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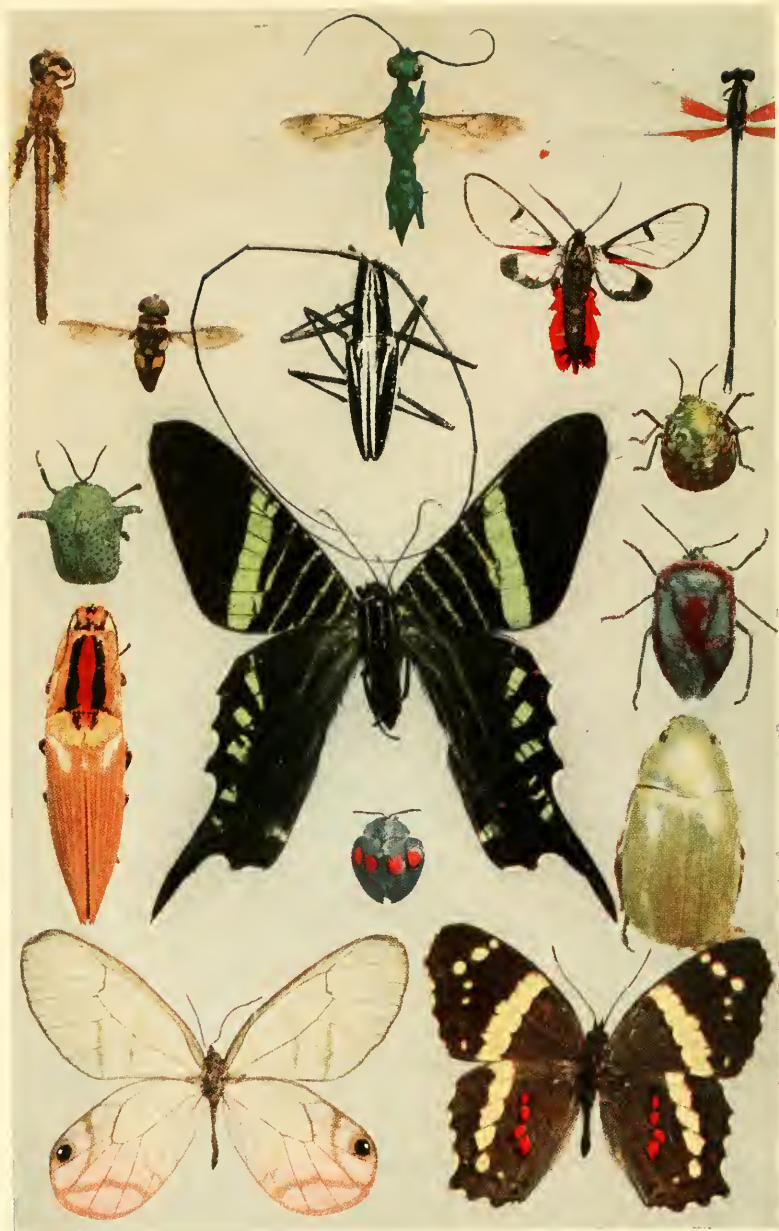
A YEAR OF
COSTA RICAN NATURAL HISTORY



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TORONTO



A YEAR OF COSTA RICAN
NATURAL HISTORY

Miathyria
marcella

Ampulex
neotropica

Hetaerina
miniata

Dinia
eagrus

Eristalis
scutellaris

Ptychodes
lecontei

Arocera
(larva)

BY

AMELIA SMITH CALVERT

Tauroma
casta

SOMETIME FELLOW IN BIOLOGY, BRYN MAWR COLLEGE

AND

PHILIP POWELL CALVERT

PROFESSOR OF ZOOLOGY, UNIVERSITY OF PENNSYLVANIA
EDITOR OF BIOLOGICAL NEWS

Uranidia
fulgens

Arocera
splendens

Semiotus
splendidus

WITH MAPS AND ILLUSTRATIONS

Mesomphalia
lebasi

Plusiotis
batesi

Callitaera
menander

Anartia
fatima

New York

THE MACMILLAN COMPANY

1917

SOME COSTA RICAN INSECTS
(NATURAL SIZE)

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WITH MAPS AND ILLUSTRATIONS

New York

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PREFACE

THE completion of the Panama Canal and its use by the ships of all the world will have a profound effect on the countries near the Isthmus. Changes in the external relations, industries and occupations of the neighboring peoples are to be expected; these may even be accompanied by changes in the face of nature herself. Costa Rica, lying immediately north of Panama, with her high mountains, her rushing rivers, her great variety of climate and of natural products, will share in these transformations. The naturalist may regret some of them but he may at least leave for the future a picture of what the past contained. To contribute to such a record, and at the same time to introduce some of the features of tropical life to immediate visitors to Costa Rica, are the aims of this book. This little republic is so readily accessible, it is so easy for foreigners to travel there and it offers such wonderful inducements to naturalists and entomologists (for many of whom the time and expense involved in visiting most portions of the American tropics are absolutely prohibitive) that it certainly should be much better known than it is at present. The information here brought together would have been welcome and time-saving to us, had it been at hand when we first entered the country, and while our descriptions relate primarily to Costa Rica, we believe that they apply also to conditions existing throughout much of tropical America.

Our primary concern in Costa Rica was a study of the dragonflies with reference to their seasonal distribution, which necessitated visits to the same localities at different

times throughout the year, and our movements within the country were mainly for the purpose of carrying out that plan. Our investigations have not yet been completed and we have little to say in these pages on that technical subject. What we here set forth are chiefly our more incidental observations recorded in our diary.

To make this record of the greatest possible value we have sought the aid of specialists for the identification of our specimens and are indebted to Señor Adolfo Tonduz, botanist of the Museo Nacional, San José, Costa Rica (while we were still in that country), and Prof. Henry Pittier (after leaving it) for the names of our plants. M. P. de Beauchamp has identified our planarians, Dr. H. A. Pilsbry the molluscs, Prof. J. P. Moore the annelids, Dr. R. V. Chamberlin the myriopods, Mr. H. W. Fowler the crustacea and lower vertebrates, Mr. N. Banks the arachnids and neuropteroids (exclusive of odonata), Mr. J. A. G. Rehn the orthoptera, Mr. G. C. Champion many of the coleoptera and heteroptera, Prof. W. M. Wheeler the ants, Prof. T. D. A. Cockerell the bees, Mr. W. J. Fox the fossorial hymenoptera, Dr. Henry Skinner the lepidoptera, Dr. W. T. M. Forbes the caterpillars, Messrs. E. T. Cresson, Jr., J. R. Malloch and C. P. Alexander the diptera, Messrs. F. Knab, E. A. Schwarz, O. Heidemann and Dr. H. G. Dyar certain insects from bromeliads, and Prof. A. P. Brown the rock specimens. Profs. J. F. Tristán and A. Alfaro and Mr. C. H. Lankester, with whom we made various excursions in Costa Rica, aided us in identifying many animals, Mr. Lankester especially the birds. We ourselves are responsible for the determination of the odonata and some of the larger coleoptera and hemiptera.

Such success as may have attended our studies in Costa Rica was largely due to the many kind friends resident in the country: Prof. J. F. Tristán and members of his family,

Mr. and Mrs. J. B. Clark, Prof. A. Alfaro, Señor J. C. Zeledon, Mr. and Mrs. C. H. Lankester, Señor and Señorita Bonnefil, Mr. John M. Keith and the United Fruit Company, all of whom we again thank heartily for their assistance.

Our appreciation of the kindly and graceful acts of the liberal and enlightened Government of Costa Rica is expressed in the first and twentieth chapters, but we wish to emphasize it in this place also.

A. S. C.

P. P. C.

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A YEAR OF
COSTA RICAN NATURAL HISTORY

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CHAPTER I

PUERTO LIMÓN

Limón, the Atlantic seaport of Costa Rica, is situated at $10^{\circ} 0' 30''$ North Latitude. It was not opened to foreign commerce until 1867 and did not attain much importance until work was begun on the railroad to the interior in the early seventies. Previous to that time travelers entering Costa Rica on the Atlantic side either ascended the San Juan River from Greytown and then its tributary the Sarapiquí for about twenty miles, thence on horseback through the pass of Desengaño, to San José, or they went up the Rio Matina from its mouth, fourteen miles northwest of Limón, and then overland and up the valley of the Reventazón River, with considerable difficulty. We arrived at Limón on the Hamburg-American steamer "Sarnia" from New York on Saturday, May 1, 1909, and left for the United States by the "Prinz Joachim" of the same line, on Monday, May 10, 1910. Between these two dates is comprised our year of Costa Rican Natural History.

The "Sarnia's" port of call before Limón was Greytown, Nicaragua, where there is no pier. We watched the lighter rising and falling as it came out to our steamer, a mile off shore, and looked at the low-lying coast with interest inspired by the opening chapter of Thomas Belt's *A Naturalist in Nicaragua*. Belt landed in Greytown and his fascinating

book was our introduction to many things which we saw in Costa Rica.

Six hours later, in the early morning, we reached Limón. The doctor's inspection was over by nine but the steamer did not dock until noon. The dock room was limited by the breaking of the largest pier a few weeks previously and two steamers were already tied up, obliging us to wait until one of them could move. At the custom house, thanks to the arrangements made for us by the late Senor Calvo, then Costa Rican Minister at Washington, our luggage was not even opened, a courtesy which we greatly appreciated. All the luggage—five little trunks, a canvas carry-all, a wooden box of bottles and a large parcel—was handled by *one* porter or "faquin" (not "cargador" as in Mexico) and all at the same time, on a small freight truck.

The pier at which we landed extended some hundreds of feet outward from the shore with the custom house near its sea end. At its land end was the station of the railroad to San José and the interior, and opposite the station stood the building of the United Fruit Company. Immediately north of this last was the principal plaza or public square, planted with many kinds of trees and shrubs. As usual in Costa Rican plazas, the outermost trees were nearly all figs or "higuerones," here of great size and beauty, which formed impressive aisles with their long, rather slender, compressed and subdivided branches. Their foliage is very dark green and produces a deep shadow. The inedible figs had fallen to the ground under some of the trees and were half an inch in diameter, pale yellow in color and stuffed with small pale fruits. One peculiarity was the abundance of aerial roots, as thick as whipcords, dark in color except the pale yellowish tips. These roots hung in profusion from many of the branches, often at heights of twenty or thirty feet above the ground and were sometimes more than a yard

long. They were the more easily seen as nearly all the foliage was at the very tops of the trees, producing a flat crown, with no leaves to conceal these roots. Royal and cocoanut palms were most conspicuous in the center of the plaza, which was the resort of many small birds and lizards. The numerous flower beds were outlined with red and pink amaryllids and contained great bushes of *Coleus* and many varieties of crotons as large as lilac bushes, with gay variegated leaves of unusual shapes.

Some blocks south of the railroad station and as many inland from the sea, was another small plaza with a neat market house in the center. On the south side of this square stood the comfortable and clean Grande Hotel, where we stayed when in Limón. Still farther inland were high banks covered with trees showing how much the land had been cut down to make the present level of the streets.

The town was clean, well-drained, well-paved, with both streets and sidewalks of good width. In spite of its cleanliness there were hundreds of black vultures or "zopilotes" flying about, perching on trees, squabbling over tidbits in the scavengers' carts, or walking in the streets with their curious rheumatic, jerky gait. Limón when we first saw it was built largely of wood, although its roofs were of galvanized iron. The ground floors were used as shops; the upper residence stories were provided with balconies where it was pleasanter to sit. There were few gardens around the houses and the town was rather closely built up. During the following year several fires occurred in different parts of Limón and the areas so bared were extensive. In May, 1910, some of these were already being built on with brick walls instead of wood so that the end result will be beneficial.

All of the bananas and much of the coffee produced in Costa Rica are shipped from Limón. They are the chief exports of the country, 9,365,690 bunches of the fruit being

sent out in 1909. On May 9, 1910, from 10 A. M. to 8 P. M. bananas were loaded on the "Prinz Joachim." A banana train of ordinary box freight cars was run on the covered pier and within a few yards of the ship's side. Negroes standing within each car handed out the bunches of green fruit singly to other negroes without, each of whom laid his bunch on his left shoulder, which was padded with a burlap bag to prevent bruising the bananas, and carried it to the end of a loading machine. Here another negro took the bunch and placed it carefully on an endless belt by which it was carried into the ship. The belt—the chief part of the loading machine—was about thirty feet long and was operated in an almost horizontal plane by a small portable engine at its side. The entire machine was covered by a canvas awning and a larger awning was stretched over the ship end of the machine and the hatch into which the fruit was passed from the belt by hand. The edges of the hatch were padded with burlap-covered cushions, so that in all much care was taken to avoid bruising the fruit or exposing it to undue heat or moisture. Once we timed the number of bunches passed on to the loading machine in one minute, finding it to be twenty-four, but at other times the number was greater.

Railroad tracks left Limón from both its northern and its southern ends. Of those to the south, some follow the coast line to the Banana River, while others soon turn westward to the interior.¹ These railroad beds are the only roads leading out of Limón and of course are not available for wheeled vehicles but only for equestrians or pedestrians. Walking southward on the tracks leading toward Banana River and keeping as near the sea as the wet and muddy ground would permit, P. had his first near view of a pelican at large, when one alighted in the shallow water of the beach

¹ See the map in Chapter XVI.

for a moment before flying off again. We had already seen them from a distance while lying off Greytown and while waiting to dock at Limón, large, low-flying birds whose heads and bodies formed a single horizontal line as they moved over the water.

The great majority of the inhabitants of Limón were English-speaking negroes many of whom came from Jamaica. Their huts and shanties were much in evidence, chiefly between the tracks and the beach. Some of them bore names as "Rest Cottage," "Seaman's Providence"; the sign of the "Jamaican Hotel" kept by Nicolo Bartoli, on the main street, announced "Beds with matrimony $\$ 2$ ". A small river, which the railroad crossed by an iron bridge, empties into the sea just at the southern end of Limón, and a sign by the side of the stream read "Sharks. Dangerous. Bathing Prohibited." A very wet spot where the river joined the sea was occupied by scores of zopilotes, some of them getting a few pickings from a fish-net spread out to dry. Beyond the bridge the railroad ran among coconut palms but was fenced in on each side with barbed wire. Striped lizards (*Cnemidophorus* or the like) ran over the ties and here and there leaf-cutting ants carried their burdens.

We called on Dr. Emilio Echeverria, who was in charge of the hospital located on a little exposed point at the north end of the town. It was the joint property of the United Fruit Company and the Costa Rican Government, had a capacity of 117 beds, and was opened in 1905. It was perfectly screened and Dr. Echeverria told us there had been no yellow fever in Limón for three years. He himself had lived here five years and although he did not consider himself immune had never had a chill or any symptom of malarial fever. But as he said, he took no risks and never sat out of doors in the evening. Some of the upper balconies of the hospital commanded fine views of Limón and the mountain barrier

behind the low coastal plain. The buildings were surrounded by beautifully kept and luxuriant gardens, from which the Doctor gave A. an armful of flowers. Among them were pink and white oleanders, camellias, a pretty flower new to us which Dr. Echeverria called "Jupiter," cotton, hibiscus and a euphorbiaceous plant resembling Poinsettia but with some of the bracts wholly red while others were red at the base only, the rest of the bract being bright green.

Close to the hospital were the towers of the wireless telegraph, while west of it were railroad tracks which follow the shore line north and west. The coast here consists of a coral rock which forms cliffs, reaching a height of a hundred feet in some places, and flat reefs which are washed by the tide. Dr. Echeverria thought the reefs were still forming, as a certain reef now visible, although awash, was not so when he first came to the hospital. Professor Pittier mentions the existence of corals in the swamps separating the Blanco and Cuba Rivers in the neighborhood of Moin, five or six kilometers from the sea; "in the midst of an extraordinary vegetation rise, here and there, pillars of the same material, naked and branching, like one sees along the reefs of the coast and which appear to have been washed by the waves only yesterday." These various observations indicate a gradual elevation of the coast in this region. The rock forming the cliffs was in some places compact and solid, in others loose, in the form of irregular fragments one to six inches in diameter embedded in a yellow clay.

In the tidal pools, on May 8, 1910, were *Neritina* snails, small sea-urchin shells (I saw no living urchins) and crabs with quadrangular carapaces. On shore also crabs were the most abundant animals, particularly a species with a squarish slaty-blue carapace about four inches wide. Their burrows were everywhere in the holes of the rock or in the

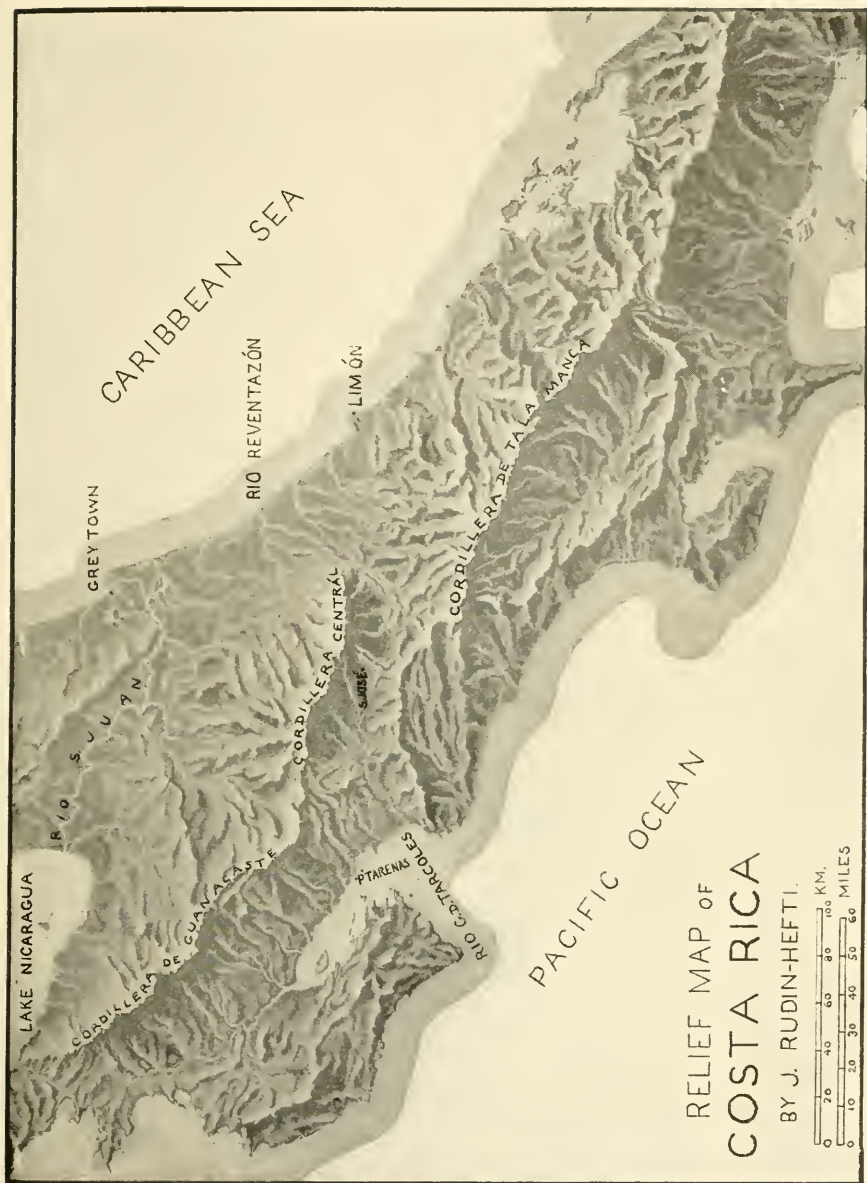
clay which covered it in many places. There were many small streams, mostly of clear water, coming down to the sea in the three miles traversed on foot this day. One of them—of dirty water, however—about a mile and a quarter from Limón occupied a gorge with rather bare sides. The fall of this stream was considerable. Many of these streams formed pools or swampy spots where they met the railroad embankment and around these the crabs were especially abundant. In some places the railroad occupied a ledge cut into the coralline cliffs, in others, where the cliffs were lower or farther inland, it occupied an embankment which had been reënforced, here and there, by dumping odds and ends of railroad iron on the sea side.

The coral cliffs offer a strong contrast with the country south of Limón along the Banana River line, which is swampy and flat. Still farther north of Limón, beyond the coral cliffs, the country is again swampy, as at Swamp Mouth for example, before the Rio Matina is reached. A number of tall deciduous trees remained throughout these three miles, seeming to indicate that formerly a forest extended to the sea. Most of the vegetation was second growth or had been still further cleared for bananas and yuca. There were many cocconut palms, fan palms, heliconias, wild gingers, pipers and breadfruit trees. I did not see many butterflies. A big *Morpho* fluttered by me twice but I could not catch it. Unfavorable weather conditions no doubt diminished the number of insects seen, as it was cloudy after nine o'clock in the morning and rained at frequent intervals, although not hard. The entire Atlantic slope of Costa Rica has a heavy precipitation, Limón having an annual rainfall of 127 inches (3224 mm.); the minimal months are February, September and October.

CHAPTER II

COSTA RICAN TOPOGRAPHY AND RAILROADS

From Limón to Puntarenas, the chief Pacific port of Costa Rica, the air-line measures nearly 125 miles (200 kilometers). A railroad now connects them but its windings and its ascent to the continental divide at a height of 5000 feet (1524 meters) increases this distance to 180 miles (289 kilometers). The divide is formed by a mountain chain, the main Cordillera, extending from west-northwest to east-southeast, beginning south of the Lake and Isthmus of Nicaragua and continued into Panamá. Near Latitude 10° North, the Cordillera is separated by the river valleys of the Reventazón (Atlantic side) and Grande de Tárcoles (Pacific side) into a northern and a southern portion, the first termed Cordillera de Guanacaste, the latter Cordillera de Talamanca. A little north of the tenth parallel, the Cordillera de Guanacaste curves to the east, forming three groups of volcanoes known collectively as the Cordillera Central. These groups, from east to west, are: 1, Turrialba (11,224 feet, 3421 meters) and Irazú (11,325 feet, 3452 meters); 2, Barba (9524 feet, 2903 meters); and 3, Poás, formerly called de los Votos (8786 feet, 2678 meters). Irazú is separated from Barba by the pass of La Palma (5098 feet, 1554 meters), Barba from Poás by that of the Desengaño (6115 feet, 1864 meters). The principal members of the Cordillera de Guanacaste, going northward, are Tenorio (4700 feet, 1432 meters). Miravalles (5675 feet, 1730 meters), Rincon de la Vieja or Cuipilapa [4500 (?) feet, 1371 (?) meters], and Orosi (5155 feet, 1541 meters). These also are volcanic in character and





The Reventazón Valley, East from Juan Viñas.

their contours from most points of view, like those of the Cordillera Central with the exception of Turrialba, rise gradually and gently to their summits.

