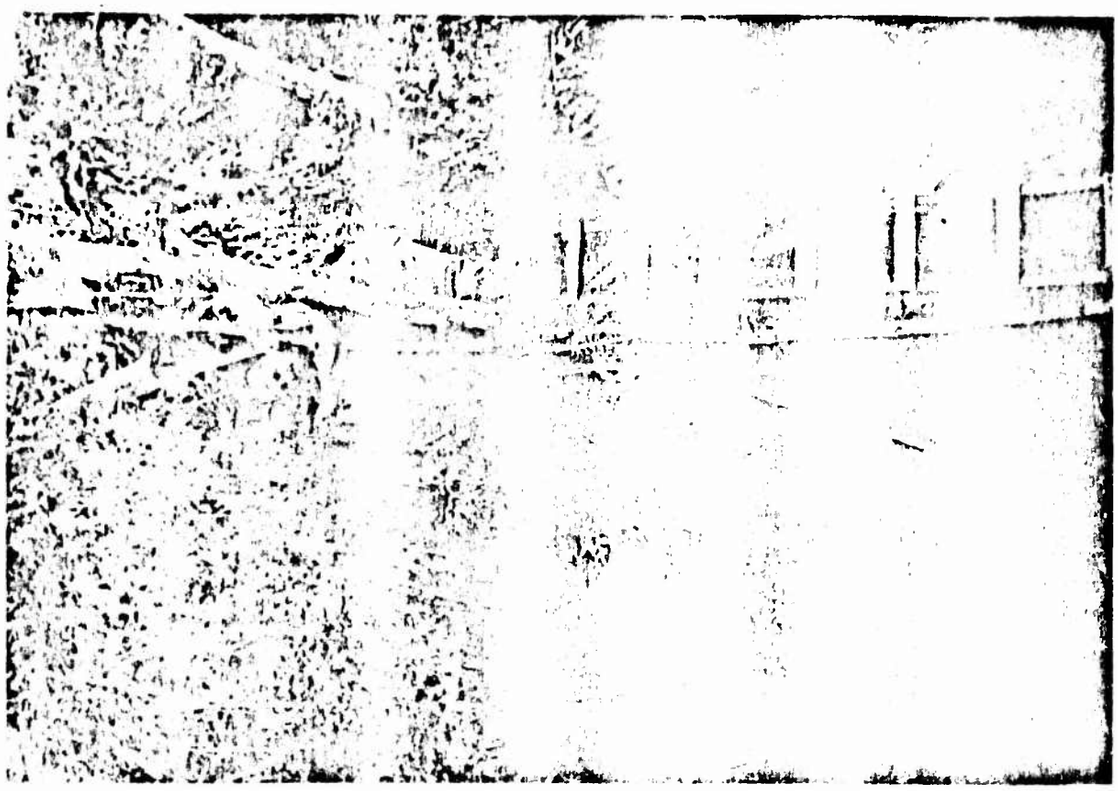

Fig. 29

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Fig. 28

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Fig. 31

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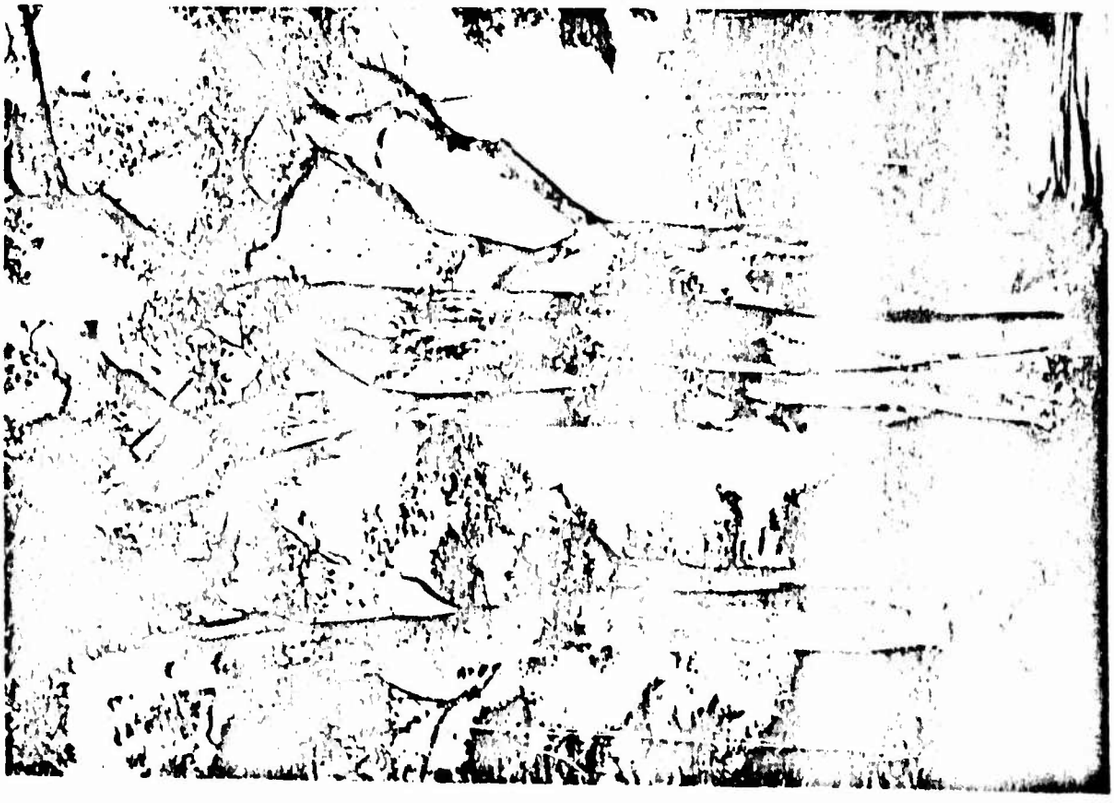

Fig. 30

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Fig. 33

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Fig. 32

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