The Cordillera de Talamanca is more continuous than the northern Cordillera and is much less known. It begins with the Cerros of Candelaria, or Escazú (7956 feet, 2425 meters) to the south and southwest of San José, and with Carpintera (5705 feet, 1739 meters) to the east. The latter connects with Irazú and forms the watershed between the Rio Reventazón and the Rio Grande de Tárcoles. Component parts of the Cordillera de Talamanca, proceeding southward, are the Cerro de las Vueltas (10,127 feet, 3087 meters), Buena Vista (11,614 feet, 3540 meters), Chirripo Grande (12,467 feet, 3800 meters), the highest point in Costa Rica, Cruz del Obispo (9100 feet, 2775 meters), Kamuk or Pico Blanco (11,794 feet, 3595 meters) and Cerro Pando, beyond which, in the Republic of Panamá, is the Volcano of Chiriqui.

The Cordilleras de Guanacaste and Talamanca are nearer to the Pacific than to the Atlantic Ocean, so that the Atlantic slope is much the larger. It is divided by the Cordillera Central into a northern and a southern portion, most of the northern portion draining directly or indirectly into the San Juan River, the outlet of the Lake of Nicaragua, while the rivers of the southern portion and a part of the northern empty directly into the Caribbean Sea.

The prevailing winds are the warm easterly trades. They become saturated with moisture as they pass over the Caribbean and the heavily forested low Atlantic coast. Farther westward, as they meet the high mountains of the interior, their moisture is precipitated so that after they pass these elevations they are much drier. As a consequence the Atlantic slopes usually have a heavy rainfall throughout the year and there is little or no distinction between wet and dry

seasons except in places which lie in "precipitation shadows" so to speak, like Cartago sheltered by Irazú. On the Pacific side, on the contrary, there is often a well-defined division of the year into a dry season ("verano") from December to May and a wet season ("invierno") from June to November, the latter due to westerly winds bringing moisture from the Pacific.

These topographical and climatic conditions largely determine the location and operation of Costa Rican railroads, for with every rain the soil and rock—in many places loose and friable—slide in large quantities down the slopes. The erosion so produced has formed a vast number of valleys, cañons and channels of all sizes, whose positions, contours and other characters are constantly changing.

The capital of Costa Rica, San José, is on the Pacific slope at an altitude of 3800 feet (1160 meters). The construction of a railroad connecting it with the Atlantic coast consequently involved the crossing of the continental divide and the traversing of the moist and ever-changing Atlantic slope. As originally planned, this railroad was to run on the north side of the volcanoes Turrialba and Irazú, crossing approximately at right angles the rivers which descend from these peaks, ascend the pass of La Palma and so reach the Meseta Central, or central plateau, in which San José lies. The tracks were actually laid on this line from Limón to Carrillo (1226 feet, 374 meters) at the north side of the pass, between 1872 and 1882, and communication between Carrillo and San José was established by means of a *carretera*, or road suitable for ox-carts, about twenty miles long. It was impossible to maintain this line in operation, however. The numerous rivers crossed by the road are subject to so many violent floods that the stream-beds are constantly shifting and railroad bridges were left high and dry over an empty channel while the river flowed in an entirely new bed. At

the time of our visit to Costa Rica trains ran westward over this line—known as “Linea Vieja” or “Old Line”—only as far as Guápiles. The town of Carrillo had disappeared, having had nothing but the railroad to maintain it; there was nothing there but a telephone guard station on the wire running to San José, which followed the line originally surveyed for the railroad. A trail connects Guápiles with Carrillo but was said to be extremely rough and the fording of the rivers, particularly the Toro Amarillo and the Sucio (so called because of its muddy waters), very dangerous. Another railroad route to the capital therefore became necessary and this was constructed by an American, Minor C. Keith, between 1884 and 1890. It diverges from the Old Line at La Junta, on the left bank of the Rio Reventazón, 38.6 miles from Limón, and reaches the interior by following the great cañon of that river, on the south side of Turrialba and Irazú. It ascends to El Alto, where between Irazú and La Carpintera, it crosses the continental divide, descends the Pacific slope to San José and continues to Alajuela.

The railroads from Limón to Carrillo, Alajuela to Cartago and from Esparta to Puntarenas were constructed when General Tomas Guardia was supreme in Costa Rica (1870–1882), by means of two loans obtained in England. When Mr. Keith undertook the building of the line from La Junta to Cartago, the first two sections just named as built by President Guardia were ceded to him. He too had recourse to foreign capital and the entire road from Limón to Alajuela when completed became the property of the Costa Rica Railway, a British corporation. The United Fruit Company of Boston, organized in 1899, began the building of the Northern Railway running from Limón to the banana districts of Zent and Matina, which was opened for traffic in 1902. In 1905 the Costa Rica Railway Company leased

its railway to the Northern Railway Company and the latter took over the operation and management of the line from July 1 of that year.

The Atlantic railroads being of English and American construction have their distances estimated in miles, a series of posts often only a quarter of a mile apart alongside the tracks giving the distances from Limón. The distances and grades may be appreciated from this list:—

PRINCIPAL STATIONS	DISTANCE FROM LIMÓN		ALTITUDE	
	MILES		FEET	METERS
Limón	0		11	3.4
Moin Junction	3.5			
Zent Junction	20.4			
Matina	21.9		55.7	17.
Madre de Dios	28.7			
Indiana Junction	35.7			
Siquirres	36.7		196.8	60.
La Junta	38.6		187.	57.
On the "Old Line" to Guápiles, technically the Santa Clara Division, are				
La Junta	38.6		187.	57.
Cairo Junction	39.6			
Germania	42.5			
Destierro	44.			
Guácimo Junction	51.2			
Jimenez	55.5			
Guápiles	58.5		984.	300.
On the "New Line" to San José and Alajuela are				
La Junta	38.6		187.	57.
Florida	43.			
Las Lomas	45.2		879.	268.
Peralta	54.2		1055.	322.
Turrialba	62.4		2037.	621.
Tucurrique	68.7			
Juan Viñas	73.8		3286.	1002.
Santiago	78.1		3536.	1078.
Paraiso	85.4		4392.	1339.
Cartago	89.4		4760.	1451.
El Alto	92.2		5137.	1566.

PRINCIPAL STATIONS	DISTANCE FROM LIMÓN		ALTITUDE	
	MILES		FEET	METERS
Tres Rios.....	96.0.....		4363.	1330.
San José.....	102.1.....		3868.	1179.
Heredia.....	108.1.....		3780.	1152.
San Joaquín.....	110.7.....		
Echeverría.....	112.0.....		
Alajuela.....	115.7.....		3231.	985.

The gauge of all the railroads in Costa Rica, on both the Atlantic and the Pacific sides, is the same, three feet, six inches (1.0668 meters). The passenger coaches, at the time of our visit, were of the American type, and of two classes, differing chiefly in the character of the seats; in the first class these were covered with cane or leather, in the second were simply uncovered wood. Some coaches were divided into a first and a second class section by a partition with a door in the center. On the daily train each way between Limón and San José there was also a "chair car" at the end of the train. In this the seats were comfortable wicker arm chairs which the passengers could move about or carry to the large observation platform at the rear of the car, which allowed a fine view of the country for the whole way. There were no return, excursion or commutation tickets on the Atlantic railroads; the rate of fare was about four cents (U. S.) a mile, first class, and anyone failing to purchase a ticket before boarding a train at any place where tickets were sold was fined 50 centimos (= 23+cents, U. S.) which fine was *not* refunded. An extra charge was made for the chair car, which made the total fare between Limón and San José nearly six dollars. When we made our first journey from Limón to San José on May 3, 1909, our baggage was divided into two lots; one weighing 142 kilos was checked to Cartago, the other to San José. After deducting an allowance of 20 kilos free on each of our tickets, we paid 17 colones, 40

centimos (or, as exchange was in Limón just then, about \$7.75 U. S.) for the transportation of our baggage. We made this trip without incident, leaving Limón at 10.30 A. M. and arriving in San José about 5.15 P. M., only fifteen minutes late.

Trains between Limón and Zent Junction could take one of two routes, either plunging almost immediately into the interior by way of the main line of the Northern Railway via Castro and Zent, or following the sea beach for about eleven miles north of Limón to Swamp Mouth and then turning westward on the main line of the Costa Rica Railway. On the first of these we traveled on May 3. For the first thirty-eight miles or so the road ran through almost uninterrupted banana farms, the names of which were posted here and there, particularly over the gateways to the main farmhouses. These were usually two-storied frame buildings surrounded by porches. The cabins occupied by the negro workmen clustered around the stations, sometimes only two or three together, at other places forming little villages. Each cabin contained only one or two rooms; the outside was usually whitewashed, the roofs either of palm thatch or corrugated galvanized iron. Many of the farmhouses and cabins were enlivened by surroundings of gay and variously colored crotons, especially the farmhouse of Monte Verde. At Gute Hoffnung (25 miles from Limón) the whole country, forest and open, was flooded in early November; in some places the water was over the tracks, concealing them completely and here the train slowed down very perceptibly. The cabins of the negroes were built on short piles, the necessity for which was made evident by this flood for many cabins stood within little lakes. There were almost no roads and the paths leading to the cabins from the railroad bed were also lifted on piles out of the water.

Near each cabin grew as a rule a group of breadfruit trees (*Artocarpus communis*) with their deeply-divided large glossy leaves. In early November the green fruit was nine inches in length and somewhat eggplant-shaped. In late November we bought a breadfruit at Siquirres, for ten centimos, and had it baked for us at Cartago. In taste it resembles a sweet potato which is not sweet—butter and salt were required, we thought. The fruit is very solid; the rind thin and marked off in little polygons, corresponding to the individual fruits composing it, for the breadfruit is a multiple fruit allied to the mulberry and the fig. We never saw it in the market at Cartago, and the tree is confined to the low warm sections. Its native home is the South Sea Islands; in Costa Rica it is known as “arbol de pan,” and the fruit “fruta de pan.”

Scattered through the banana plantations stood giant trees whose great trunks, without a branch up to a height of fifty feet or more, proclaimed them to be remains of a forest which formerly covered all this area. Lianas hung from their branches or bromeliads with long narrow green leaves and bright red flowers grew on the trunks even of dead trees. Especially near Siquirres, huge festoons of the gray moss-like bromeliad *Tillandsia* depended from among the proper foliage. There were also rubber trees (*Castilloa* sp.) here and there—but not those cultivated under that name in the United States as ornamental plants, which are properly figs (*Ficus* sp.).

The alternative rail route from Limón to Zent Junction, the main line of the Costa Rica Railway, ran in sight of the surf to Swamp Mouth, then bent to the west and entered a forest consisting in some places exclusively of “swamp palms,” in others of the same palms mixed with exogenous trees. These palms have leaves resembling those of the cocoanut palm but rather coarser, and differing in that each

leaf—twenty to thirty feet long—apparently springs from, or very near, the ground, instead of from the top of a distinct trunk. The number of great leaves is such as to hide the trunk within. This forest extended to a point between Waterloo and Estrada stations, sixteen and twenty miles respectively from Limón. Swamp palms also occurred along the railroad leading from Limón southward to the Banana River. The banana planters say, "Wherever swamp palms are growing, it's no use to plant bananas there."

Siquirres, the starting point and terminus of trains on the Santa Clara division, was an important shifting station for the railroad and, in the early months of our year, was headquarters for engineers and others engaged in the replacement of the bridge over the Reventazón River, but is not an attractive place. In May and June, 1909, the railroad crossed the Pacuare and Reventazón Rivers on temporary wooden bridges. We saw the ironwork of former bridges, swept away by floods in the preceding December and January, lying here and there in the stream-beds, but before November new steel bridges had been put in place. At Las Lomas the banks of the Reventazón, along which the railway is cut, are particularly soft and wash much with every heavy rain, both above and below the tracks. These "slides" are a constant source of expense due to the frequent repairs they entail and unfortunately they are by no means limited to the vicinity of Las Lomas. Every now and then they cause delays in the running of trains lasting from a few hours to several days.

Along the Reventazón from La Junta nearly to Turrialba the railroad lies in the river valley and the tracks are not very far above the water level. They wind with the windings of the rushing stream, which with the high trees and the fern-grown banks contribute to make this part of the ride



The Reventazón Valley, West from Juan Viñas.
The Volcano Irazú, from a field near Cartago.



A Poró Fence near Cartago (leafless but in blossom).



Fruits of the Poró, *Erythrina corallodendron*.

very beautiful. On the rocks in the river black cormorants (*Phalacrocorax vigua vigua*) stood upright watching for prey. A short distance northeast of Peralta the train passed through a tunnel and crossed the Chiriqui River where it empties into the boiling, surging Reventazón. As Turrialba station is approached the railroad is higher above the river and farther from it, and much of the land was cleared, grass-covered and used for grazing. The "Banana Country" has been left far behind and with it most of the negroes, for few were seen beyond Turrialba. From now on there are more and more extensive views of the country, with hill and dale, mountain and valley and often magnificent distances.

Turrialba was looked forward to eagerly as the "pineapple station," just as Irapuato on the Mexican Central was known as the "strawberry station." The negroes, chiefly women, brought to the passenger coaches both whole pineapples and also slices thereof. The whole fruit cost 30 centavos, a single slice 5 centavos. They were thoroughly ripe, sweet and juicy and exceedingly refreshing, for the train had just risen from the hot lowlands. Everyone thrust his head from the car windows to devour the luscious dripping fruit, presenting rather an amusing spectacle as one glanced along the train.

Near Juan Viñas station, which in our year was the breakfast (almuerzo) stop at 11 A. M. for the daily train down from San José to Limón, the tracks in several places are on a shelf cut into the side wall of the cañon of the Reventazón and so close to the edge of the shelf that one can look from the car window down on the river 800 feet below. Here are some of the most glorious views of the whole ride, for here are spread out the whole breadth and depth of the great Reventazón valley, stretching east and west for many miles. Between Juan Viñas and Santiago the barranca or

valley of the Rio Birris is crossed on a high bridge. The railroad now diverges widely from the river. Cartago, the capital of the country until 1823 and until May, 1910, the second largest town, lies in the midst of cattle pastures, while to the north rises the huge and gently sloping mass of Irazú. El Alto, at the continental divide, was not a settlement; the highest point on the line was marked by a stone cross set up by the side of the wagon road which is parallel and close to the tracks. South of this road is a stretch of swamp and open water, the Laguna de Ochomogo.

The railroad now descends the Pacific slope and the difference in the amount of moisture received during the year is almost immediately indicated in the greatly diminished number of epiphytic plants on the trunks and branches of trees, as contrasted with the conditions visible on the Atlantic side. Many more coffee plantations (*cafetáles*) are now visible from the car windows than earlier in the journey and between Tres Rios and the capital they border the tracks on both sides. This train ran no further than San José, but from the same station other trains ran westward to Alajuela. The train for the Pacific coast left from another station in the lower, southern, part of San José, although the Atlantic and Pacific stations were connected by rail.

The Pacific Railroad (*Ferrocarril al Pacifico*) is State-owned and was constructed between September, 1897, and November, 1910. It now connects San José with Puntarenas, but from 1902 to the end of 1910 it was in operation from the capital only as far west as Santo Domingo, now known as Orotina. During the whole of our stay in Costa Rica, trains from San José ran only as far as this place. To reach Puntarenas it was then necessary to take horse or mule 14 miles to Esparta, whence another short railroad carried one to the port. The principal stations on the Pacific road are as follows:

STATIONS	DISTANCE FROM SAN JOSÉ		ALTITUDE	
	MILES	KILOMETERS	FEET	METERS
San José.....			3800.....	1158
Sabana.....				
Las Pavas.....			3516.....	1072
San Antonio de Belen.....			3119.....	951
Ojo de Agua.....			2850.....	869
Nuestro Amo.....				
Ciruelas.....			2794.....	852
Turrúcares.....	19.8.....	32.....	2230.....	680
Cebadilla.....				
Atenas.....				
La Balsa.....			1512.....	461
Escobal.....			1348.....	411
Concepción.....			1040.....	317
Orotina (Santo Domingo).....	46.....	74.....	853.....	260
Coyolar.....				
Puntarenas.....	68.....	109.....	10.....	3

On leaving San José the road passes through rolling country lying between the volcanoes of Barba and Poás on the north and the cerros de Candelaria on the south. Some distance to the north of the railroad are the roofs of the towns of Heredia and Alajuela. The chief crops in cultivation at the time of our visit were coffee, corn (maize) and rice. One of the most characteristic trees seen from this railroad, below 3000 feet, is the "Guanacaste" (*Enterolobium cyclocarpum*). They often stand alone and are very handsome trees with trunks three to four feet in diameter and an immense spread of branches. The head is as large as our spreading oaks but the spray is more graceful and lacks the stiff ruggedness of the oak. The guanacaste is a Mimosa with a much divided leaf as fine and delicate as a maidenhair fern.

Beyond Pavas the line crosses the deep valleys of the Rios Torres, Virilla and Bermudez. San Antonio de Belen has an historical interest for the naturalist for in 1847 it was

the headquarters of the Danish botanist, Anders Sandoe Oersted, to whom some of the earliest scientific exploration of Costa Rica is due. At Ciruelas a branch road runs off to Alajuela. Beyond Cebadilla Station the Rio Grande de Tárcoles is crossed by the longest bridge in Costa Rica, a cantilever 452 feet in length and 300 feet above the water. Tablets at the end of the bridge state that it was designed and built by Milliken Bros. of New York. Alongside the single track is a walk about three feet wide for pedestrians. The bridge commands some fine views of Barba and Poás to the northeast, the Aguacate Mountains to the north and northwest and the cañon of the river. To the southwest is a deep notch in the hills marking where the cañon opens to the Pacific but the ocean itself is not visible.

Atenas was the meal station and as we saw it in October, 1909, was an odd place. Under an open shed stood tables on which all the comestibles were spread out to view. There were no plates or forks. Everything was served on "tortillas" or maize cakes;—broiled chicken joints, stewed beef, sausages, "picadillo," cheese, omelettes—each portion was laid on a tortilla and the customer picked up what he wanted and finished the meal by eating his "plate." Most of the things were excellent. For drinks there were milk, and coffee "sin ó con leche" but cooked with dulce or brown sugar, in the Costa Rican style. The town of Atenas is five miles (eight kilometers) distant from the station. Beyond Atenas Station the train ran around the southern base of the bare and steep Aguacate Mountains, wherein are the principal gold mines of Costa Rica.

In the wet season the track of the Pacific railroad was often in very bad condition and trains were frequently delayed for hours owing to landslides. The worst place was at Las Lapas, where the track ran on a shelf cut in a soft decomposed rock which slipped and slid and carried the whole

roadbed with it. When we went down to Orotina on October 15, 1909, we were glad to learn that the "bad part of the road was now good"—for this day only perhaps, but sufficient unto the day are the slides thereof. We approached Las Lapas slowly and cautiously. The most dangerous part was a very sharp narrow bend around a small side valley. Here there was a Y-shaped track, our train approaching along one arm of the Y toward its stem. The engine had previously been put on the rear end of the train, and we were now pushed on to the stem of the Y far enough for one car to be over the switch and uncoupled. It was held back by some twenty peons while the engine pulled the rest of the train away over the same arm leaving the one car on the stem. Then the switch was thrown open for the other arm (which was three to four feet lower than the first arm), the car went down by gravity and was stopped by its own handbrakes in the middle of a none-too-safe-looking timber bridge. This operation was repeated for each car and the engine, until the train was made up again, each car reversed, on the bridge and the engine pushed us on ahead of itself. The track was extremely uneven and shaky. As we crawled along the cars swayed and lurched from side to side and endwise, the tracks groaned and brakes screamed, but we did somehow stick to the tracks. For half a mile each side of this place the track looked as if it would slip away any minute. There were many marks of recent slides, the most impressive being a basket on a cable, stretched from one arm of the Y to the other arm, to convey passengers when the road was really impassable. In January, 1910, the passing from one branch of the Y-track to the other at Las Lapas was accomplished in a much shorter time, for the stem of the Y had been lengthened by cutting into the hillside, so that the entire train could be run onto the stem at once and then off to the other arm.

Beyond Las Lapas we wound about the deep side valley of Rio Concepción, a northern tributary of the Rio Grande de Tárcoles. The track twists and turns in a most extraordinary fashion so that there were many places where one could look across and see another section of it running parallel to that on which the train stood, and every turn opened a new and beautiful vista. West of Turrúcares the grade is very steep; going in that direction the main thing is to hold the train from running too fast down hill, but traveling east is another story. On the return trip in the same month of October, the train pulled out of Orotina at nine o'clock—"a la punta" plus some minutes. The distance from Orotina to San José is 46 miles, the difference in elevation about 3000 feet and our running time was *twelve hours*. The day was bright and beautiful until almost four in the afternoon and we had little rain at any time. The scenery was magnificent and the ride should have been a pleasure, but fatigue made it tiresome before we reached San José. In addition to the dangerous condition of the roadbed there was no coal, whereby the locomotive was forced to burn wood instead. The consequence was that it could run only a few miles before the steam was exhausted and it was necessary to stand still and wait until the pressure rose high enough.

These delays could sometimes be utilized. At Rio Concepción we stopped fully half an hour. A stream of clear water flowed alongside the track from a brook serving as a water supply. There were six or seven species of dragonflies flying over this water so P. rigged up the net and caught specimens of all but the two most common ones. No one had ever collected these insects here before—and it gave some passengers something to look at while they waited.

In such wise we made the trip, running fifteen or twenty minutes, then standing three-quarters of an hour to get up

steam again so that it was almost nine o'clock when we reached San José. Yet three days earlier the train went from Orotina to San José in three hours; but on October 22 it was so delayed that it only reached San José at 5 A. M. of the 23d!

CHAPTER III

SAN JOSÉ

The American traveler Stephens wrote of the capital of Costa Rica as he saw it in February, 1840:

“San José is, I believe, the only city that has grown up or even improved since the independence of Central America. . . . The buildings in San José are all republican; there is not one of any grandeur or architectural beauty; and the churches are inferior to many erected by the Spaniards in the smallest villages. Nevertheless it exhibited a development of resources and an appearance of business unusual in this lethargic country; and there was one house in the plaza which showed that the owner had been abroad, and had returned with his mind so liberalized as to adopt the improvements of other countries, and build differently from the custom of his fathers and the taste of his neighbors. . . . In San José, by-the-way, all the ladies were what might be called good business-men, kept stores, bought and sold goods, looked out for bargains, and were particularly knowing in the article of coffee.”

During the following seventy years the “development of resources” brought considerable grandeur which has been described in English many times by visitors of very different abilities. Owing to this wealth of description, to the existence of several albums of photographic views (such as that of Zamora) and to the character of the present volume, we shall devote but a very few pages to the capital.

On Dec. 31, 1910, San José had a population of 30,854. Its plan was that of a chess-board with perfectly straight

streets, "Calles" running north and south, "Avenidas" running east and west. The two main thoroughfares, the Calle Central and the Avenida Central, divided the city into four quarters; the Calles were numbered 1, 2, 3, etc., east or west from the Calle Central, correspondingly the Avenidas 1, 2, 3, etc., north or south from the Avenida Central. The streets and many buildings were lighted by electricity. The Calle Central and the Avenida Central contained many of the shops and other important edifices and in 1909-10 were traversed by lines of electric cars with overhead wires. At the same time the ox-cart was still almost exclusively in use for all kinds of hauling, including the carriage of the traveler's trunks to his hotel and formed a striking contrast to the bustling "trolley" as they passed each other. Coming from Cartago to San José one day in February, P. found the street by the railroad station, from the opposite curb to the adjoining freight station, filled with ox-carts taking away or bringing goods. Never had he seen so many. In addition to the electric cars there were many two-horse carriages for hire in the streets, which were much patronized.

In the northeastern quarter were the station of the Atlantic railroad, the custom house (Aduana), the National Park with its group of statuary commemorating the defeat of the American filibuster Walker by Costa Ricans in 1857 (an event which assumes large proportions in the national histories), the tall iron building occupied in our time by the Escuelas Superiores, and the Parque Morazan. All these lay within three blocks to the north of the Avenida Central.

In the outskirts of the northwestern quadrant was the imposing and finely situated penitentiary; in the portion nearer the center of the city the various Government offices and the Post Office (Correo). The method of distributing postage stamps and postal cards was quite a novelty to the traveler from the north. The Government did not issue or

sell stamps, etc., but gave a concession to do this to some agency, at that time the Banco de Costa Rica, formerly to the Banco Anglo-Costaricense. The Bank made a contract with engravers in England or in the United States to print certain quantities of stamps of different denominations as approved by the Government. A percentage of the face value of the stamps was paid by the Bank to the Government in return for the concession and this sum largely paid the expenses of the Post Office Department. The Bank sold the stamps to anyone who wanted them, a discount of 6 per cent being given on sales amounting to 25 colones (\$11.62+) or more, so that a person buying 25 colones' worth of stamps from the Bank paid only 23½ colones for them. Many storekeepers throughout the country bought stamps at this discount and retailed them, at face value of course, making a little more than 6 per cent on the transaction. It was not part of the duty of postmasters to sell stamps, although they might undertake it like other shopkeepers if they chose to do so; before we knew this we were astonished at being unable at times to buy stamps at the Cartago Post Office. Periodicals (newspapers, magazines, etc.) could be mailed *free* to points on railroads in Costa Rica, as part of a policy to extend knowledge and diffuse information.

In the southwestern quadrant was the Plaza Central, whose border of fig-trees, represented in many pictures, had been removed previous to our visit, giving the square a barer and more open appearance than is usually to be found in such places. On the east side of this Plaza was the Cathedral, on the north side the principal barracks. This quadrant contains also several hotels of which the Imperial was most frequented by foreigners, the Banco de Costa Rica and the Gothic church of La Merced with a single spire over the main (west) entrance and another over the junction of nave and transepts. Nearby were the large hospital of San Juan de

Dios and the Escuelas Mauro Fernandez, named for the recent Minister of Education whose portrait appears on the 5 centimo postage stamps of this period. These Escuelas were two-storied with a basement under part of them. The Palacio de Justicia, a one-storied building with a small patio planted in roses and containing courts of "Casacion" and "Apelacion" and a law library, and farther west on the south side of the Avenida Central the almshouse and the Asilo Chapui for the insane also belong to this quarter. The west-bound electric cars turned to the south at the west end of the Avenida Central and skirted the southern edge of the Sabana, a common forming part of the land bequeathed to the "sons" of San José by the prelado presbitero don Manuel Antonio Chapui de Torres in 1777. On various sides of the Sabana and facing it were some handsome private residences, gardens and club buildings; there was also a Sabana station on the Pacific Railroad here.

In the southeastern section was the magnificent Teatro Nacional, the chief architectural monument in the country, which was largely constructed of white and yellow Italian marbles and has often been described. Here too was the one-storied Museo Nacional, which, under the administration of Señores don Anastasio Alfaro and don Juan J. Ferraz, has, with limited means, accomplished much for the exploration of the country and its natural history. It was founded by the Government May 4, 1887, as "a public establishment where are deposited and classified all the natural and artistic products which may serve as a basis for the study of the riches and culture of the country." At the same time don Anastasio Alfaro was named administrating Secretary, to act under the direction of a Committee, appointed January 28, 1888, consisting of Señores don José C. Zeledon, don Manuel Carazo Peralta, don Juan Rojas, don Juan Francisco Echeverria, don Enrique Pittier and don Pablo Biolley.

The Museo contains public collections of the animals, woods, native pottery and prehistoric goldsmith work, maps, arms and armor of Costa Rica, an extensive herbarium, a scientific library and study collections in various groups of animals. One of its earliest acquisitions was the important collection of Costa Rican antiquities formed and bequeathed to the Government by don José Ramón Rojas Troyo of Cartago. Connected with the Museo at different times have been the naturalists Paul Biolley (born in Switzerland, 1862, died at San José, 1908), George K. Cherrie, an American (member of Colonel Roosevelt's Brazilian expedition of 1913-14), Cecil F. Underwood, an Englishman, and J. Fidel Tristán, a Costa Rican. To Director Alfaro and to the botanist of the Museo, M. Adam Tonduz, we were greatly indebted for assistance in our work. The first volume of the *Anales* of the Museo was published in 1887, since which time nine volumes have appeared, some of them under the joint title of *Anales del Instituto Físico-geográfico y del Museo Nacional*.

The Instituto Físico-geográfico was established by Presidential decree April 7, 1888, under the name of the Instituto Meteorológico Nacional, although meteorological observations were begun by its director, Professor Henri Pittier (de Fabrega), a native of Switzerland, on December 12, 1887. Its title was soon changed to that of Físico-Geográfico, indicating its enlarged scope. Professor Pittier served as Director of the Instituto until 1904, developing it to such an extent that Dr. Karl Sapper, who visited it in 1899, wrote of it as being entirely on the plane of European institutions of a similar kind. In addition to the *Anales* above mentioned, the Instituto published a *Boletín* in 1901-03. In later years the Instituto has become the meteorological section of the Museo Nacional whose building it immediately adjoins, and the yearly operations of both establishments have been described in the *Memorias de Fomento*

presentada al Congreso Constitucional by the Sub-secretario de Estado en el Despacho de Fomento.

A few blocks from the Museo was the three-storied Colegio de Señoritas, the highest educational institution for girls in the republic. Its director, Professor J. Fidél Tristán, educated under German professors in the University of Santiago, Chile, and speaking English fluently, was our chief guide and mentor in our explorations and to him more than to any other one person do we owe much of our success. Education receives great attention in Costa Rica and the sums spent for this purpose form a large part of the national expenditures.¹ The report of Don Alfredo Volio, Secretary of State in charge of Public Instruction for 1909, gave the number of official primary schools in October, 1908, as 357, of which 82 were for boys, 79 for girls and 196 for both sexes. The 357 schools had 887 teachers and 27,452 pupils (14,210 boys, 13,242 girls). The Colegio de Señoritas had a five-year course and gave instruction in mathematics, geography, physics, chemistry, natural sciences, history, pedagogical psychology, the practice of teaching, Spanish, French and English, domestic economy, singing, drawing, manual training, calisthenics, morals and religion. The number of students including those in "preparatorio" increased from 97 in 1899 to 306 in 1908. The roof of the Colegio (like any other of the higher buildings in San José, indeed) commands magnificent views of the vicinity of the capital. Along the northern horizon from east to west are Irazú, the pass of La Palma leading northward to Carrillo, the lesser cerros of Zurquí, the volcano Barba, the pass of Desengaño, the volcano Poás and lastly the Aguacate Mountains; on the east, La Carpintera (5700 feet) separates

¹ For the figures for 1909 and 1910, respectively, see the *Bulletins of the Pan American Union*, vols. XXXI, p. 121, and XXXIII, pp. 87-88, Washington, D. C., July, 1910, and July, 1911.

this valley from that of Guarco in which Cartago lies; to the south is the imposing ridge of Candelaria (Escazú), while to the west a gap indicates the way to the Pacific. The earthquakes of April and May, 1910, rendered the Colegio building unsafe and instruction was transferred temporarily to the one-storied Presidential residence on the north side of the Avenida Central.

On the outskirts of the southeastern quarter, facing each other on opposite sides of a wide street, were the Liceo de Costa Rica and the Escuela Normal. The Liceo was two-storied with an oblong patio, where the ceremony of awarding certificates took place and behind was a separate gymnasium of ample dimensions. The Liceo and the Escuela were of exactly the same size and shape externally, which seemed a pity, and both were covered with cement or stucco highly colored to represent stone, which spoilt the effect greatly. The Liceo was the highest educational institution for boys in the country and offered, in 1908, a five-year course, a normal course of two years, a commercial course of two years and a one-year technical course. Including 30 students in the "preparatorio," the total in attendance in 1908 was 241. The former University of San Tomas in San José has been discontinued for many years.

South of the Liceo and separated from it, in our time, by several open blocks was the gaily-stuccoed abbatoir, and near it the station of the Pacific Railroad. This was also the southern terminus of the electric cars of the Calle Central, their other terminus being the village of Guadalupe north of San José.

Herr Alfred Brade, a German naturalist and collector, had a flower garden, with a few animals in captivity, which formed one of the sights of San José at this time; these were also in the southeastern quarter. Among the animals were "tigres" of different kinds and some "pavones" (*Crax pana-*

menis), handsome gallinaceous birds allied to turkeys and peafowl. The male was black with golden yellow wattles, the female brown and yellow, barred like a pheasant. Both had erectile crests of curled feathers on the head and upper neck. They were very tame and when Herr Brade put his hands in the cages and petted the birds, it was a great sight to watch these crests rise as the birds responded and looked eagerly for tidbits.¹

¹ A female pavon belonging to Herr Brade is figured from a photograph and described by C. Wercklé in *Boletín de Fomento*, Año IV, No. 1, pp. 62-64, San José, Jan., 1914.

CHAPTER IV

THE TOWN OF CARTAGO AND ITS LIFE

During the twelve months that we lived in Costa Rica we made Cartago our headquarters, always retaining our room in the hotel and keeping there our rather large equipment. From Cartago we made excursions to many different parts of the country, remaining away one to two weeks but always bringing back our material to be worked on and stored in Cartago until we were ready to send it to Philadelphia. By this method we avoided many of the dangers and discomforts of a long sojourn in the tropics. Cartago has a cool and bracing climate—it was one of the places where Panama Canal Zone employees were permitted to spend their vacations—, it was almost free from mosquitoes and malaria was not endemic. Cartago lies on the northern slope of the so-called Valley of Guarco, a slope which ascends northward to become the great mass of the volcano of Irazú and southward descends gradually to the Rio Agua Caliente, a tributary of the Rio Reventazón. On the south side of the Agua Caliente the hills rise much more abruptly. The railroad station of Cartago is 4760 feet above sea-level, the Agua Caliente at the bath house, two and one-half miles away, is 4460 feet, while Irazú rises to 11,300 feet. The town is laid out with great regularity, its streets running almost exactly north-south and east-west; many of the north and south streets are continued northward as lanes and tracks which form a maze over the lower slopes of Irazú running between the stone walls that enclose the potreros or pastures. To the south of the town some of these streets become wide



Cartago, from the Tierra Blanca Road.
Towers of Nuestra Señora de los Angeles and behind them La Carpintera.



A Street in Cartago, looking toward Irazú.

A Corner of the Park, Cartago.

cartroads leading to the neighboring villages of Dulce Nombre, Concepción de Cartago, Agua Caliente, San Isidro del Tejar, Tobosi and the more distant villages of Paraiso and Orosi. Others were lanes cut off by fences after a distance of half a mile or so, and some of these lanes formed our richest collecting fields about Cartago.

The town was much spread out, especially along the main east-west street, the Calle Real, and contained six to seven thousand inhabitants. The streets were unusually wide for a Spanish town and there were scarcely any two-storied buildings because of the frequent earthquakes. The houses were of plastered adobe and were often tinted but not usually of a bright color. Our hotel was pale green, the stores across the street a salmon yellow. The roofs were of curved red tiles, the eaves projecting some two feet beyond the walls, and the sidewalks were so narrow that in many cases the eaves completely sheltered them. Only on a part of the Calle Real, which leads to the Panteon, was there a sidewalk as much as five feet wide. With the years, the red tile roofs become coated with green and gray lichens and in the depressions spring up ferns and *Echeveria australis*, a plant resembling houseleeks. It has an inflorescence about a foot high and when we arrived in May the old flower-stalks were standing up bare and brown, in great numbers. The rains were bringing out the new buds but as yet they scarcely showed. The windows were almost invariably casements protected within by heavy wooden shutters, and often the house was so little raised above the ground that the window sill was not more than two feet from the level of the sidewalk. Our own was about four feet.

Some of the main streets had excellent macadam paving, with deep rounded gutters of solid concrete at each side. Where such streets intersected the gutters were covered with stone slabs at the roadway level. During the dry season

a novel method of sprinkling the dust was employed on these streets. By temporarily and partly damming a gutter where it passed under the stone slabs, considerable water was soon accumulated behind the dam and a troop of small boys, straddling the gutter, scooped up this water with tin basins and dippers and threw it out on the roadway until the dusty surface was well dampened. Then the temporary dams of boards and cloths were removed to the lower end of the next square. The poorer streets displayed various degrees of paving from stone blocks to soil, but in these cases there was a gutter down the middle one to two feet wide, well defined by stones and carrying a stream of water several inches deep. Clear water was constantly rushing down these gutters of the north-south streets from the mountain, and in addition the surplus water from the town reservoir, three-quarters of a mile above the town, was turned into the streets every night carrying off any surface drainage. Water for domestic purposes was not taken from these streams but was piped to the houses. Even far out of the town it was common to see a water-pipe, tap and cement sink outside the house door. Neither did Cartago depend upon surface drainage but had an excellent sewage system and during our stay there was planning the installation of a sewage disposal plant.

It was a common thing to see women washing clothes in the stream flowing down the middle of the street, rubbing and soaping them on the large stones forming the edge of the channel and later, following the invariable custom, hanging them up to dry on the nearest barbed wire fence. The barbs were a most convenient form of clothespin, always at hand when needed, and as barbed wire has been used in amazing quantities all over Costa Rica the washerwomen are never at a loss and greatly prefer to hang the wash on the fence rather than to follow their own native custom of drying clothes on the ground.

Cartago was lighted by arc lamps and most of the houses used electric lights. The town was well policed, clean and orderly.

We rarely saw the people carrying loads on their heads or backs. There were some pack animals, but the hauling was mostly done by bullock-carts, as the roads about Cartago and San José are numerous and fairly good. The carts often had solid wheels, each one the section of a tree-trunk, but iron tires. They were often painted bright colors, blue, red or occasionally yellow. The oxen were large, powerful, handsome creatures, for the cattle in this grazing country are of good breed. The yoke rests partly on the horns, to which it is strapped, partly on the head, and there is an odd wooden shield over the neck. The driver walks in front of his team carrying the goad, a long slender staff with an iron point, so that the sharp end rests on the yoke. Occasionally the goad is laid across the yoke and the driver walks beside his team. There was at least one horse cart in Cartago and a few carriages but most people rode on horse-back. Away from the line of the railroad, indeed, everyone must either walk, travel in ox-carts or ride, for no vehicle less sturdy than the ox-cart could survive the roads.

The "Hotel de Cartago" where we lived consisted of two excellent native houses thrown together by doorways and passages, and Mr. Weldon, the American proprietor, had introduced sanitary features such as additional plumbing and windows and in every room had removed one pane of glass for which he substituted fine wire netting. The importance of the latter improvement was not apparent to us until we learned—by transgressing—that the police regulations of Cartago did not permit first floor windows to be open or unfastened after midnight. These houses were built around patios in the usual style and in each patio there was a large cement sink with fine cold, clear, running water,

while in the kitchen patio there was even a hot water tap—the rarest of luxuries. The main patio, of which the dining-room formed one side, contained some flower beds, a large “Peruvian pine” or *Araucaria* and was further adorned with two big macaws, the common red and blue and a somewhat rarer brilliant red one, and a tame but chained white-faced monkey. The antics of these three creatures provided endless amusement and they had frequent little differences—really a “monkey and a parrot of a time.”

The food in Cartago was extraordinarily good. Fowls and pigs were plentiful and the cattle raised on Irazú furnished excellent beef. Sheep are not bred in Costa Rica so that mutton is unknown. The vegetable gardens produced the greatest variety of vegetables throughout the year and we enjoyed fresh peas, string beans, young carrots, young beets, cauliflowers, onions, sweet and white potatoes and green corn nearly every month of the year, while there were only a few months in which we did not have fresh asparagus and strawberries. The latter in particular were of exceptionally large size and delicious flavor. These introduced plants only grow to such luxuriousness and perfection in the higher parts of the country. There were also, of course, the native fruits and vegetables, especially bananas, plantains, frijoles, or black beans, the tips of the young fronds of a tree-fern, called “rabo de mico” (monkey’s tail) because of their curved ends, the “manihot” or “yuca” (*Manihot utilissima* and *palmata*) and above all “chayotes.” The chayote (*Sechium edule*) is a cucurbit with a globular or ovoid fruit having but one large seed. It is a most useful plant. The young leaves are eaten either cooked like spinach or to enrich soups. The young fruits, an inch or so long, are stewed or baked in milk. When ripe the fruits are six or seven inches long, with a firm prickly skin and are then baked whole, or halved and stuffed before baking, or fried

in slices. There seemed no end to the possibilities of the chayote in cookery. This plant, under the name of "cho-cho," is already grown in some parts of the southern United States, particularly in Louisiana. In their seasons, anonas, mangoes, grenadillas (or "may-pops") and aguacates or "alligator pears" as the Americans call them, were common, while oranges and pineapples were good, plentiful and cheap almost the whole year. Anonas or "custard apples" are particularly delicious tropical fruits. Under a dull green or brownish skin with indistinct overlapping scales is a rich, juicy, finely flavored pulp of the consistency of a firm custard, in which are embedded a number of large, black, shiny seeds about three-quarters of an inch long, the whole fruit being six to eight inches long, three to four across. The flavor suggests both grape and pineapple although it is quite distinct from both.

Good milk was obtained from several dairy farms, notably the Lecheria belonging to Don Ricardo Jimenez, situated on the upper slopes of Irazú at about 9000 feet elevation. He not only sold milk but also made excellent butter, chiefly for sale to the foreigners. Most Costa Ricans, certainly all the poorer families, do not make or use butter at all. Any surplus milk over the day's needs is made at once into a soft white cheese, which is very good and often used on tortillas as butter is used by those who are accustomed to the latter article.

Cartago was a market town and owed some of its importance to that fact, as it had no manufactures. Coffee and cattle were the chief agricultural productions of the surrounding country. The market was a large enclosure near the station, with corrugated iron roof; stores and a hotel occupied the north and south sides, while the east and west ends were merely fenced in. The great weekly market was held early Sunday morning. Then the streets were full of country

folk and ox-carts, the shops were all open, everyone wore his or her gayest and best, and it was one of our pleasures to wander about the market at that time. There were few stalls or booths except those in which shoes, clothing or imported enamelware were sold. Most of the market people squatted on the cement floor with their wares about them—sacks of oranges or lemons, little heaps of vegetables, and fruits, beautiful flowers, unglazed pottery of local manufacture, polished cows' horns and quite artistic combs and pins made of the horn, tanned hides from which sandals could be cut and equipped with thongs all ready for wear, while the customer waited, sacks of green coffee and great quantities of beans, maize and rice. Little wheat is grown in Costa Rica and the imported wheat flour is rather costly. Outside of the towns the tortillas made of ground maize are the staple bread stuff and are very good when hot and freshly made. We found them dry and unpalatable when they were cold. In the towns excellent bread is made of wheat flour and is used except by the poorer people. There were also little charcoal stoves over which tortillas were baked, coffee boiled or black beans or rice cooked for sale in the market, and coops of live fowls at times or perhaps one or two held by a string about one leg. No cattle, pigs or horses were sold in this market as there was a weekly cattle market in another part of town, on Thursdays. At festival times there appeared great numbers of shiny tin ornaments, flowers and candle-holders, destined to adorn the shrines of favorite saints.

Tortillas being a staple food, the grinding of the maize into meal is a daily occupation of the poorer Costa Rican women. The native instruments are the "piedra" (stone), a large block of the common lava, the upper surface smoothed and slightly hollowed, and the "mano de piedra," a sort of stone rolling-pin without handles. The piedra may be much

more elaborate and those exhumed from old Indian graves usually have four short legs and often have animals' heads carved on the ends, while the *mano de piedra* has a handle and looks in side view like a modern chopping knife. Some *pedras* of this more elaborate pattern are still in use, but in the ordinary kitchen the simpler style is the common one. It was interesting to see how this old native implement was being replaced by a modern imported machine of the coffee mill or meat-grinder type, so familiar in most American kitchens, and both the iron grinders and the *pedras* were sold in the market.

The Plaza of Cartago was particularly pretty, a large square shaded around the outer sides by tall, thick, *higuerones* (*Ficus* sp.) and by a great variety of other trees within. There were many well-tended flower beds, containing a wonderful variety of plants, not masses of one or two kinds only. The number of different plants in bloom at one time was often very striking. The gravelled walks were neatly kept, there were plenty of comfortable benches and the park in every way was an ornament to Cartago and the town was justly proud of it. As in other Costa Rican towns, the bandstand occupied the middle of the park and here the military band played on Tuesday and Thursday evenings and twice on Sundays. The almost invariable existence and good playing of the bands even in small villages in Latin America astonish most northern visitors, and certainly a North American town of the size of Cartago that had so excellent a band would be unusual. On July fourth the "Star Spangled Banner" was included in the program of the evening concert as a compliment to the American visitors.

On the north side of the Plaza was the Municipal Palace. On the east side stood the Parroquia, a large unfinished church, begun many years ago and damaged by an earthquake before the roof was on. In 1910 it was a big, thick-

walled, roofless, stone building, apparently without foundations as there was no excavation within the walls for a cellar so that foundation walls could not be seen. There were the bases of the usual two towers, two chapels on each side, a curved chancel, and down the interior two rows of bases for the columns that will divide the nave from the aisles. Around the inner sides of these towers ran stone steps up which we climbed for the sake of the fine view from the top of the walls.

In the southwest part of Cartago a large square was occupied by the "Central American Court of Justice," erected in great part at Mr. Andrew Carnegie's expense for the peaceful arbitration of subjects of dispute among the republics of Central America. When we arrived in Cartago the "Peace Palace," as it was familiarly called, was up to the level of the first floor and work progressed steadily though slowly during the year we lived there. It was practically finished by May, 1910, and was a very handsome building of brick and plaster, with some beautiful carved marble statues. The dedication was planned to take place in June, 1910, but the Peace Palace was absolutely wrecked by the earthquake of May fourth.

"Cartago" is the name of one of the five "provinces" of Costa Rica, of the "cantón central" of that province and of the town which is at once the capital of the province and head of the canton. Every canton is divided into "distritos." In this case the chief villages of several distritos are not only adjacent to Cartago but perfectly continuous with it—a geographical fact which is difficult for strangers to appreciate, but which explains the widely different estimates of the size of Cartago. Thus the villages of Carmen on the north, San Rafael to the northeast, Los Angeles to the east, San Francisco to the south and Guadalupe on the west are to the visitor absolutely undistinguishable from



A Branch of Higuérón, *Ficus* sp.

Flowers and Fruits of the Targuá, *Croton gossypifolius*.



Echeveria australis, from house roof.

Two Chayotes and a Sapayo.

Cartago and the latter name was frequently applied to the whole assembly of villages.

Each district had its own chief church as well as smaller ones. Cartago proper contained the handsome Gothic church of San Nicolas, the unfinished Parroquia, the Soleidad and several others including the pretty chapel of the Orphan Asylum at the west end of the Calle Real. The Orphan Asylum had quite extensive buildings and we often saw the boys at work in their large garden. The district of Carmen lay just north of the railroad and the Carmen church was very conspicuous from its extreme width and disproportionately low, squat, square towers.

South and east of the Parroquia was the large church and monastery of San Francisco. It was unfinished when we settled in Cartago and on Sunday, the eleventh of June, a big "Turno" was held for its benefit. The town was placarded for days with large posters announcing a "Turno General" for the benefit of the church of San Francisco de Cartago and we waited with some interest to learn what a "Turno" might be—the dictionaries vouchsafing no pertinent information. The event proved to be an occasion on which everyone "turned to" and worked for the church. The market that day was exceedingly crowded and there were all sorts of extra things for sale,—more flowers, more pots, more cooked food, little odds and ends that looked like personal treasures—all to be sold for the good of San Francisco. Outside the market were numbers of temporary booths where young ladies—not market people—sold or more frequently raffled everything imaginable, just like a church fair at home. There were many groups of pretty little girls in the streets all day selling "chances" on dolls, toys and so on. About eight o'clock in the morning we saw a long procession of oxen coming down the mountain and when they were nearer we found that each pair dragged a

large log or tree-trunk, pointed at one end so it could be more easily hauled. There were twenty-five or thirty teams in this one file and we followed it to the back of the church. Here a previous procession had deposited almost as many loads of sand, stone, gravel, bricks and other building materials. The gates were open giving us a glimpse into the garden where we could see some monks in their brown robes with hoods and rope girdles. They looked pleased and with reason, for all this labor and material was donated and work on the church progressed rapidly after the Turno. Before we left Costa Rica the church and other buildings had been finished, forming one of the finest ecclesiastical groups in Cartago. Alas! We not only saw it finished but utterly destroyed a short time after its completion.

At the extreme east of the town stood the Church of Nuestra Señora de los Angeles, one of the most remarkable of the Cartago churches from the large collection of silver votive offerings and the sacred spring behind the church. The shrine enclosing the spring was a curious eight-sided pavilion; there was no roof but the sides were filled in with iron grillwork and a sign invited alms for the completion of the edifice. The door was locked but one could look through the ironwork of any side. Steps and an inclined path of cement led down to the spring in the center, and this path was bordered on each side by wonderful constructions of cement apparently representing the waves of the sea and a lighthouse. Each wave was coated with sea-shells, and there was besides a tiny full-length figure of the Virgin under a glass case, a large Sacred Heart under another glass case, while a little promontory between two windings of the path was occupied by a tiny garden of real flowers carefully enclosed by chains and wire netting. The inside walls below the grillwork were adorned with paintings of landscapes—hills, a train crossing a high bridge, people walking on a

boulevard, etc. The diameter of the enclosure was not much over thirty feet; its contents formed a curious mixture.

This shrine marks the place where a healing spring miraculously appeared in the early eighteenth century, bubbling through a hole in a round flat rock on which was found a small image of the Virgin. The image was often familiarly and affectionately known as "La Negrita" because it appeared in a part of the old settlement occupied by the poorer people and such few negro slaves as there were. Both image and spring have always been endowed with miraculous healing powers and the fame of Nuestra Señora de los Angeles spread in time to Guatemala and even to Mexico and Peru. Many pilgrims traveled long distances to arrive in Cartago on August second, when La Negrita made a formal procession from some strange church (to which she was translated at midnight of August first) back to her own church. The pilgrims joined in the procession escorting the image and many strange vows were performed which had been promised if a cure was effected. Some of these were highly ridiculous such as painting the face strange colors, neglecting to shave, dressing like women or carrying heavy stones on the head. The more usual vow took the form of offering a gold or silver (preferably gold) replica of the afflicted organ. There was a wonderful collection of silver arms, legs, heads, hands, feet, ears, eyes, livers, and almost every part of the human anatomy, in glass cases (well fenced in) and some years ago there were also many gold ones but a German bishop gathered up the best of them and took them to the Berlin Museum. This procession was held annually until a few years ago, when a more intelligent Cura opposed the custom and it was finally abolished. The spring still bubbles through the circular stone, and in former years there were many precious bits of stone

sold as healing relics, the stone miraculously lifting itself up and growing whole again overnight. The round stone is of the black volcanic rock so common about Cartago—the inference as to the origin of the fragments is obvious.

At the western end of the village of Guadalupe, west of Cartago, stood the very picturesque church of Guadalupe, shaded by a magnificent higueron and across the street was the Panteon or cemetery. The latter was surrounded by a high, thick wall containing many niches each of a size to hold one coffin, which was hoisted into place by a big traveling crane. When a body was put into one of these spaces the end was sealed and ornamented with the name and date, done in various styles,—black and gold, plain marble, sky-blue with bright sprays of posies, or whatever the taste of the mourners dictated. There the coffin remained as long as the rent was paid, but it was removed to some general unmarked grave as soon as the payments ceased. In addition to the tiers of niches in the wall there were a number of isolated vaults at the ground level, or groups of three or four, and some monuments and life-size carved statues. A few trees were planted, among them junipers trimmed into ghastly likenesses of crosses, crowns, etc., but there was nothing—in this land of flowers!—approaching a garden effect. The lower part where the poor were buried was the most desolate spot imaginable—bare ground, jagged holes half full of water, new mounds all unmarked, irregular, loosely filled in, with here and there a wooden cross all aslant or a feeble attempt at a flower. The people do not seem to object or they would change it of course, but it looked dreary in a country where trees and flowers run riot if given a chance. On All Saints' Day we walked out to the Panteon to see if there was any particular decoration in honor of the day. Some of the tombs had fresh wreaths and garlands, some of fresh flowers, some artificial, and others of

bright tin, and there were perhaps more people there than usual.

Palm Sunday, or Domingo Santo de Ramos, was the beginning of the great Holy Week celebrations. Early mass was celebrated in a number of churches, but the chief event was the procession of *Nuestro Señor del Triunfo* through the streets from the church of Guadalupe to the Church of the Soledad. The procession consisted of several hundred men and boys walking on the left side of the street, as many women and girls on the other side, with the band in the middle playing a gay march anything but religious in tone. Behind the band a space was kept clear, then followed three ragged barefoot boys, the middle one carrying a small diamond-shaped purple banner while the outer boys held tall candles. After them came two men leading a donkey on which was a life-size figure of Christ—*Nuestro Señor del Triunfo*—holding the reins in the right hand and a large bunch of palm leaves in the left. The figure was dressed in purple velvet, with a long flowing purple velvet cloak embroidered in gold, a wide lace collar and a big purple hat from under which hung long curls—such a costume as Charles the Second of England wore. It had not been possible to tie the figure on the donkey securely and in spite of men who walked close on each side and held the image in place with their hands it swayed and lurched from side to side in a manner more suggestive of a drunken man than a sacred figure. Behind the donkey came a crowd of men and boys filling the street solidly from curb to curb and extending about half a block behind. All the men walked bare-headed, and most were peons although there were plenty of people of the upper classes waiting in the park to join the procession as it came by and apparently to go to church with it.

On Monday afternoon there was a procession from the

Soledad to San Nicolas, escorting a life-size Christ seated on a gold chair. The figure was dressed in red and gold, hatless but with a large nimbus. Immediately behind walked some priests most elaborately dressed, and back of them the band, the drums beating a strange muffled tattoo when we heard it. The usual crowd of men and boys surged down the street after the procession, the women and girls walking on the sidewalks only.

On Tuesday the procession of Jesus of Nazareth left San Nicolas church about 6.45 P. M., went south two blocks, then east to the Soledad and returned to San Nicolas by the main street. There were many men bearing square glass-sided lanterns with one candle inside, mounted on long poles and held high in the air. Each lantern, from a distance, gave a cross-shaped light so marked that when the men came near it was hard to believe the lanterns were simply square-sided boxes. The lanterns walked on each side and behind the figures, but not in front. The police, caps in hand, kept the street clear of men and boys immediately in front of the procession. The first figure was a life-size standing St. John in blue carrying a large cup—shaped like a huge double egg-cup—in his right hand. Next came a life-size standing Christ in red, with bowed head and bound hands; in addition to the carriers, men walking on each side held long red cords that seemed to be fastened to the hands. (In the flickering torchlight it was impossible to see details.) Priests followed the Christ, then the band playing a very mournful and subdued air. The third figure was a standing Virgin with eyes and head upraised—also in blue. This figure was carried by young girls. Then followed more priests and the usual crowd. As the swaying figures and twinkling lights passed slowly down the street and around the corner into the church, accompanied by the mournful music, the effect was impressive and solemn, almost beautiful.

About five on Wednesday there was a procession consisting of a life-size Veronica carrying a large cloth on which were painted three thorn-crowned faces; St. John in blue with his cup; a Christ with red velvet robes embroidered in gold, an immense head of curls reaching below the waist and crowned by a huge nimbus, and the Virgin, followed by the band and the usual accompaniment of men, women and children. It was noticeable that in these processions very few hatted women were to be seen. Many of the poorer women do not usually wear hats, although the custom of doing so is gradually spreading. During Holy Week, however, all hats seem to be laid aside by them and the *rebosa*—here either black or some very light color—is draped tightly and closely around the head and shoulders. The women of the upper classes always wear hats but these women do not appear in the processions, only as spectators.

Holy Thursday seemed to be the greatest gala day of the year! All day long, country folk in their cleanest and starchiest, city people in their newest, brightest, gayest, most ballroom-y attire strolled up and down the streets, visited the churches and generally enjoyed themselves. In the evening A. went to see the decorations in some of the nearby churches. All were beautifully and tastefully decorated and all were full of people, particularly the great Franciscan church from which the evening's procession started. The people were sitting all over the floor so that if we had cared to approach the altar we could not have done so. There was much subdued gossiping and visiting about from group to group and the frankest criticism and discussion of the gorgeous costumes and huge picture hats of some of the Costa Rican young ladies, who did not hesitate—as we did—to force a way through the crowd and rarely ran the risk of soiling their fine dresses by kneeling on the floor. In the afternoon the governor of Cartago and his staff, in black

clothes and high silk hats, accompanied by the band in full dress uniform with red silk pompons in their caps, visited the churches and shrines. In the evening the figure of Christ was led to trial escorted by Roman soldiers.

About eleven o'clock on Good Friday morning the procession of Christ bearing the cross left Carmen church and went to San Nicolas. At that corner it was met by a second procession of Veronica, St. John, Mary Magdalene and the Virgin. As the two processions met, the first halted, the figures in the second bowing to the Christ, until the Virgin was opposite when the Christ and his mother bowed to each other. Then she turned and took up her station beside him. A long pause was made here while an impassioned and fiery sermon was preached from an open-air pulpit. Then the processions moved onward and the Crucifixion followed. The burial took place about four o'clock, when the figure was carried through the streets in a gold-trimmed glass coffin accompanied by a dozen little girls as angels, holding ribbon streamers and followed by the Virgin in a magnificent black velvet robe spangled with silver. The coffin was put into a space in the altar of San Nicolas.

The church bells were of course silent from Good Friday to Sunday, but on Good Friday the small boys carried—and frequently sounded—wooden rattles like an old-fashioned watchman's rattle, sticks that they clapped and beat together and a noisy device consisting of a board with a number of iron loops or rings fastened at one point only. The board was turned and twisted quickly from side to side making the metal rings flap up and down. These various rattles were the only noises permitted on Good Friday.

It should be noted also that no one rides horseback on Good Friday. Costa Ricans never do and for a foreigner to ride on that day is to run counter to deep-seated conventions



A Street Corner in Cartago and Church of San Nicolas.
Church of Guadalupe, Cartago.



The Good Friday Procession.
The Palm Sunday Procession.

and lay himself open to rebuke and dislike or stronger measures.

Early Easter morning—long before light—the church bells began to ring with a great clamor and the band was heard playing its gayest march as it conducted a procession from church to church.

On Sunday, June thirteenth, we walked about the streets to see the celebration of the last day of Corpus Christi. Being market day there were many visitors in town and large crowds around altars erected at the street crossings. These were large wooden platforms each with a high back supporting a canopy. They were all differently decorated and finished, but all had much tinsel, many beautiful flowers and enormous quantities of white *paraffin* paper crumpled up over the whole background for clouds. The effect of this background was astonishingly good and pleasing. There were four altars in our part of town, forming the corners of a large rectangle two blocks on a side. Along the streets connecting the altars men had set up branches of trees so that the streets were lined with green. Many of the houses were decorated with coarse lace curtains hung outside the windows and doors, and looped up with crepe paper festoons, ribbons or banners bearing the words "Viva Jesus Sacramentado." The crowd of celebrants passed along the street from one altar to the next, headed by the band. When they reached the altar there was a service and singing, the crowd kneeling in the streets. The altars now were occupied by half a dozen little girls dressed in pale blue, pink or yellow, with huge wings, representing angels, who were disposed among the white paper clouds very prettily. All the men who happened to be near stopped during the service and stood bareheaded until it was over. As soon as the service was ended at an altar the latter was taken down and we saw the little angels being lifted from their resting places among the clouds, before

the procession had reached the next stopping place. The daily rain at that season made it necessary to remove the altars at once.

On December fifth a turno was held for the benefit of the Orphan Asylum. It was not as great a function as that for the Church of San Francisco in July. Many articles were sold by chances at booths at the east end of the market house and a number of the guests of the hotel took chances and won small prizes. In the morning a few ox-carts brought gifts of firewood.

In December the shops were given over to the most astonishing collection of small toys, mostly of tin, for "La Noche Buena" or Christmas Eve—such toys as we had never seen before as well as dolls of a familiar pattern, and many drums and whistles. The children seemed to play with toys very little at other times so that the shop windows were doubly attractive to them. It was the custom to go to confession on Christmas Eve, then attend midnight mass. All evening there were bombs and bells from the churches, increasing each hour. We were rudely awakened about one o'clock by the passage of the pious churchgoers, on their way home from mass. The air was rent with firecrackers, bombs, whistles, horns and church bells, with wild savage yells making us think of Indian warwhoops.

On Christmas evening we went to the chapel of the Orphan Asylum to see some reputed decorations but found none. Service was in progress and we stayed a few minutes, the orphans singing the responses rather pleasingly. On the way home we went into a house to look at an elaborate "portal" or representation of the first Christmas. The whole portal occupied a raised platform about five by ten feet, enclosed by a little green-draped fence a foot high. The Holy Family were seated under a sort of altar which was stable as well, for cows and horses were looking through

the walls and climbing over the top. Three wise men were riding, single file, up an inclined plane leading to the middle of the altar. The rest of the space was taken up by farms, trees, wild animals, a railroad train on little tracks, hunters, horseback riders, a glass lake in a very realistic bower of branches and moss, with swans, ducks and geese swimming on its surface and giraffes feeding in the underbrush, a windmill, etc., etc. All these things were dolls and other toys, cleverly dressed and arranged in the midst of moss, lichens and green cloth, with small tree-trunks, bushes and little toy houses. These Christmas altars were said to be in many houses in Cartago, but this was the only one we saw in our short walk.

The Fifteenth of September is the Costa Rican "Independence Day" and was celebrated in Cartago by the school children singing patriotic songs. The military band played in the Plaza, the first number on the program being "Himnos Centro-Americanos," or the national anthems of Costa Rica, Guatemala and so on. The twelfth of October, being the anniversary of the day on which Cristobal "Colon desembarca en la isla de S. Salvador," as the daily calendar in the hotel dining-room put it, was observed as a holiday, stores and schools being closed.

The Presidential Election was held in August, 1909, and when we arrived in Costa Rica in May we found the houses and shops everywhere freely placarded with the red signs and posters of Don Rafael Iglesias or the blue signs and posters of Don Ricardo Jimenez. The former was the candidate of the Civlista Party and supposed to be favored by the United Fruit Company and almost all the foreigners. The latter was the candidate of the Republicanos and we were told that Don Ricardo was the really popular candidate supported by the large majority of Costa Ricans and particularly by the numerous element that disliked all foreigners

and the Americanos most of all. We were also told that although Don Ricardo was the popular candidate his election would never be "permitted" and further that in such a case there would certainly be civil disorders. But it is safest to prophesy after the event.

The red posters, usually bearing the words "Viva Iglesias," vastly outnumbered the blue in Limón and the little settlements through the banana country owned by the Fruit Company. But blue signs with the legend "Viva Jimenez" began to appear as the railroad ascended from the lowlands, and even before Cartago was reached had become more frequent than the red. Cartago was the home of Don Ricardo and naturally the center of his party. Political meetings and discussions occupied much time and attention among the Costa Ricans and sometimes became very heated—phenomena at which no American had any right to wonder. But at no time was there any disorder and although we cannot pretend that we read all the newspapers we certainly did not see in those we did read any such wholesale and unrestrained vituperation or vilification of the opposing candidate as characterized our own recent campaign. As the election time approached the excitement of course grew intense. We were in Cartago during the three days of the election. Indeed we particularly planned to be there, so much had we been told about the probability of grave disorders in smaller places—a precaution utterly needless as it turned out.

The first day of the election, August 29, was very quiet and peaceful. The returns began to come in about ten o'clock on the second day with reports of overwhelming majorities for Don Ricardo. There was naturally much enthusiasm in Cartago, and by night the town was given over to a screaming, cheering mob who waved blue banners, blue flags or blue rags and blew horns, while the band wildly played each instrument with cheerful disregard of all the

others. The small boys were of course in their element, and we had not suspected that these sad-looking youngsters could be so hilarious. This enthusiasm was mild compared to the excitement of the third day, as the successive bulletins came in and Don Ricardo's victory grew. At the last moment before the election, the existing government, which had been counted on absolutely by the Iglesias faction to work for them, turned to Jimenez and orders were issued to chiefs of police, etc., to vote for him. This no doubt accounted for his overwhelming success, but it seemed certain that Jimenez was the popular candidate and would have received the most votes. In the evening a really big crowd went to the station to meet the San José train, as Don Ricardo was expected home on it. He did not come, however, so the crowd and the band swarmed up and down the streets. There was much shouting of "Viva Jimenez," "Viva Ricardo Jimenez," etc., but little of the concerted cheering to which we were accustomed. On the contrary each one cheered at random, and much of the yelling bore a strong resemblance to warwhoops and shrieks of the Indians in Buffalo Bill's show. It sounded very unlike the deep roar of one of our enthusiastic crowds.

The San José paper, *La Informacion*, for September 1 gave the final results as Jimenez 38,000, Iglesias 14,000. This election determined the electors (similar to our electoral college) who met in February to cast votes for the presidency—Costa Rica has no vice-president. Contrary to the fears of many foreigners there was no disorder anywhere in the country during the election.

CHAPTER V

NATURAL HISTORY WORK IN CARTAGO

One of the chief objects of our expedition being the study of the living dragonflies or Odonata, and of their larvæ, we very soon began to rear at Cartago such eggs and larvæ as we could procure. Eggs were obtained from the Zygopterous species (those having wings of equal width, often called damsel flies) by bringing home and keeping in homeopathic vials the plant tissues in which we had seen the female insert her eggs. The Anisopterous dragonflies (or those having the hind wings wider than the fore wings) could often be induced to oviposit if we dipped the tip of the abdomen repeatedly into water in a vial. When the eggs in these vials hatched, as they usually did sooner or later, the young larvæ were watched, drawings of several of the early stages were made from life, in many cases under the binocular microscope and some individuals of each stage, with exuviæ, preserved for future study. Larger larvæ, which were collected either near Cartago or brought there from other places, were kept in glass jars, tumblers, or bottles for observation. Most of these larvæ were kept one in a bottle, for the practical reason that if they did not start one in a bottle they quickly became so. There were a few exceptions to this rule. *Thaumatoneura* larvæ, for instance, are sluggish and not aggressive, and if the difference in size be not too great can be safely kept together but in general it is dangerous to attempt it. Each larva had a stick, branch, clump of water weed or small bromeliad for a resting place, and we soon found it was desirable to allow the stick to pro-

ject above the surface of the water even with larvæ not ready to transform. Every jar was covered with mosquito netting at once to keep out mosquitoes and to keep in the rightful occupant. Each moult was recorded and the exuvia preserved. And first, last and all the time the larvæ had to be fed. As the number of jars containing larvæ increased, the task of feeding and caring for such a family was at times quite absorbing. The necessity of looking after them was one reason for our frequent returns to Cartago, and if we wished to be absent more than a fortnight it was essential for one of us to return for a day or two purposely to feed the live stock.

We were fortunate in finding suitable food with little difficulty. To the youngest larvæ to be fed, those which had just used up their egg-yolk, we supplied infusoria, copepods and similar small animals, which we nearly always could be sure of finding in abundance in any grassy pool. For the older ones we gathered mosquito larvæ, or small Agrionine larvæ which at times could be literally raked in by dozens and were quite popular. Our main dependence, however, was on the red larvae of the gnat *Chironomus*, which always could be caught in any desired numbers, by the aid of a little water net, in a certain dirty ditch at the lower end of the town. The existence of these "blood-worms" in such unvarying abundance was really the secret of our success in rearing as many species as we did. They are greedily eaten by all but the extremely young dragonflies and were served up in "assorted sizes," tiny worms to tiny dragonfly larvæ, middle-sized worms to half-grown larvæ and fat full-grown worms or pupæ to the big fellows. They are very juicy with few hard parts to be discarded and have the further advantage of wriggling constantly, so that our charges saw them readily. It was a droll sight (although undoubtedly hard on the blood-worms) to watch a hitherto motionless

larva "sit up and take notice" when a squirming worm suddenly appeared in his tumbler, to see how he followed its movements until the chance came to strike out for it with his jointed mask with its sharp jaws at the end, then how he held the prey and chewed away until the last wriggling bit had been eaten, when he immediately started after a second worm. The large larvæ sometimes ate nine or ten blood-worms as fast as they could be dropped in and one could see them "swelling visibly" and trace the red worms in the alimentary tract through the thin body walls. The little dragonfly larvæ were often turned head over heels by the prey, but they hung on and continued to eat no matter what position they were knocked into by the unfortunate blood-worm. Even *Thaumatoneura*, which probably feeds on quite different larvæ in its native waterfalls, ate the blood-worms in confinement if these were made to wriggle over the stone directly in front of its head. I never saw these sluggish larvæ pursue the blood-worms as other species did. Collecting the blood-worms was easy for all that was necessary was to hold a water net at the narrow end of a certain ditch, and the worms carried by the current were caught and held by the net. We gathered them for months and the supply showed no signs of failing. On February 24 we counted the worms that passed downstream, without any disturbance on our part, the number reaching one hundred and fifty in five minutes, and on March 11 we counted one hundred and eighty in the same space of time. The only unpleasant feature of gathering them was the dirtiness of the water in the ditch—a house drain—but it is the habit of these worms (which are world-wide in their distribution) to live in such water.

One day in December we supposed we had gathered plenty of food, chiefly Agrionine larvæ and copepods, to last for six days, but on examining the dish some hours later, this

was found to be a miscalculation. Not only had the larger devoured many of the smaller, but in addition, when the pail of water was poured into a flat dish and left to settle, there appeared incredible numbers of green hydras. These attached themselves to the sides of the dish in such quantities that they looked like green moss; they were equally thick all through the mass of mud that had been gathered in with the larvæ. Even the larvæ themselves were adorned with them. I found hydras attached to heads, eyes, antennæ, wing-pads, legs, abdomens and gills, sometimes so thickly clustered that I thought the larvæ were green-striped or spotted. These hydras ate up all the smallest kinds of food, the copepods and daphnids, so that it was soon necessary to go out for more.

If a larva in rearing showed signs of being ready to transform we usually removed the twig with the larva upon it to a dry netted tumbler so that the perfect insect could not fall back into the water and drown or soak its wings before they hardened. Occasionally this happened during our absences but we had few accidents of that kind. Owing to the elevation of Cartago we had little difficulty with mould and mildew, while cockroaches and ants did not give us anything like the trouble we would have had at a lower location, so that we were able to preserve our specimens with the minimum of labor.

Of the dragonflies which we found in the immediate vicinity of Cartago, three species were especially familiar, as they occur also in the eastern United States. Two of these were species of *Pantala*, *flavescens* and *hymenæa*, large insects of strong flight, with a wing-spread of almost four inches and the hind wings very broad at the base; the former with a yellowish body and some yellow at the base of the hind wings, the latter predominantly olive and with a rounded brown spot on the hind wing base. Both have an

extensive distribution. *P. flavescens* is well known as the most widespread of all dragonflies of the world, having been found in all quarters of the globe except Europe, in many an oceanic island, in a Himalayan pass at an elevation of 11,000 feet and was observed to fly in numbers at 11 P. M. of the 11th of April, 1896, on to a Peninsular and Oriental steamer in the Indian Ocean, 290 miles from the nearest land. *P. hymenæa* is confined to the New World, but ranges from New Jersey and South Dakota to Chile and Argentina. It is, therefore, not surprising to find these Pantalas in Costa Rica.

The third species is much more remarkable. It is the smallest of all the species known in the United States and bears the disproportionately long name of *Anomalagrion hastatum*. It is, in one respect, unique among all dragonflies in that the stigma, or opaque spot, is, on the front (but not the hind) wing of the male, set back from the front edge of the wing instead of being bordered by that edge,—whence *Anomalagrion*. The body of *A. hastatum* is very slender and its delicate wings do not permit of anything but a weak flight. Yet it has been found throughout the United States east of the Rocky Mountains, in Mexico, Central America, the West Indies, Venezuela and even in the Galapagos Islands, although, previous to our collecting it, it had not been reported from Costa Rica. Within the last-named country we found it at altitudes between 5000 (El Alto) and 2200 (Turrúcares) feet, and on both the Atlantic and Pacific slopes. As it has been found at sea-level in Guatemala and Honduras, it is likely that it occurs at the similar location in Costa Rica. One of the unsolved problems of geographical zoölogy is why this feebly-flying insect should have so extensive a distribution when other species of more powerful flight and living in similar situations, both as larvæ and adults, are confined to much smaller areas. In its larval stages, *Anomalagrion* must possess a great range of

adaptability to temperature, since it is exposed to freezing weather in the United States while in Costa Rica it has never to contend with that condition.

The wide distribution of *Anomalagrion hastatum* has apparently not led to the formation of different races characteristic of different parts of its area of occurrence, as in many other species of animals. Thus, the Costa Rican males have an average length of abdomen of 18.3 millimeters and of hind wing of 10.5 millimeters; corresponding figures for individuals chiefly from New Jersey and Pennsylvania are 18.9 and 10.8. The females are slightly larger, longer in abdomen and have distinctly longer wings. Figures corresponding to the above for the so-called "black" females are: Costa Rica 19.1, 13.2; United States 19.5, 12.9; and for the "orange" females: Costa Rica 19.2, 13.1; United States 19.2, 13. The slight differences here shown may in part at least be due to unequal shrinkage of the abdomens after death, as all these measurements are from dried specimens.

The abdomen of the male is yellow, becoming more and more of an orange from its fore to its hind end, with marked black spots on all but the last two or three segments. The size and shape of these black markings vary much, but the tendencies of their variation are the same in specimens from Costa Rica and from the United States.

The females for the most part appear in two forms; one, known as the "orange" female, has a large (anterior) part of the abdomen orange, the other, the "black" female, has the entire upper surface of the abdomen black. Other less conspicuous color differences also exist. The majority of dragonflies as they grow old show on one or more parts of the body an appearance similar to the "bloom" of a plum or dark grape, whence they are said to be "pruinose." This pruinosity is frequently to be found on the black females of *Anomalagrion* but not on the orange females. Transitional

females are also found in which the orange area of the abdomen is faintly or deeply clouded or almost black. Combining all this evidence, the conclusion seems justified that, in this species at least, the "black" females are merely older stages of those which formerly were "orange." There is thus a marked color change accompanying age in the female sex of this species, but not in the male.

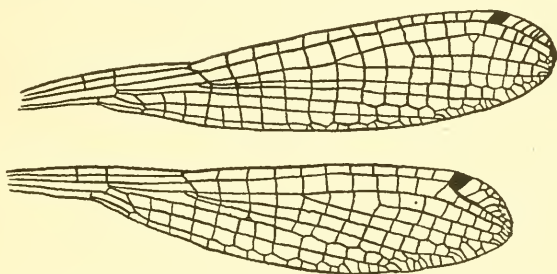
Even greater color changes of this character may be found in both sexes of another species far more abundant about Cartago—*Anisagrion allopterum*. The individuals which have just transformed from the larval stage and expanded their wings, so that they are able to fly weakly, have the head and thorax of a pale dull brown ("light pinkish cinnamon") and the abdomen of a pale yellowish with a dark brown or black cross ring at the hind end of most of its segments. Eventually, when some pruinosity is visible on limited parts of the body, the head has become black above, between the eyes, with four adjacent blue spots, the thorax is of a greenish-blue with a middle black stripe and a black shoulder stripe each side, and the abdomen is black above except for a fine pale bluish ring at the fore end of each of the second to the seventh segments.

It is evident, therefore, that a very great difference exists between the colors of the recently metamorphosed individuals and those which are partly pruinose. As we found individuals representing many intermediate conditions, flying in the same localities, it seems justifiable to conclude that the difference represents a change accompanying advancing age. This conclusion is strengthened by the fact that those with pale colors possess a weaker and softer chitinous covering on their bodies, while the predominantly black ones have a much firmer and harder exoskeleton.

The color changes which take place in the different regions of the body of this *Anisagrion* appear to be, to some

extent, independent of each other, so that a given stage in the blackening of the abdomen is not necessarily correlated with a certain stage in the blackening of the thorax or of the head. In other words, these changes appear at different times in different parts of the same individual and in different order in different individuals, just as changes in the color of the hair of different parts of the human body, or of different parts of the human head, take place at different rates in different persons or even in the same person.

The females of *A. allopterum* become pruinose on a slightly more extensive area of the body than do the males and



Right wings of the dragonfly *Anisagrion allopterum*, male. Enlarged 4 times.

this pruinosity appears at an earlier stage in the blackening of the abdomen than in the other sex, but on the other hand the blackening of the thorax and of the head takes place relatively later.

In all stages of its winged existence, whatever be its colors, the male of *Anisagrion allopterum* is easily recognized by a peculiarity of its hind wings which is not to be found in any other dragonfly of Costa Rica. The vein which parallels the front edge of the hind wing near its tip, when it reaches the stigma is distinctly bent away from the front edge and towards the hind edge, but continues to the wing-tip. For some little distance outward from the point where the bend occurs, this vein is markedly thickened and at the wing-tip

the cells (or small areas bounded by veins) are distinctly smaller than they are in the corresponding part of the fore wing. In the older males these small cells become partly or completely filled by thickening of chitin (of which the veins are chiefly formed) and in this condition strongly suggest the condition to be found in any dragonfly's wing which has been injured before, or at, the time of transformation. Twenty-five years ago, this peculiarity of *allopterum* males might have been seized upon as an example of an inheritance of mutilation effects, but it can hardly be regarded as such now. Insignificant as these structural details of the wing of this little insect may seem, they are very constant. Indeed the arrangement of the veins of the wings of these and many other insects is among the most reliable of recognition marks, and the trained entomologist can often identify an insect from a detached wing or even, in some cases, a wing-fragment, with perfect certainty. Finally be it added that the hind wing of the female of *allopterum* shows only a slight tendency toward these features of her partner.

Still more abundant about Cartago, perhaps the most abundant dragonfly of the vicinity, was *Argia extranea*, about $1\frac{3}{8}$ inches long, $\frac{1}{8}$ to $\frac{1}{4}$ of an inch longer than *Anisagrion allopterum*. The male is bright blue marked with black; the female has the blue of the male replaced by a pale brown or a violet brown. The genus *Argia* is very characteristic of tropical America, where it is represented by many species, some of them resplendent in metallic body colors, and a few species reach even to Canada. It is distinguished, among other features, by the length of the stiff hairs or bristles on the legs, which are twice, or more than twice, as long as the intervals between them. *Argia extranea* lives throughout a large part of Costa Rica. Watching a female laying eggs in a plant at Juan Viñas on June 24, 1909, we brought a bit of the plant in water to Cartago and

kept it in one of our tumblers. The eggs hatched between July 21 and August 5 and we were able to rear one of these larvæ in the tumbler until its final transformation to the winged state on February 23, 1910, the larval period thus lasting about seven months.

When we were in Cartago in May, June and July we frequently went out in the early evening with cyanide jars, to capture the numerous moths which were then resting on the houses nearest the arc lights. Although the collection of Lepidoptera was entirely a secondary consideration with us, no entomologist could have passed by such opportunities as these walls offered, for the number and variety of species were a constant source of wonder and admiration. During July A. often captured great numbers of moths in the mornings, "sleeping" on walls, door-jambs or window frames. None were ever taken on the sunny side of the street and they were most numerous on the main street where the lights were brightest at night. On one occasion we happened to see and to gather a number of large handsome sphinx moths on a Saturday morning, when, being a school holiday, the small boys were out on the streets in force. Their attention was naturally attracted and by the time we reached the corner of our hotel street we had enough interested assistants around to block the sidewalk completely. Our bottles and hands being full we were glad of the excuse to retreat to our room lest the police should consider it necessary to disperse the mob and arrest the ringleaders. Others helped us also and on the evening of December fourth Mr. Turner, who was staying at our hotel, brought a huge moth which he caught near an electric light. It was alive and vigorous. We put it in a tin can with chloroform on cotton, and measured and papered it next day. Its body was $2\frac{4}{5}$ inches long, its front wing nearly 6 inches and the total spread of its front wings $12\frac{2}{5}$ inches. Its wings were colored in differ-

ent shades of gray in zigzag lines above, dark purples with pale spots below. It was *Thysania agrippina*, the largest known species of the Noctuæ, recorded from Mexico to Brazil in the *Biologia Centrali-Americana*.

A striking-looking moth which came to the electric lights on May 13 and June 16 was *Manidia lunus*, having a wing-spread of about $3\frac{1}{2}$ inches, the wings on their upper surface of different shades of brown crossed by nearly twenty wavy lines of white or yellow, the hind wings with "tails" $\frac{3}{4}$ inch long bordered by three black "eye-spots" with blue "pupils." In daylight, resting in the corners of rooms in the hotel, were often seen large moths whose wings were of different tints and shades of brown and purplish-brown, crossed by many wavy lines of lighter and darker colors. They were attracted by the electric lights both out-of-doors and indoors. Some of these were *Erebus odora*, stray specimens of which are frequently observed far north in the United States; it reaches a wing-spread of six inches or more and has on the front wing, not quite halfway out from the base, a comma-shaped mark $\frac{1}{4}$ inch high, in black and blue margined with a buff line. Another and similarly colored was a *Letis*, a smaller insect (wing-spread 4 inches) with a patch of orange hairs along the fore edge of the upper surface of the hind wings.

On the morning of May 18, while out in the street near our hotel, we saw a bright yellow-breasted bird seize a sphinx moth which was resting on the ground, fly with it to an electric light wire and alighting there feed upon the moth, subsequently letting it fall. The moth (*Pachylia resumens*) had more than the posterior half of its abdomen eaten, but its legs and wings still fluttered when stimulated. The bird in the meantime found another sphinx moth and flew off with it. These moths were resting near an electric street light fixture to which they probably had been attracted the



Scarabæid Beetles—Nearly life size.
 1, *Enema endymion*, male. 2, Female and 3, Male of *Xyloryctes lobicollis*. 4, Female and 5 Male of *Cælosis biloba*.
 6, *Phanæus excelsus* male (from Liberia). 7, Female and 8 Male of *Strategus julianus*.



Scarabæid Beetles—About life size.
Megaceros philoctetes, male (from life).
Dynastes perseus, male (from life).

preceding night. We record this occurrence because it was the only time during our entire year in Costa Rica that we observed a bird feeding on Lepidoptera. We went there very favorably disposed toward the theories of mimicry and of protective resemblance. We expected to see many instances of birds pursuing and feeding upon butterflies, and frequently looked for such, but were utterly unsuccessful. Our experience in this respect entirely coincides with that of Mr. William Schaus in his three years in Costa Rica.

Among the conspicuous insects which were attracted to the electric lights in Cartago, as in other parts of the world, were scarabaeid beetles, armed on the upper surface, in the males at least, with prominent horns. Like their allies of the temperate climes, the June bugs and chafers, they are heavy blundering fliers and their size was frequently such as to cause a momentary annoyance if they struck against one's head. To one interested in the variety of form which Nature displays, the horns offer a field for much speculation. They may be one, two or three in number and variously placed on the head or the prothorax.

Xyloryctes lobicollis, a dark brown scarabaeid an inch long, which came to the Cartago lights in May, has a single sharp-pointed rhinoceros-like horn, on the top of his head but no horn on the thorax, although there is a low knob-like swelling on the middle of that region (which is somewhat hollowed out in front of and below the swelling). The female, of the same size and color as her mate, has a shorter pointed cone on the top of her head corresponding to his horn while her prothorax is smooth and convex throughout with no indication of knob or concavity.

Enema endymion came to the lights on the same nights with *Xyloryctes*. He is longer— $1\frac{1}{4}$ inches or more in length—and wider— $\frac{3}{4}$ inch as against $\frac{5}{8}$ —and of a much redder brown; his wing-covers are much smoother and show,

to the naked eye, very few of the longitudinal rows of pits and punctures so easily seen on the preceding species; on the other hand his prothorax has a more roughened surface. He too has but one horn and that on his head, but it is curved more strongly backward so that the interval between it and the prothorax is much less. The latter has no horn or knob but is flattened and smoother on the middle of its forward half. We did not take the female of this species. As described by M. Chevrolat, she differs by the horn on the head being triangular, its base occupying the entire width of the head, and her thorax more distinctly pitted.

Pinotus (or *Copris*) *carolinus*, the largest of the dung-beetles of the eastern United States, was also at Cartago, with its broad body, 7-grooved wing-covers and steep fronted prothorax, and his flat head bears a single broad horn notched at its tip.

Coelosis biloba did not meet us at Cartago but was at Cachí and at Juan Viñas and may occur at the higher town. He is 1½ inches long, of a reddish-brown which becomes darker to blackish on the front of the prothorax and on the head. The latter has a stout horn which is curved upward and then backward through more than a quadrant, so that its pointed tip lies in the interval between the two broad and rather thin prongs of a great forwardly-directed projection from the prothorax. These prongs diverge (as one looks at the beetle from above) and each ends in a tip which is cut squarely across. The female offers a striking contrast owing to the total absence of both horn and thoracic projection.

Megaceros philoctetes male, which was at Cartago in March, develops the horns of *Coelosis* to a greater degree. This is a heavier beetle although of the same length, its color is a blackish-brown, its wing-covers without conspicuous lines or furrows as *Coelosis* has them. The horn on the head

is longer and stouter, not so strongly curved backward so that it by no means reaches the interval between the prothoracic prongs and is notched at the tip. The prothorax rises into a projection which at its summit divides into a right and left prong, widely separated from each other by a straight edge. While we found no female of this species, we have seen specimens collected in Panama by Mr. G. C. Champion. Her head has a minute point on its upper surface to represent his horn, her prothorax is convex but not elevated and two very small points, near its fore edge, close to the middle line and about $\frac{1}{16}$ of an inch apart, may correspond to his prongs.

The male of the giant Perseus beetle (*Dynastes perseus*) also of this family, one individual of which lived as our boarder, as related on another page, has also developed a cephalic horn and a prothoracic process or horn. The length of the body exclusive of the horns is three inches, the head and prothorax are blackish, the wing-covers green pitted with black.

This Central American Perseus has been confused with the South American Hercules which is still larger and has three teeth on the upper surface of the cephalic horn instead of two. We have not seen the female of Perseus but the female Hercules is of a dull brown throughout, has a small point (not a twenty-fifth of an inch high) on the top of the head, no projection of any kind on the prothorax and the surface of her wing-covers is finely netted, quite unlike the elytra of her partner. She is about two and one-half inches long.

Quite a different arrangement of the horns exists in *Strategus julianus* which also came to the electric lights of Cartago in May. This beetle is $1\frac{3}{4}$ inches long, its head and prothorax blackish-brown, almost black, the wing-covers a rich deep mahogany-brown, the last smooth and polished but with some discontinuous longitudinal scratches, and a

continuous groove parallel to the suture where the wing-covers meet and less than a sixteenth of an inch distant from it. The head in both sexes is roughened and pitted and bears two small projections too low to be called horns. The male has three great horns on his prothorax; the female has one very low pointed tubercle in the place of the front horn of the male, and still less to represent the two lateral horns.

Much speculation has been indulged in as to the use of these horns. Darwin (1871), chiefly from lack of evidence as to any function, came to "The conclusion that the horns have been acquired as ornaments." We have been able to find no recorded observations on the uses to which the horns are put in any of the Costa Rican species just described, and very few for allied kinds throughout the world. Such as we have brought together are as follows: Mr. G. E. Murrell quoted by Lintner (1889) observed many *Dynastes tityus* on ash-trees at Coffe, Virginia, "never using their horns, so far as I can see, except for fighting." Dr. F. Ohaus (1911) "was able to observe in *Megasoma hector*, a few specimens of which he found near Petropolis, Brazil, that the beetle uses its cephalic horn as a good weapon, with which it can pinch hard, . . . the South American Dynastids used this organ chiefly as a weapon." Dr. Albert L. Bennett (1899), who observed *Goliathus druryi* in German West Africa and in French Congo, says: "the male beetles use their cephalic horns in fighting with one another, as well as for puncturing the bark of vines in order to bring about a flow of the sap upon which they feed." Mr. J. Doll (1885) found, in Hell's Cañon, Colorado, a *Dynastes* which was thought by Dr. G. H. Horn to be *D. granti*. Doll says: "They are always found near the tips of branches [of the mountain ash], where by means of their projecting thoracic horn they scrape through the soft bark to cause a flow of sap which is very sweet, and of this consists their food."

Prof. R. W. Doane (1913), of Stanford University, observed that *Oryctes rhinoceros*, feeding on the growing heart in the crown of the cocoanut trees in Samoa, has first to pass through a web-like sheath before it reaches the hard wood. "In doing this the head is lowered and the [cephalic] horn thus thrust forward. The horn becomes imbedded in the tissue of the plant and when it is raised serves as an anchor to hold the insect while it pulls or pushes its body forward with its legs, or while it tears the tissue of the plant with its heavy mandibles." Baron von Hügel informed Dr. David Sharp (1899) that in Java he had "observed large numbers of *Xylotrupes gideon*; he noticed that the males sometimes carry the females by the aid of their horns."¹ Dr. Ohaus has also kindly informed us that a correspondent of his friend Herr Nagel has observed, in Venezuela, that the males of *Dynastes hercules* fight very violent battles among each other for the females; that they seize and crush with the cephalic and prothoracic horns, the weaker male often having its thorax and elytra crushed, and that the victorious males take the females between the horns and carry them away.

One Sunday, July 25, a peon brought to A. at Cartago, a male *Dynastes perseus* which he said he had found in the market among sugar-cane which had come from Juan Viñas. He was evidently afraid of it and was glad to sell it. We kept the beetle alive until August 24, most of the time in a

¹ As the observations are very much scattered, it may be useful to give here the exact references to the original statements. Darwin, *Descent of Man*, Part II, Chapter X, 1st ed., 1871, New York edition of 1896, p. 297. Lintner, *5th Rept. on Injur., etc., Insects*, State of New York (42d Rept. N. Y. St. Mus. Nat. Hist.), 1889, p. 231. Ohaus, *Deut. Ent. Zeitschr.*, 1911, p. 230. Bennett, *Proc. Ent. Soc.*, London, 1899, p. xiii. Doll, *Bull. Brooklyn Ent. Soc.*, VII, p. 121, 1885. (See also Lintner, *7th Rept. on Injur., etc., Insects*, State of New York, p. 252, footnote †, 1891.) Doane, *Science*, n. s., XXXVIII, p. 883, 1913. Sharp, *Cambridge Nat. Hist.*, VI, p. 199, 1899. (Cf. also Cunningham, *Sexual Dimorphism in the Animal Kingdom*, p. 254, 1900.) Andrews, *Journ. Exp. Zool.* xxi, pp. 435-436, 1916 ("the significance of these male horns [of *Dynastes tityus*] remains entirely problematical").

tin vasculum, and supplied him with sugar-cane. He ate readily and his attitude when feeding on the cane is shown in our photograph from life. He was very slow and ponderous in his movements and never made any effort to fly when out of the box, but twice, at night, we were awakened by the sound of his bumping against the inside of the vasculum, as if he were trying to fly, accompanied by a hissing. We learned nothing of the uses of his horns. He came to an untimely end by chloroform and the autopsy was performed at once. Two species of mites, a millimeter and six-tenths of a millimeter long respectively, were found living on this giant and were later described by Mr. Banks as new species (of *Celænopsis* and of *Hypoaspis*).

The squirrels in the Plaza were a great source of amusement. The common one (*Sciurus adolphei dorsalis*) is a handsome little animal, very dark gray above, reddish-tawny below and on the under surface of the tail, pale gray on the cheeks and with extremely large black eyes. I watched one trying green mangoes by nibbling one, finally selecting and eating another, dropping down the green skin and eating the hard pulp. Before this one was half eaten it too was dropped and the squirrel was off to a third.

As the country immediately around Cartago was all under cultivation we did not see there any large wild mammals, but on November 1 as we left the hotel door we saw two boys carrying two small armadillos, about a foot long, which they offered for sale. We stopped to look at the interesting little creatures. The bands, twelve counting head and tail, were still quite soft. Even the large ears were scaly and stood up like a bat's. The claws were very strong, long and curved. The boys said the armadillos ate earthworms and no doubt they eat insects also.

The English sparrow has not reached Costa Rica, the bird most nearly taking its place being *Brachyspiza capen-*

sis peruviana. This sparrow is about the same size as the English sparrow but much handsomer, with a reddish streak over each eye and a greater contrast of light and dark browns on the back. It has a pleasing song and is less aggressive and pugnacious than the English sparrow but is much like it in its tameness and intimacy with man and his dwellings. The notes of the common Costa Rican robin (*Planesticus grayi casius*) in April, its size and shape and general behavior were so like our own that I never grew accustomed to seeing its yellowish-brown breast instead of a reddish one. In April we also heard a meadow lark (*Sturnella magna alticola*) with a note much like that of our northern bird. Late in December we saw a night hawk, very close to (if not the same) subspecies (*Chordeiles virginianus virginianus*) that we have in Philadelphia from May to September. It looked quite homelike but we did not hear its familiar cry. Our northern subspecies has been observed in Costa Rica, in May and in September by Mr. Carriker.

Although the black vulture (*Catharista urubu brasiliensis*) is the common one all over Costa Rica we once, on September 9, saw a pair of red-headed vultures or "zonchiches" (*Cathartes aura aura*) in a lane in San Rafael. It was the second time we had seen this species; the first occasion was a few days before near Alajuela when we met a pair in company with three or four of the black species, eating the carcass of a small dog. The black species is entirely slaty-black including the naked skin around the head and neck, the beak and the legs; it is called "zopilote" by the Costa Ricans and "jim crow" by the Americans. The other species has the head more slender, red, beak white, legs reddish-white and the remainder of the body brownish-gray. It is a close relative of the common Turkey Buzzard of North America, but is smaller; the brown borders to the

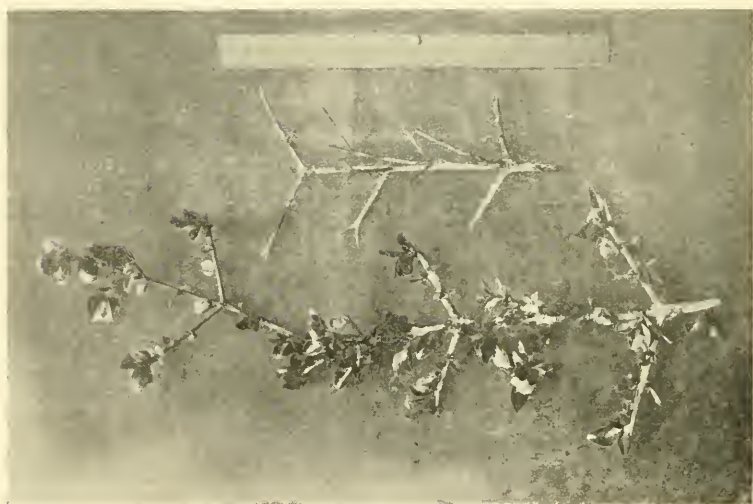
feathers of the back are narrower, less well marked, or even lacking, while the color of the upper side of the shafts of the primaries (brown when freshly moulted) soon bleaches to an old ivory, or yellowish-white, instead of remaining permanently dusky brown as is usually the case in the northern form (Nelson).

At the bottom of the hotel street, perhaps half a mile south of the railroad, was a large white slaughterhouse and in the mornings it was no uncommon thing to see a line of black vultures on the top of the front wall, waiting for their share, while many others were on the ground or perched in nearby trees. These zopilotes are very numerous around Cartago and are of course exceedingly useful scavengers. We sometimes watched them bathing. Their habit was to fly into the water, take a few runs through it in their usual stiff-legged fashion, then lower the head into the water, and, crouching, walk forward until the feathers were thoroughly wet. This happened in a short time for the feathers seemed to have very little oil on them. Then up flew the birds into some sunny place and after a few preliminary shakings assumed the "spread eagle" attitude, with wings outstretched, head thrust forward and always with their backs to the sun. Occasionally one would make some hopping steps, ruffling all its feathers, then spread out again. A hundred or more of these awkward birds all facing one way and all standing with their great wings spread out as far as possible, presented a ludicrous spectacle.

The slaughterhouse stood below and outside the town itself on what we always called the "Slaughterhouse Road" and which we usually followed when going to the numerous lanes south of Cartago. These lanes, though running straight and parallel to each other for fully half a mile south of Slaughterhouse Road, were remarkably individual in character, and one of them, our "Shady Lane," was much



The Bottom of the "Shady Lane," with *Xylosma* on each side.
The Cartago Slaughterhouse and Zopilotes.



A Flowering Spray of *Xylosma salzmanni*.



Carboncillo—*Calliandra grandiflora*—in flower and fruit.

the richest place we found near Cartago and became our favorite collecting ground here.

One lane led directly to the town refuse heap—where we went once and having watched and listened to the horde of vultures had no desire to go again. However in justice both to the town and the vultures it should be said that this garbage heap was astonishingly inoffensive, and moreover flies were not a great pest in Cartago. The day we went along this lane was May 10, 1909. The rains of the two preceding days had changed the dusty roads to damp and produced little swampy spots in the pastures. Over one of these swamps a species of dragonfly (*Sympetrum illotum virgulum*) was swarming. The males have bright red bodies, the females dull brown and many pairs were engaged in laying eggs. Big blue and blackish *Aeshna* dragonflies flew swiftly about and several smaller species were found here and there by the roadsides.

There was an exceedingly handsome frog here (*Agalychnis helenæ*), one of which we took to the hotel and kept for some days. When "asleep" its body, exclusive of legs, was two and one-half inches long. Ordinarily the upper surface of body and legs was a bright pea-green; below, the body was speckled white and reddish-brown, with a band of brilliant beautiful blue on each side of the abdomen. There were great color changes, however. When first caught it was pale green; when we took it out of the vasculum at home it was a dark dirty green with pale spots on the back. While we photographed the frog it grew light again with paler spots over the back. After nightfall it was again very dark, but although it spent the night in a dark cupboard it was pale green when we first looked at it in the morning and again at 4.30 P. M. The tips of all the toes (four on the front, five on the hind feet) are expanded into large fleshy discs with which the frog climbs readily. It was able to cling to the

vertical side of our glass graduate without other support than its toes. When caught it secreted a quantity of sticky mucus having a powerful and disagreeable odor, which it was difficult to remove from the hands.

The morning of May 11 was not so bright as that of the preceding day, although the sun was shining. We revisited these same swampy spots but not a single individual of the bright red species of dragonfly nor one of the peculiar frogs was to be seen there, although we did find one of these frogs later in the morning in the bottom of a nearby ditch.

Other lanes were bordered only by the living fences of poró. Such fence-rows are very pretty, especially when the conspicuous red blossoms were seen in relief against the deep blue sky, and the shade afforded by the trees—often fifteen to twenty feet high—is most grateful but it is neither dense enough nor constant enough to encourage a shadow-loving fauna.

But our "Shady Lane," really a continuation of the Calle de las Monjas, although bordered primarily by the poró fences, contained so many other trees that it was like a little strip of woodland with a grassy path running through it. At its upper end, the side vegetation consisted of young Anona trees, thickets of blackberry, *Xylosma*, lantanas, with scattered higuerones. We once pulled off a few twigs from these wild figs, finding the milky juice quite sticky. The nearly spherical, brownish-black figs were about half an inch long and filled with small dry fruits. There was no pulp and no marked taste to the little fruits or to the figs as a whole and they are not used as human food, but bats are extremely fond of them. As the lane descended, the higuerones were larger, real giants three to four feet in diameter, some of them, and more closely clustered and as the shade grew denser the trees were more thickly covered with epiphytic plants such as bromeliads, orchids and Colum-

neas. A tiny stream flowed down this part of the lane, Selaginellas and thick green mosses covered the stones and tree-trunks, and it was often hard to realize, while standing in the cool deep shadows of these trees, that less than fifty feet away the open potreros were panting under the brilliant tropical sunlight. Still lower, there were few trees, but hedges of *Xylosma*, many clumps of wild roses with pale pink, very double flowers and scattered through the grass numerous boulders of andesite lavas, each one the center of a little thicket of roses or the creeping sensitive plant. The lane ended in a grassy cross lane (that is, east-west) along one side of which ran the "bloody ditch" a stream that carried the refuse from the slaughterhouse and this cross lane finally led to the main road to Agua Caliente,—but as it lost in interest as it neared the high road we rarely followed it so far.

When we first traveled down the Shady Lane in May, 1909, it contained no water except the little stream in the lower part, but the conditions varied greatly during the year. In late June there were many pools but we could pick a path through the lane. On August 20 we found the greater part of the lane a pond with hummocks of higher grass as islands and the smaller plants almost entirely submerged. Many dragonflies—or "planchitas" as we once heard an Indian call them here—were darting about laying eggs and from the place once a dry grassy path we dredged up quantities of dragonfly larvæ and a tadpole two inches long. In this condition the lane remained for about two months, a most useful source of food and material to us and always interesting to visit. On October 14, therefore, we were greatly disappointed to find that it had been utterly ruined for our purposes of larva-hunting, by having a number of cattle driven through it. Their hoofs trampled the smaller plants and converted large grassy watery stretches into

black mud so that we were driven to look for larvæ in other pools, particularly one in the lane to the east, the Calle de P. Peralta. A lull in the rains caused the pools to shrink considerably about the middle of November, but on November 29 the pools were full again and all the potreros soaking wet. On February 19 we found both these lanes much drier than they had been for months. Even the deeper pools in both which served as homes for aquatic animals since August had now no water and hardly any spots of wet mud. By February 24 the Shady Lane was dry and beginning to resume the conditions it presented when we first knew it. The bottom of what had been the deepest pool was now covered thickly with yellow-flowered *Jussiaeas*. P. dug down into some pockets of soft wet mud still remaining to see if any traces could be found of the dragonfly larvæ so common here in the wet season, but without success. A similar trial in the dried pool in the next lane east, a prolific source of larvæ in that period, was also a failure, although the empty shells of snails, former inhabitants of the pool, were there. By March 11, 1910, the conditions of dryness approached those found on our first visit to the Shady Lane nearly a year before.

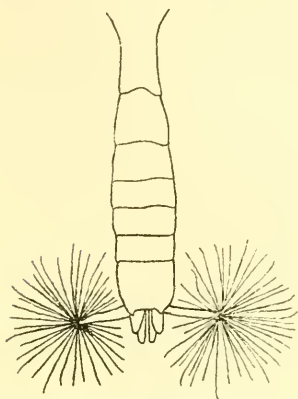
On May 27, 1909, when returning through the Shady Lane, I caught a butterfly which to my great astonishment, as I was taking it out of the net, thrust out from each side of the hind end of the abdomen a brush of blackish hairs looking like an ordinary camel's hair brush. I immediately thought of the two brushes as possibly odor-producing organs to diffuse some disagreeable smell which would act as a means of defense, but I could not detect any odor whatever. I took the butterfly home alive and kept it so until the afternoon of the following day. As I took it from the envelope some hours after catching it the butterfly voluntarily thrust out its brushes once, and again on the next day when I began

to work on it, but at no other time even when the abdomen was stroked, rubbed, or its tip slightly irritated. By pressing on the hind part of the abdomen with thumb and forefinger most of the brush could be made to extrude and the process completed by gently pulling with a small forceps. At no time could either of us detect any odor connected with the apparatus and a colorless or slightly yellow liquid that sometimes passed out from the abdomen was tasteless to me. However in a specimen taken on May 29 above Cartago there was a distinct odor resembling cedar shavings.

This butterfly (*Lycorea atergatis*) had the body 30 millimeters long and a wing expanse of 90 millimeters ($3\frac{3}{4}$ inches). Its wings were tawny-brown, black, yellow and white, black predominating on the front wings, tawny-brown on the hind wings. The black on the front wings forms three streaks from the base outward which unite together at half the wing's length; the black outer half bears six or seven mostly elongated yellow spots and some small whitish dots near the wing margin. On the hind wings the black forms a border containing thirteen small rounded whitish spots; there are two other blackish-brown stripes united at their outer ends not reaching to the black border. The head is black with some small white spots, the thorax and abdomen are striped with black and dull yellowish. The antennæ are 18 millimeters long, blackish, but the last 7 millimeters yellowish.

When the brushes were thrust out each appeared through a vertical slit. Each brush consisted of a stalk and the bundle of hairs. When at rest within the abdomen the hairs lie inside the whitish stalk through whose translucent walls they can be indistinctly seen. By the lengthening and turning inside out of the stalk the hairs were gradually brought into view but were all closely pressed against each other forming a straight, parallel-sided brush, but when the stalk

had completely lengthened and brought even the bases of the hairs into view the hairs were directed every way and the brush became spherical. The brushes of right and left side



Abdomen of butterfly, *Lycoreia attergatis*, male, showing brushes fully extended. Drawn from life. Enlarged 1.7 times.

were thrust out together, in our experience, and when fully expanded gave an extreme width of about 24 millimeters or 1 inch to the apparatus at the tail end, which of course was in striking contrast to the same end when the brushes were withdrawn. Each stalk was about the same length as the last abdominal segment and on its inner side was a flesh-colored elongated tubercle about half as long as the stalk. Each brush was composed of some hundreds of hairs, each hair was about 6 millimeters long. Under the compound microscope the hairs are pale yellow for a short distance at their bases and entire in outline, but for most of its length the hair is black, opaque, and its outline is saw-toothed. The teeth are sharper as the tip of the hair is approached, and are apparently little scale-like protuberances directed toward the tip of the hair.¹

Lycoreia is a representative of the Danaine butterflies (of which the Monarch or Milkweed butterfly is the best-

¹ In an African Danaine butterfly, *Amauris prytalea*, Dr. G. D. H. Carpenter made the observation that the male fluttered about four inches over the female's head, quickly protruding the brush at the hind end of the abdomen and as quickly drawing it in again and adds "it was impossible to doubt that the male was endeavouring to excite the female" (*Proceedings, Ent. Soc.*, London, 1914, p. cxi). Scent organs of male Danaine butterflies have recently been discussed by Dr. H. Eltringham in the *Transactions* of the same Society for 1915, pp. 152-176, through which further references to the literature on the subject may be obtained.

known member in the United States) a group characterized among other features by the possession, in the males only, of the pair of anal hair tufts. *Lycorea atergatis* is found from the State of Vera Cruz, Mexico, to Peru.

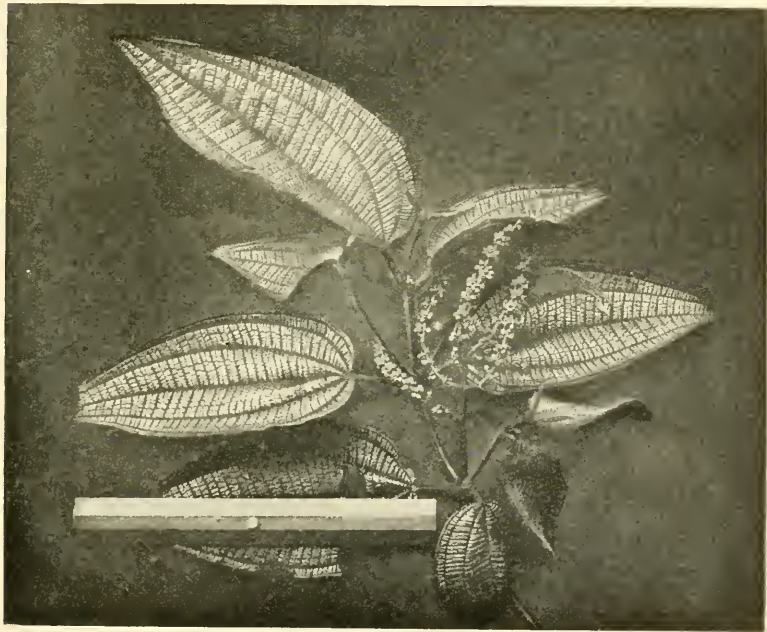
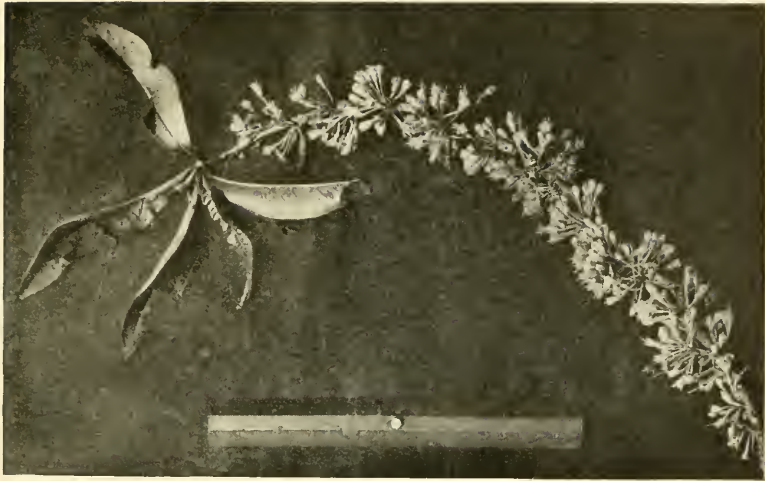
Off to one side of the Shady Lane, close to the fence where the ground was higher than in the center, was a tiny by-path running under the big trees and vines. Here we were in a deep arbor of shade, very narrow to be sure but thick enough to be quite dark, and here were often flying numbers of the beautiful clear-winged Ithomiine butterflies. These have very few scales, only along the wing margins and on some of the principal veins, the rest of the wing being as transparent as a fly's. They are exceedingly hard to follow as they fly in these dark places. Occasionally they issued into the clearer sunlight but were far more common in the shade.

The Ithomiine butterflies, like the Danaine, are Nymphalids but their males, instead of possessing the anal hair pencils, have one or more tufts on the upper surface of each hind wing near its front edge. On June 17th, three species of these Ithomiinæ were taken in this little stretch of the lane—*Dircenna klugii* ($2\frac{1}{8}$ to $2\frac{3}{4}$ inches spread) with the margins and bands of the front wing and the margins of the hind wing pale blackish-brown, the transparent membranes, especially of the hind wings, with a reddish tinge; *Episcada apuleia* (one and seven-eighths inches spread) with the membrane very clear, the margins and veins narrowly blackish-or reddish-brown, a milky spot at the front edge of the hind wings; and *Ithomia heraldica* (two and one-eighth to two and one-fourth inches spread) a non-transparent species, whose front wings are reddish-brown at base, the rest blackish-brown with yellow spots, the hind wings semi-transparent pale reddish-brown with narrow blackish-brown margins.

In June, when the morning sunlight was particularly

brilliant in contrast to the afternoon mist or rain, we found many insects flying over the pools and submerged parts of this lane. Beautiful Syrphids hovered over the flowers, their gorgeous colors looking wonderfully gem-like. They are bright green above, the green melting into a vivid dark blue while beneath, the green turns in certain lights to a rich copper-red. As the insect hovers in one place for some minutes, then darts off to another spot and hovers again, the wings, like a humming-bird's, vibrating so rapidly that the fly seems to hang motionless, all these colors shine and glow so that the little creature is fairly dazzling. It is *Volucella obesa*, a species found from Florida and New Mexico to Chile, and in the East Indies; its body is 11 millimeters long, its wing-spread 24 millimeters. The wings have a brown spot on the front edge at a little beyond mid-length, not reaching halfway across the wing and a brown dot also on the front edge a little before the wing-tip.

The "bloody ditch" harbored quite a varied fauna. On June 17 P. dredged up some snails, a few small fishes (not over two inches), leeches, a large number of black or sand-fly larvæ (*Simuliidæ*), dragonfly larvæ, and many individuals of the bug *Deinostoma dilatatum* an inch long. These last are interesting on account of the habit of carrying the eggs—to the number of twenty to a hundred—on the back. The eggs stand side by side and are attached by their tail ends, for when the time of hatching approaches two dark spots indicating the eyes of the young may be seen under the shell of that end of the egg which is toward the observer. We took one of the egg-bearing bugs indoors and kept it in a glass of water; some of the eggs hatched and the young at once swam actively around in the water, but the parent died before more than seven or eight of the eggs had hatched. On other days we found two kinds of frogs in our net. We wondered whether the leeches were able



Guitite—*Acnistus arborescens*—in flower.
Terciopelo de Santa Maria—*Miconia æruginea*.



Clavel del Monte—*Jussiaea* sp.
Lengua de Vaca—*Conostegia lanceolata*.

to take blood directly from the water or whether they took it from the muzzles of cattle when these chanced to drink at this stream or some of its affluents higher up, but when the stomach of a well-preserved specimen was examined its contents were found to be sand-fly larvæ only. These leeches were identified by Professor J. P. Moore as probably *Erpobdella triannulata*, a species described from Lake Amatitlan, Guatemala, although larger, some being 3 inches long. There it is said to "abound, seeking concealment by day beneath stones and similar objects in the shallow waters and at night becoming active in the pursuit of small worms, insect larvæ and even the smaller members of its own species, which constitute its chief food. Having no toothed jaws it is not an habitual blood sucker, though it doubtless, like related species, attacks abraded surfaces of higher animals when opportunity offers."

The adult sand-flies were naturally quite abundant and at times troublesome. The bite produces a characteristic mark on the skin. At first there is a red dot surrounded by a paler red circular area which may be one-eighth inch in diameter. The next day the surrounding area becomes bluish while the central dot remains red, becoming darker and darker with succeeding days until it is at last almost black and although small (one-fiftieth inch) is quite conspicuous and raised more or less on the top of a little lump. Meanwhile the surrounding area has resumed its usual color, and these stages may occupy a week or more. The pain and irritation produced vary much in different individuals.

Although dragonflies were our chief objects, we also collected Microdiptera regularly at each locality we visited. This was the easiest possible collecting, for all that was necessary was to sweep a special form of net (devised by Mr. E. T. Cresson, Jr., for this purpose) over the grass and low herbage, emptying the contents into a cyanide jar. Later,

we poured the catch into some convenient flat receptacle and sorted out the insects from the grass seeds and other vegetable debris. Of course all sorts of small insects beside microscopic flies were gathered, in such sweepings, and looking them over gives a faint idea of the astounding variety of shapes and colors existing among insects less than an eighth of an inch in length. In this sort of collecting we obtained a really wonderful number of genera and species.

The common plants, wild flowers and weeds around Cartago were a constant joy to us, they were so numerous and so beautiful. Some showed no periodicity at all that we could observe, being in bloom every month in the year. Among these were the lantanas (*Lantana camara*), the pretty double wild roses, the "Hoja del Aire" (*Bryophyllum calycinum*), the "Guijarro" (*Stemmadenia bignoniæflora*), the common red and yellow milkweed or "Viborrano" (*Asclepias curassavica*) the yellow Bidens (*B. pilosa*) and the showy yellow "Clavel del Monte" (*Jussiaea* sp.). Others were rarely without a few flowers but produced the great mass of their blooms at one time. Such were the poró and the magnificent "Reine de la Noche" (*Datura arborea*).

The poró (*Erythrina corallodendron* and *costaricensis*) is a tree much used as a "living fence," the trunks a foot or less apart and connected by three or four strands of barbed wire. It endures an indefinite amount of pruning and branches out again with great rapidity. Whether pruned in the fence-row or allowed to grow more naturally in the cafetales, where it is sometimes planted for shade, the poró is a straggling tree that seems never to have made up its mind whether it will really flower or not. The ternate leaves are large and glossy, the leaflets much like the leaves of a balsam poplar. The papilionaceous flowers are a brilliant beautiful red, the keel enormously elongated (two to three inches long) while the other petals are extremely reduced.

Both in producing new leaves and in flowering it is as irregular, as full of caprices and vagaries, as plant could be. It flowered sporadically from May to December, the greatest number of blooms being noticed in November when the trees were most nearly leafless. At that period the color effect of a number of porós together was astonishingly like that produced by red maples in bloom, both in the rich yet misty red color and the stiff straggling spray. At such times, one branch might be leafless and loaded with red blossoms, another on the same tree bare of flowers but full of new leaves. In March, however, it was really full of leaves and fruits. The latter are long, narrow, brown pods, constricted markedly between the beans; they open while on the tree, showing the bright coral-red beans attached to the margins of the pods. The poró is of the same genus as the "palosa-bre" described by Belt in his *Naturalist in Nicaragua*.

The Reine de la Noche grew freely among trees along the roadsides and borders of streams, reaching a height of ten to fifteen feet. Its white trumpets were ten to twelve inches long, and in April at the height of its season covered the plant so thickly that the foliage was almost entirely hidden. A stream-bank bearing a thicket of these plants in full bloom is a sight never to be forgotten.

Still other species have a very marked season, such as the Poinsettia or "Pastora" (*Euphorbia pulcherrima*) which blooms at Christmas time and in its full glory is a wonderful sight with its clusters of brilliant red leaves and little red and yellow flowers. The castor-oil (*Ricinus communis*) and the common blue sage (*Salvia polystachya*) flowered most freely in December. This sage, although a troublesome weed, is a beautiful plant, the flowers being the deepest, richest blue imaginable and borne in great profusion, so that a field infested with it presents a solid sheet of color. Many of the numerous mimosas and acacias also had a seasonal blooming.

One of the prettiest was the "Carboncillo" (*Calliandra grandiflora*), a bush often twelve feet high with an extremely compound feathery leaf, a stem handsomely striped with dark red, and large conspicuous flower clusters, of which the long dark red filaments were the showiest part. Its flat, dark red pods, borne on the outer ends of twigs, were also pretty. We found it flowering from October to February. This plant grows by choice on the edges of banks or cliffs or stream ravines, often overhanging the water and never far from it.

The "Guitite" (*Acnistus arborescens*), a shrub or small tree reaching fifteen feet in height, bloomed in May and June; its small, exceedingly sweet-scented, white flowers were thickly clustered along the stem and were highly attractive to many kinds of insects and therefore to humming-birds. The fruits were ripe in August, pretty little orange-colored berries which many birds greedily devoured and which we ourselves liked very much when we cautiously tasted them. We found them deliciously sweet and juicy, reminding us of currants or gooseberries. As the Guitite is a Solanaceous plant we thought it wise not to eat too freely of the berries since the Costa Ricans do not seem to use them as food.

Melastomes were numerous both in species and individuals and varied greatly in habit. An herbaceous species with particularly handsome foliage, very common along fences and hedgerows, was the "Terciopelo de Santa Maria" (*Miconia aeruginosa*). Its leaves, often six inches long, were a rich dark green but covered with a beautiful velvety pile of long, soft, dark red hairs. Its flowers were inconspicuous and we found them borne most freely from April to September. Another common Melastome, a woody species, ten to fifteen feet high, growing in fields and potreros, was the "Lengua de Vaca" (*Conostegia lanceolata*). It had narrow, stiff leaves but its pretty white flowers, which we saw in

July and August, made the tree both conspicuous and attractive. On wooded banks and roadsides we often found the delicate *Tibouchina bourgeauana* as well as the beautiful *Arthrostemma campanulare*, the latter bearing large pink flowers more than an inch across.

Acalyphas (such as *A. leptopoda*) were common in wet places, and crotons were also numerous, both small ornamental species and trees such as the flat-topped "Targuá" (*Croton gossypifolius*), which grows thickly in rough or waste land. Their blooming extended over some months but we found the targuá fruiting in August. In the parks, crotons were to be found blooming all the year round, practically. From August to November the "Alacrancillo" (*Dalea alopecuroides*) was exceedingly abundant. It is a leguminous weed, troublesome in the pastures but very pretty nevertheless. It grew two to three feet high with racemes of small lavender to white flowers, the inflorescence having a delicate gray or pearl color. The commonest solanaceous plants were the "Berengenas" (*Solanum* sp.), straggling woody shrubs with small blue or white flowers, large coarse leaves and clusters of green berries. They grew by the roadsides and in poor, neglected pastures, much as Jamestown-weed does in the eastern United States. They were unattractive plants to us but the chosen food of many potato beetles and we often hunted over the leaves for them. These beetles (*Leptinotarsa undecimlineata*) much resemble the common "potato bug" of the United States (*L. decemlineata*) but differ in having the legs, except the pads, and the under surface of the body black, while in the latter these parts are chiefly reddish or reddish-yellow. Around houses, in poor pastures and on the open roadsides were great quantities of a most troublesome malvaceous weed, "Escobilla" (*Sida rhombifolia*). It formed thick clumps covered with pretty little buttercup-yellow blossoms half an inch across. These

only opened when the sun was hot and full upon them and having rather woody stems and stiffish leaves, both leaves and flowers wilted almost as soon as plucked and never revived in water. Consequently the only way to photograph this plant was at mid-day *in situ* and a hot and trying task it was!

The flower beds in the Plaza at Cartago contained not only a great variety of so-called garden flowers and plants but also many of the common native plants allowed to reach large size as individuals—a practice we highly approved. It was in the Plaza we first saw the huge *Gunnera insignis*, which is not a native of the Cartago neighborhood but grows in the sheltered ravines and pockets on the volcanoes, the “Guacamayo” (*Bocconia frutescens*) the “Ortiga” (*Wigandia urens*), the handsome red *Salvia involucrata*. We made lists on several occasions of the plants blooming in the Plaza. On May 16 A. noted the following: *Agapanthus*, *Ageratum*, *Amaryllis*, asters, balsams, calla lilies, campanulas (blue and white), cannas, *Cassia*, chrysanthemums, cosmos, *Dahlia*, daisies, evening primrose, geraniums, gladioli, *Hibiscus*, *Lantana*, larkspur, lilies (red and yellow), lobelias, *Nigella*, *Oleandra*, poppies, roses, *Scabiosa*, squills, sweet williams, *Stephanotis*, *Tradescantia*, tropæolums, *Zephyranthes* and among foliage plants were bamboo, bananas, crotons, *Coleus*, numerous ferns, and palms.

On Christmas Day we found the Plaza a riot of flowers and noted the following: *Abutilon*, *Agapanthus*, *Agave* (2 sp.), *Amaryllis*, asters, balsams, begonias, borage (blue), *Bougainvillea*, large bromeliad, *Browallia*, cannas, chrysanthemums, *Cleome*, *Cobæa scandens*, *Coleus*, yellow composite resembling *Lactuca*, cosmos, daisies, *Dahlia*, *Datura arborea*, geraniums, *Gladiolus*, *Heliconia*, heliotrope, *Hibiscus*, honeysuckle, jasmine, *Lantana*, larkspur, lilies (orange yellow, red-green, tiger) lupine, maize, manzana rosa, marigolds,

Mimosa, morning-glories, *Ænothera*, olive, purple orchids, ortiga, palm, papaya, pastora, *Phlox*, poppies, roses, *Scabiosa*, *Sedum*, *Senna*, Spanish paint brushes, spiræas, *Stephanotis*, sweet alyssum, *Tradescantia*, tropæolums, yellow umbellifer, *Verbena*, violets, *Vinca*, zinnias, and ten others entirely new to us.

Where hedgerows were allowed to grow there was a wonderful tangle of bushes and vines. The hedge itself was usually composed of *Xylosma salzmanni*, a plant looking somewhat like the California privet but armed at the tip of each twig with a pair of sharp strong thorns. In May and June it bears solitary white flowers. Blackberries and wild roses climbed through and about the *Xylosma*, while melastomes, large-flowered Jussias, the showy "Zorillo real" (*Hamelia patens*) with its red and orange tubular flowers, "Pavoncillo" (*Cestrum aurantiacum*), yellow *Bidens*, lantanas and ageratums grew in its shelter. Occasionally, where a hedgerow was backed by poró or other trees, there was now and then a solitary guijarro (*Stemmadenia bigoniæflora*); this is an apocynaceous tree with large glossy leaves and magnificent tubular flowers, creamy-white on the corolla lobes and shading to deep sulphur yellow in the throat. These are followed by highly colored twin fruits. The follicles have a greenish rind over an orange flesh and when they open show masses of shiny black seeds each embedded in a vividly red pulp. Like so many members of this order, the juice is quite poisonous and it is said that to use the ashes of its wood in preparing maize for tortillas causes serious sickness. In spite of its beauty, therefore, it is rarely used as a decorative plant, but we always enjoyed seeing it.

The "Santa Lucia" or ageratum (*Ageratum conyzoides*) is by no means confined to hedgerows, for it is a troublesome weed almost ubiquitous on the plateau. Its color ranges

from pinkish white through pale or sky-blue to beautiful lavender, and like the more intensely blue salvia often covers the fields with its exquisite color. On the higher parts of its range, as on the Cerro Jocosal, Carrizal and Poás, the blue tends to become darker.

In rainy weather we often found the railroad track with its banks and ditches the best or indeed the only available path for pedestrians. East of Cartago the line crossed a number of small streams on low iron trestles, and usually a little footpath led down to the water so that we could get into the pastures easily. Boulders and masses of andesite lavas or tuffs are scattered thickly over these potreros on the slopes of Irazú and the superficial likeness to a granite-strewn New England pasture is striking. A second glance shows that the trees along the stream are melastomes, crotons and mimosas, highly characteristic tropical American groups, instead of birches and maples, while the boulders are encircled with sensitive plants, wild roses as double as chrysanthemums, or masses of bryophyllum, and the pastures are enclosed with living cerclos of poró, their crimson blossoms flaming against the deep blue sky. No, it was not New England, but a far richer land pulsating with life all the year round!

On the railroad banks many flowers were abundant. Sometimes a pretty little composite (*Zexmenia longipes*) studded them. Almost always the delicate lavender flowers and halberd-shaped leaves of the "Churristate" (*Anoda hastata*) could be seen among the stronger milkweeds, ageratum, lantanas and coarser composites. Here and there we were sure to see the long graceful panicles of *Iresine paniculata*, one of the Amarantaceæ. This plant was common not only near Cartago but also at Juan Viñas, in both places growing on roadside or railway banks.

On November 30, P. made a list of the conspicuous plants



Zorillo real—*Hamelia patens*.
Pavoncillo—*Cestrum aurantiacum*.



Churristate—*Anoda hastata*.

Flower (and fruit on a smaller scale) of Guijarro—*Stemmadenia bignoniiflora*.

that were in bloom along the track east of Cartago. It included a species of *Commelina*; *Bryophyllum calycinum*; the leguminous *Dalea alopecuroides*, poró, *Indigofera anil* (vine with purple flowers), another unidentified vine with yellow flowers, *Calliandra grandiflora*, a creeping sensitive plant with spherical pink inflorescences and a few large paired leaflets, and a mimosaceous shrub with white flowers; an unidentified euphorb; *Sida rhombifolia* and *Anoda hastata* of the Malvaceæ; a species of *Jussiaea*; the guayabo (*Psidium guayava*) with ripe fruits on the ground beneath; the common milkweed; *Lantana camara*; *Salvia polystachya*; *Eryngium carlinæ*; Pavoncillo (*Cestrum aurantiacum*) and three species of *Solanum*; and three composites, *Ageratum conyzoides*, *Bidens pilosa* and *Zexmenia longipes*—in all twenty-five species.

The fence trees here carried quite a number of epiphytic bromeliads on their trunks, all of very small size, only two or three inches long. One of the commonest was *Catopsis fulgens*. They contained little or no water and their fauna consisted of a few earwigs, cockroaches, spiders, isopods and often ants. When the latter were abundant the others were less likely to be present.

The roads that climbed up the volcano, especially the narrower and less traveled paths, were often fragrant with the perfume of the sweet pale violets, growing in profusion among the clumps of *Bryophyllum*, ferns and mossy stones. They were well concealed and their fragrance was usually the first indication of their presence. A very different roadside plant, preferring sunny bare places, was a showy species of *Siphocampylus*, growing two to three feet high with long racemose inflorescences crowded with tubular red and yellow flowers. We met it from the level of Tierra Blanca to the Reventazón River at Juan Viñas, always on sunny exposed banks.

CHAPTER VI

WEST AND NORTH OF CARTAGO

The Continental divide in the central portion of Costa Rica is formed by the mountain or mountains called La Carpintera lying about three miles west of Cartago. The greatest altitude of these mountains is given as 5695 feet by Pittier. The railroad crosses the divide through a pass between La Carpintera and Irazú which also accommodates the Carretera Nacional from Cartago to San José, the highest point being El Alto. To the south side of the tracks, is a flat swampy place among the hills, with some standing water filled with grasses, knot-weed, rushes, etc. It is known as the Laguna de Ochomogo and apparently occupies the floor of an old crater with very irregular and broken-down walls. It is the site of the first battle of the first civil war of Costa Rica, when, on April 5, 1823, adherents of the Mexican empire of Iturbide, from Cartago and Heredia, met in arms the republicans of San José and Alajuela. Padre Francisco Quintana, crucifix in hand, induced the combatants to separate, but the republicans subsequently occupied Cartago and the capital of the country, hitherto at that town, was removed to San José. In the second civil war in 1835, Ochomogo was again the scene of a Carthaginian defeat by the forces of President Braulio Carrillo.

P. first visited the laguna on July 7, 1909. It ought to be a good place for dragonflies but careful search along its edges discovered only a single species, the tiny *Anomalagrion hastatum*, which we have described in connection with Cartago. A strong wind was blowing from the east during most of this

day and the blustriness was rather disagreeable in certain exposed spots.

On September 25, Professor Tristán and P. were at Ocho-mogo. The laguna is in the midst of a pasture enclosed by barbed wire fences and on entering we received permission from a man working there to go around the laguna and catch insects. We employed ourselves in this fashion from eight o'clock until noon, when the sky became very threatening and more rain was falling than previously during the day. There were a great many frogs all around the edge of the swampy area, a number of swallows skimmed swiftly over the center; once a large brown heron (?) was disturbed by our presence and we saw a few wild ducks. The fields bordering the pasture contained chiefly maize, some of it very high, perhaps ten to twelve feet, and in tassel.

As we left the field bordering the laguna, we paused by a house and as it was raining and three hours before the next train for Cartago and no shelter at the "station," Professor Tristán asked permission to wait at the farmhouse. This request led to an exciting dialogue. The farmer at once accused us of "disregarding the rights of the proprietor"; when told that his brother had given us permission to pass around the laguna he admitted that, but said we had no permission to hunt ducks. Professor Tristán replied that we had not hunted ducks and that if we had any we would pay for them. The farmer retorted that we would pay for them by being shot, while Professor Tristán called out that if he shot us we would send him to San Lucas (the penal island). The farmer ran indoors and brought out a double-barreled shot-gun and came near us threateningly, Professor Tristán explaining calmly what we were doing; but the farmer disbelieved our story, saying that although we had no guns we were hunting ducks with our insect nets! We offered to open our boxes and show him that no ducks were there and th^o

man then lowered his gun and walked back disgustedly to his house without accepting our offer. He did not seem drunk; perhaps his conduct can be explained as due to ignorance. He was an exception to all the Costa Ricans I met in his treatment of us. Professor Tristán told me that in Costa Rica everyone is free to go into a pasture or coffee field, but not into a man's house or the enclosure surrounding it.

Tres Rios or La Union, a town of 1500 inhabitants (1910), lying six miles west of Cartago, is in the midst of plantations producing some of, if not *the*, best Costa Rican coffee. The numerous streams in its neighborhood flow ultimately into the Pacific. On the fourth of December P. after exploring along the southern and eastern edges of Tres Rios found a pretty road which finally led high up on Carpintera. It crossed several streams along which were numbers of a velvety dark blue moth (*Ardonea morio*) with a wing-spread of one and three-eighths inches. Not having planned to climb Carpintera to-day I had no breakfast, but the weather was fine and clear and the trail fairly good so that I concluded to go up as far as the trail led and be hungry, unless I found a chance of buying tortillas at some peon's cabin. Human residences, people and even cattle were few, however, and no food was to be had. The trail, winding, steep and in some places slippery, eventually terminated near the top of a spur lying next east of the highest peak. This spur had been cleared of trees and was in part planted in maize, but was mostly potrero which had become charral (overgrown with bushes) to such an extent that the bushes were as high or higher than one's head; they grew close together and were often bound together by vines so that going through them was slow work and it was hardly possible to gain any spot from which one could have a view in all directions. From the north of this spur, a little below its top, I had a grand view to the north bounded by the moun-

tains Irazú, Zurquí, Barba and Poás, terminating westward at the Aguacate Mountains while in the valley enclosed by these volcanoes I could plainly see the towns of Tres Rios, San José, Heredia and Alajuela, the last-named distant about eighteen miles. Between Irazú and Zurquí the pass of La Palma gave me a glimpse of low-lying clouds evidently overhanging the plains of Santa Clara while above the clouds was a perfectly clear horizontal line which suggested the Atlantic Ocean but must have been some sort of mirage.

Crossing over this spur gave a fine view of Cartago and its surroundings, although I could not certainly make out Paraiso. To the west was the highest point of La Carpintera, about a mile away; it was apparently covered with forest to the top so that it seemed as if no one point there was sufficiently open to afford a view in all directions.

There were no Alpine plants on this spur of Carpintera. I noted the familiar targúa, escobilla, guacamayo, the blue sage, a pokeberry (*Phytolacca* sp.) as well as the beautiful "San Miguel" (the melastome *Blakea gracilis*) and *Monnina costaricensis*.

La Carpintera has many pretty spots along the trail followed, which does not pass through any old forest; small flowing streams begin high up on this spur. Descending by the way I had come until near the bottom, I found some insects new to me in the shape of brilliant metallic green Chrysomelid beetles, butterflies, and my first female *Libellula foliata* (a dragonfly). Then instead of returning to Tres Rios I turned off eastward hoping to reach El Alto in time to catch a train, due about 3.30, for Cartago. I might have done so if I had not stopped to stalk (and eventually catch) a couple of dragonflies of two species (*Brechmorhoga pertinax eurysema* and *Macrothemis pseudimitans*), which I had previously taken only at lower levels. Similarly unexpected was the sight of four green parrakeets (*Conurus*)

which flew screaming over my head. In time I came out on the Carretera Nacional which I followed for the rest of my journey, but long before I reached El Alto I could see the train ahead of me. So I reached Weldon's Hotel on foot about five o'clock, decidedly tired.

On March 17, 1910, we started on horseback from Cartago, along the Carretera Nacional. Before reaching Tres Rios itself we turned south into a road running toward Carpintera. The carretera was not particularly attractive, being hot and dusty, but this side road was pretty, winding about among coffee fields and in places grassy and shady. After a pause for breakfast we rode on up until the road became so steep, rocky and slippery that we thought it inadvisable to take the horses farther and therefore tied them in a grassy place and finished the climb on foot.

The road was still prettier in the upper part, where it was always shady and in places thickly overgrown. At intervals were beautiful clumps of large white begonias in flower and early fruit, with less frequent pink begonias having narrow pointed leaves. On one of the trees we saw among many other epiphytes a large and curious orchid with long narrow white petals. A pretty violet mallow with flowers over an inch across grew by the fences and there were numerous fruits we did not know at all—clusters of oval red berries and of stiff papery balloons resembling the fruits of a "balloon-vine," but this plant was a shrub. The savagely thorny "Horquetilla" (*Xylosma salzmanni*) used in Cartago as a hedge plant, had been planted for the same purpose along this road but had been allowed to grow up into trees, pretty to look at but not always easy to "duck" under where they hung low.

After climbing about an hour we crossed a gate and entered an open potrero at 5730 feet, near the top of the spur visited on December 4. (This altitude, furnished by our aneroid,

is probably a little too high.) One of the reasons for making this particular trip was the magnificent view of the mountains from this potrero, for which we carried the whole photographic outfit. In this we were grievously disappointed, for even when we started the mountains were not perfectly clear and we could see, in our successive glimpses, how they were misting over. By the time we reached the potrero the Aguacate Mountains had disappeared, Poás was almost invisible and Barba so faint that I could not focus on it in the camera screen, while even the pass of La Palma was disappointingly misty.

On the return we had some fine opportunities to watch the curious scissor-tail fly-catchers (*Muscivora forficata*) which perched on the telegraph wires, and made short erratic flights after insects. Both perching and flying, their extravagantly long forked tails were opened and shut constantly with a jerky motion and also moved up and down in the ordinary fashion of birds in balancing.

Through the western part of Cartago flows a small stream, the Reventado, which arises high up on Irazú in the old crater or Laguna del Reventado, and eventually empties into the Agua Caliente River in the bottom of the valley. For much of its course it is a rapid, rocky, brawling little stream, its bed full of boulders. The part near and above Cartago we always called the "Paltothemis River" because the showy, swift-flying *Paltothemis lineatipes* was very common there and seemed to rule the stream. This handsome dragonfly has a wing-spread of three and a half inches and a conspicuous red body one and seven-eighths inches long, and the habit of each individual's patrolling a certain limited bit of territory was well marked and easily observed. It was often amusing to see how quickly an interloper was attacked and driven off by the dragonfly in possession. A smaller dragonfly, *Hetærina cruentata*, was also abundant

here and we obtained its larvæ clinging to the submerged stems of plants growing on the bank.

We visited many different parts of the Reventado, particularly above the town on the slopes of Irazú. As the stream had cut little ravines and gorges for itself in many places, it was not always possible to keep at the water's edge so that sometimes we followed its course at the top of the ravine, sometimes on its banks. In one of the potreros above the Reventado we took *Gomphoides ambigua* on December 15; this is a Gomphine dragonfly not previously known from Costa Rica, although we also obtained it from San José and from the peninsula of Nicoya. The little river was often heavily shaded with big trees, with undergrowth of ferns and caladiums, tradescantias and mosses. A particularly charming bit was evidently the bed of an extremely old crater, roughly elliptical in shape with high steep walls except on the south side, and containing many fine large trees. The current here was swift and the stream was poor in dragonflies. On May 24 A. obtained a stone-fly and two stone-fly exuviæ, small may-fly larvæ, a couple of species of caddis-worms, a galgulid ("toad-shaped bug")—all similar in general appearance to forms in the eastern United States.

On the same day some Ithomiine butterflies, *Hymenitis oto* (with clear transparent wings spreading two and one-eighth inches, whose margins and veins are blackish, and with an oblique milky-white band and milky-white spots on the front wings) and *Dircenna klugii* (already mentioned in Chapter V) were found only in dark shady spots in these woods. The transparency of their wings made them much more difficult to see, whether in flight or at rest, than other butterflies whose wings were of the normal style—colored and not transparent. Dr. Sharp, in the *Cambridge Natural History* (Vol. VI, p. 346), quotes Wallace briefly as making a similar observation on these butterflies. However on May



Mimetic Butterflies (x 3/4).

Dismorphia praxinos, female.
Mechanitis doryssus, female.
Lycorea attergatis, male.

Eueides sorcaon, male.
Heliconius telechia, female.
Melinaea imitata, male.

29, while Ithomiines (*Ithomia heraldica*, see page 79, *Dircenna klugii*, *Episcada salvinia*, very similar to *E. apuleia* described on page 79 but a little larger, and *Mechanitis doryssus*) were taken in shady lanes near this part of the stream, a male of *D. klugii* was caught in bright sunshine and two males and a female of this species were taken in bright sunlight at Cartago on August 21. Ithomiines (the species not recorded in our notes nor represented in our specimens) were seen flying in bright sunshine both in the morning (11 A. M.) and about 1 P. M. of May 30, in the same general locality, and in bright sunshine on a road above Tierra Blanca on July 12. In this last case the country was open for many rods on both sides of the road and the wind was blowing strongly, which may account for this occurrence. Of *D. klugii* we have four specimens, three males and one female, expressly labeled as having been taken in bright sunlight and four (three males, one female) labeled as having been caught in the shade; on placing these in two parallel rows for comparison, I could find no constant difference between the two lots. We also have two males of *Ithomia hippocrenis*, a clear transparent-winged species with markings similar to those of *Hymenitis oto*, taken in sunshine, on flowers, in a new road in the forest at Guácimo, on June 7; our other specimens of *hippocrenis* from Guácimo and Guápiles, are labeled "Forest," with no mention of shade or sunlight. On December 4, on La Carpintera, the clear-winged *Episcada apuleia* and *salvinia* were observed flying both in shadow and in bright sunlight. We may conclude that while the Ithomiine butterflies are chiefly to be found in the shade they are not restricted to that condition.

Three of the species of butterflies collected in the Reventado region above Cartago on May 29—*Lycorea atergatis*, *Mechanitis doryssus*, and *Melinæa imitata*—are so exceedingly alike in colors and color-pattern, and not so unlike in

size or in shape of wings, as to furnish a very typical case of mimicry. Messrs. Godman and Salvin in their volumes on the butterflies in the *Biologia Centrali-Americana* mention four other species namely: *Eresia mechanitis*, *Eueides zorcaon*, *Heliconius telchinia* and the female of *Dismorphia praxinoe*, as having colors and patterns very similar to the first three mentioned. The last four also occur in the same localities with the first three and although we did not meet them together some of our readers may make their acquaintance in nature and wish some means of distinguishing them apart, for it will be noted that not merely seven *species* but seven *genera* are involved in this case of resemblance.

One of these genera, *Dismorphia*, has the usual number of functional legs of insects, six, and each of the two claws at the tip of each leg split lengthwise or toothed, features which place it in the family Pieridæ. The other six genera have only four legs used for walking, the first pair being unfitted for this action, and in consequence belong to the family Nymphalidæ. This is divided into several sub-families, of which we are here concerned only with the Danainæ (*Lycorea*), Ithomiinæ (*Mechanitis*, *Melinæa*), Heliconinæ (*Heliconius*, *Eueides*) and Nymphalinæ (*Eresia*). Danainæ, Ithomiinæ and Heliconinæ have the central basal area of the hind wings known as "the cell" enclosed on all sides, while in many Nymphalinæ, including *Eresia*, the cell is open at its outer end. The Danainæ and the Ithomiinæ have the last (hindmost) vein of the front wing apparently formed by two veins uniting near the wing-base; in the Heliconinæ on the other hand this same vein arises singly. One distinction between Danainæ and Ithomiinæ has already been mentioned on page 79, the males of the former having two retractible tufts of hairs at the hind end of the abdomen, but not along the front edge of the hind wings, while the males of the Ithomiinæ lack the abdominal

tufts but have a patch of long hairs along this wing edge. The Danaïne females have the last section (tarsus) of the first pair of legs more shortened than in the Ithomiine females. The two Ithomiine genera mentioned, *Mechanitis* and *Melinæa*, differ in a number of structural details of which the most readily seen, is that the first two veins (costal and subcostal) of the hind wings are united, or very close together, in the basal half of their course in *Mechanitis*, while these two veins are widely separated, except at the extreme base, in *Melinæa*. Finally the two Heliconine genera concerned differ from each other in that *Heliconius* has each antenna more than half the length of the front edge of the front wing, with only a slight club-shaped thickening at the tip, while *Eueides* has each antenna less than half the length of the front edge of the front wing and ending in a distinct club. As differences of secondary importance but more easily seen, *Melinæa*, *Mechanitis* and *Lycorea* have the cell of the hind wing longer than half of the wing, while *Heliconius* and *Eueides* have it shorter than half of the hind wing.

By way of summary, the relationships and classification of these seven butterflies may be shown thus:

Family Pieridæ		<i>Dismorphia praxinoe</i>	
Family Nymphalidæ	Subfamily	Danaïnæ	<i>Lycorea atergatis</i>
		Ithomiinæ	<i>Melinæa imitata</i>
		Heliconinæ	<i>Mechanitis doryssus</i>
			<i>Heliconius telchinia</i>
Nymphalinæ	<i>Eueides zorcaon</i>		
		<i>Eresia mechanitis</i>	

While there is an undoubtedly close external resemblance between all these seven butterflies, it is quite another question whether this (*unconscious*) *mimicry*, to use the technical term by which it is known to zoölogists, is of importance as a means of protection to any of the species concerned.

As stated on page 79 the male *Lycorea atergatis* can emit an odor like cedar shavings, but we were unable to make any observations tending to show that this odor, or the resemblance of the other butterflies to the odoriferous *Lycorea*, has a defensive value against birds or other animals.

Over these slopes of Irazú,—as all around Cartago—indeed over all Costa Rica down to sea-level—we frequently saw that commonest of butterflies, *Anartia fatima*. It is a Nymphaline and has a wing-spread of one and seven-eighths inches. Its wings are dark brown above, darker at the tips than at the bases. The front pair have a cross-band of yellow at about mid-length, three yellow spots in a row at four-fifths' way to tip and two smaller yellow spots between the hindmost of the first three spots and the yellow cross-band. The hind wings have a yellow band of nearly the same width as that on the front wings and almost in continuation of it, but lying much nearer to the outer edge of the wing; a short distance on the basal side of this band are four red spots. The edges of all the wings have narrow whitish scallops here and there. The undersides of the wings are a much paler brown, the yellows and reds of the upper surface are repeated and are of greater extent but paler. Professor Tristán has found that it is the most frequent butterfly visitor of the common milkweed (*Asclepias curassavica*) and the chief agent in its pollination. The pollen masses are carried from inflorescence to inflorescence attached to the claws of the insect's feet.

The whole southern side of the great mass of Irazú below the forest was covered with pastures or big fields of maize or potatoes, each enclosed in a loosely built stone wall topped by a strand or two of barbed wire. The maize harvest was all over by March. On March 15, 1910, we rode up Irazú toward the village of Llano Grande, going up to 7000 feet. Everywhere, as high up as we could see, the corn was cut

and the ears piled up ready for the ox-carts or else the field was already plowed or plowing.

There were some small collections of houses here and there on the mountain as well as the villages of Cot, Tierra Blanca and Llano Grande. An intricate network of lanes and roads followed the outlines of the potreros and we frequently explored the smaller byways. Well-traveled roads led to the villages, the one to Tierra Blanca in particular continuing as an excellent cartroad all the way up to the Jimenez Lecheria (at 9000 feet) and thence toward the east, and these main roads kept their own direction so that one knew where one would arrive. But the smaller lanes—often shaded so that one did not see readily down the mountain—had a habit of running up hill then turning and running down again and it was impossible to tell without trial whether any lane would lead in the desired direction or not. They were delightful places for walking, nevertheless. On a bright, breezy morning in May many species of butterflies flew or were blown into or across these lanes. Scarabæid beetles were abundant, at least as individuals. We saw a great buzzing metallic green thing suggesting *Allorhina*, a species looking like our own rose-beetle (*Macrodactylus*) and one or two others of the same size or a little larger, all but the first-named falling on one's hat or clothing almost constantly.

The rose-beetle-like species were also taken at Cartago on June 17 and July 5. Compared with our rose-beetle of the eastern United States (*Macrodactylus subspinosus*) they are slightly larger, being about three-eighths of an inch long, the head and thorax a more vivid green which is also metallic in its reflections, while the wing-covers are a deeper and redder brown. In one species (*M. suavis*) each elytron bears two distinct rows of very short whitish hairs similar to those which cover much of the upper surface and the lower sur-

face of the entire body. This species has the tarsi of all the legs and the apices of the hinder four tibiæ black, the rest of the legs red. The other species (*M. sericinus*) lacks these hairs on the wing-covers; instead a little more than the rear half of these organs is metallic green; the tarsi of all the legs and *all* of the hinder four tibiæ are black. In both species the females may be distinguished by having a slender process on the prosternum just behind the first coxæ and by having one or two pale bristles (in addition to the numerous short whitish hairs) on each side of the ventral surface of the abdominal segments.

In April, small blue butterflies (*Lycæna isola*) were very abundant on the eastern road to Tierra Blanca at an elevation of 5000 to 6000 feet, particularly over damp spots and on horse-droppings. This species, which has a wing-spread of three-quarter inch, has been found as far north as Illinois.

Below Cartago the Reventado ran through coffee fields too thoroughly cultivated for the stream to have much interest for us or was simply an unshaded brook in open pastures.

San Rafael was a good-sized village northeast of Cartago and practically continuous with it. North of San Rafael was the berry farm of Juan Rudin, a Swiss who had been in Costa Rica some twenty years. He had about two manzanas of beautiful fertile land in strawberries, the finest berries and most perfect plants imaginable. We found this farm on March 29, 1910, after some inquiries, one of the things by which we were to recognize it from the road being a large and beautiful rosebush in the patio. After a little preliminary conversation under the rose tree—which fully justified its reputation in this land of fine roses, for it grew ten feet high, spread out in both directions the whole length of the house and was covered with magnificent pinkish-

white roses—we were conducted into the fields and made free of the berries. Mr. Rudin seemed much gratified at our delight and indeed it would be hard to find a prettier field. The berries were in perfect order, the rows as straight and plants as clean as if just arranged for a prize contest. Each plant was about a foot across, covered with tiny buds, open flowers, young and ripe fruit. They were allowed to bear fruit for ten months in the year only, otherwise they would exhaust themselves. The berries were large, sweet, juicy and tender. At first we felt shy about eating the fruit but Mr. Rudin's urging soon induced us to try a few and the more we picked the more clumps of berries we saw at a short distance that called to us. So we wandered over the field eating strawberries as we had never dreamed of doing, and whenever we stopped picking for a moment Mr. Rudin gathered a handful on their long stems and urged them upon us. Here and there among the berries were tall rose trees, seven to eight feet high, with large, not very double shell-pink roses of exquisite shape, color, texture and perfume. We gathered a few, which caused Mr. Rudin to send for his shears and cut a huge bunch of roses and carnations, for he also had some rows of these flowers. Orange trees were full of flowers and ripe fruit, and on a little sunny bank were masses of long-stemmed sweet violets.

When we had eaten all we thought we could we moved out toward the gate, where we untied our horses and prepared to take some pictures before we left. We coaxed the babies—five little children all remarkably pretty—into position, photographed them and then started to say good-by. But no. We must sit down in the corridor a minute. So we were conducted to a table in the corner of the corridor and there beheld a huge dish of the biggest and finest strawberries—and we were expected to eat them all!

We had only intended to make a short stay at the berry-

farm but we were there for two hours and it was almost breakfast time when we rode away. However no one wanted breakfast after our strawberry feast so we sent the flowers and a message home with a boy and started on our delayed ride. From San Rafael we went east along a winding, shady road until we came in sight of a neat-looking two-story house whose inhabitants were all out on an upper balcony watching us. The man of the family seemed to think we were coming to call—which had not been our intention—and came down the road to meet us, so we rode in and tried to buy maize for the horses. He fed the whole five (we were riding with a party from the hotel), gave us milk and bread and would not consider our paying for the refreshment as we had hoped to do. He told me the place was called "Matamora" and that he and his family were spending a few months there, Cartago being their home. From Matamora we rode on, the road quite boggy at times but always pretty and shady, until we issued on a better traveled road and turning to the right soon came in sight of Paraiso, quite a little below us, and then returned to Cartago by the main road from Cot through San Rafael.

To anyone looking up the huge slopes of Irazú from Cartago, the village of Tierra Blanca, and the light or whitish clay from which it took its name, were conspicuous landmarks. Tierra Blanca was over 2000 feet higher than Cartago and the several roads leading up to it vied with each other in difficulty; the eastern road in particular was a miracle of steepness and slipperiness. This village was a sort of halfway house to those making the volcano trip—though it was by no means halfway up. We passed through it a number of times and also made several excursions with Tierra Blanca as the objective point, while in July, 1909, P. spent some days in the Telegraph Office as the guest of Señor Federico Tristán, who was then acting telegraph oper-

ator there. On the tenth of July, as we sat on the steps of the office, we saw many individuals of the migrating butterfly *Timetes chiron*. They were flying from north to south and consequently down the mountain, and although we made no actual count it seemed a case of true migration.

On July 12 P. took up his quarters in the office, which according to his aneroid was situated at an elevation of about 6875 feet, consequently about 2100 feet higher than Cartago. It was a small one-story frame structure divided into a narrow passage leading to the little window where telegrams and postal matter could be received and distributed (for the post office was also located here) and four rooms communicating with each other, while a fifth compartment was at this time devoted to ducks and chickens. The building was raised a couple of feet above the ground but this space below was not enclosed. Each room had one window; the sashes in the window slid up and down in a country where most windows are casements, but had no sash cords and the upper sash was fast. My bed was a canvas stretcher covered with a straw matting. Señor Tristán lent me a pillow but had warned me to bring covers for my cot as he had only his own, but the wind blew hard those nights and so much came through the cracks between the boards of the walls and floor that it was decidedly chilly. Besides the ducks in the fifth room there was a recently hatched duckling and its "hatcher," an elderly hen, who spent the nights in Señor Tristán's bedroom and had the run of the four rooms during the twenty-four hours if they so desired, for there were no doors to separate the rooms from each other. It was just as well, therefore, that there were no floor coverings, otherwise hen and duckling would not have improved them.

Tierra Blanca at this time had 137 males over twenty-one years of age and its total population was about 500. Most of its houses were on the eastern road from Cartago, which

was here so steep that the highest house was fully 500 feet above the lowest. At one of the houses on this road, that of Eduviges and Ramona Brenes, we had our meals. It was situated on a raised bank or terrace on the east side of the road, the terrace having a stone retaining wall bordered at one end with clumps of flags (*Iris*) and purple lilies. This terrace was nearly level on top, the bare earth hardened and flattened by long use. On this terrace, at perhaps twenty feet from the retaining wall, stood the two-roomed, one-storied house with thick whitewashed adobe walls. It had the usual tile roof, gabled at each short side and the eaves projected over the front or west wall of the house nearly four feet. At one end under the projecting roof were two cement sinks fitted with brass spigots and supplied with water piped (in galvanized iron pipes) from the mountain above. Each of the two rooms had one door but no windows and no ceiling, for, looking up when inside, one saw the slanting roof beams which supported the tile roof. The floor was the same hard beaten earth as the terrace and on the same level.

The room nearest the sink was the kitchen; it had no chimney—these houses rarely do. The smoke finds its way out by such holes, accidental or otherwise, as may exist near the roof and incidentally filling the room and blackening the interior. All the cooking was done with wood of course. I saw an iron coffee mill, used not only for grinding coffee but also maize for the making of tortillas. The darkness, the smoke and my own disinclination to intrude, however, prevented my seeing many details of this room, besides which the kitchen was more or less occupied by the persons of Señora Brenes herself—a large motherly woman—others of the family and one or more female neighbors.

The other room was bedroom and everything else, furnished with beds and narrow, backless wooden benches. On

the whitewashed wall of this room, opposite the door, a large picture frame was outlined in red and blue; in front of this stood a table holding several pictures of saints, including two which evidently had the Immaculate Conception of Murillo as their foundation.

Our meals were served on a table placed in front of the house under the projecting eaves and covered with a muslin tablecloth. We had white china dishes, except that some of the coffee cups were colored or bore inscriptions, and the labels on the knives indicated German manufacture. The food was good, clean and well-cooked; for my four days' board, twelve meals, I paid 3 colones, 90 centavos (\$1.80). At seven or so we had "café," consisting mainly of sweetened coffee (that is, boiled with dulce) without milk, and tortillas, but in addition I had a couple of "huevos pasados por agua"—soft boiled eggs. At eleven was "breakfast"—rice, black beans, a combination of eggs with some vegetable such as potatoes or sapayo (one of the squash-cucumber family), boiled or stewed beef, boiled potatoes, yuca, chayote, plantain, etc., finishing with coffee. Dinner at five was much the same except that it began with soup and the coffee was preceded by a "dulce," usually in the form of stewed fruit, such as peaches.

Peaches are grown to a considerable extent around Tierra Blanca and brought for sale to the market at Cartago, but always green or at least more or less unripe. Professor Pittier says in his recent book on the common plants of this country that it is rare to see a ripe peach, the people seeming to prefer them unripe. There is, moreover, great difficulty in ripening them on the trees owing to the fondness for them shown by birds and by wasps and other insects. Even when not destroyed by wasps the fruit rots on the trees when ripening, which seems to indicate that the peach is not adapted to this moist climate.

Tortillas and bread, the latter not home-made but bought at the store, were also served at breakfast and at dinner. The bread is almost always in the form of narrow loaves of varying size and shape but pointed at both ends, more like elongated rolls with hard crust on all sides. Once at the Brenes' we had a sort of corn bread, at least Señor Tristán said it was made from maize; it was thicker than the tortillas, not yellow, so apparently it contained no eggs and rather heavy—I did not care for it. Butter there was none, but a substitute was often present in a fresh white cheese resembling Neufchatel, in the form of a fairly solid cake with a little whey. It was unsalted, but a piece of it on a tortilla with a little pinch of salt improved the tortilla very much in my opinion.

The most novel feature of our meals at the Brenes' was the animal surroundings. The beasts belonging to the establishment consisted of two cows, each with a frolicsome calf, a young bull, a couple of young pigs, a dog (and another which usually came from across the road) a cat, three ducks and numerous chickens. All of these gambled or strayed on the terrace under the projecting roof and not infrequently into the rooms of the house. Usually when we were eating, some one was continually employed in chasing the live stock away. The two cows were not present often but once they were milked under the eaves just previous to our meal. Two larger pigs were doubtless only prevented from joining our party around the table by being too big to push between the barbed wires which bounded their pen back of the house. A priest and his brother took meals at the same table for part of my stay, and I have a distinct recollection of one evening, when the priest sat at one end of the table while eight inches from the back of his chair were the flanks of the young bull whose head was through the kitchen doorway.

There was so much mud in Tierra Blanca owing to the

frequent rains, the sticky nature of the soil and the degree to which it was washed on account of the steepness of the roads, that it was no wonder that the clothes of the inhabitants were usually stained. The existence of the cement sinks at the Brenes' produced an improvement over the usual method of washing clothes, for here it was done in one of the sinks while ordinarily it was done on stones on the banks of some stream irrespective of the cleanliness (or muddiness) of the water thereof. All washing of clothes was of course in cold water only.

Señor Tristán had a broom of the usual civilized type in the telegraph office, but at the Brenes' a bundle of leafy twigs did duty for sweeping, an operation which was usually performed by the man of the house during my presence there.

After dinner we returned to the office until seven o'clock, then went back to the Brenes' where Señor Tristán had a phonograph and for two hours American, Spanish and other songs were produced in the sleeping room for the gratification of the family and a few neighbors. Señora Brenes joined us later and indulged in her cigarette, sitting on the edge of the bed in which the little girl was sleeping. The illumination was furnished by a single candle. The phonograph provided Señor Tristán's usual evening amusement and must have added greatly to the pleasures of these people.

The road which led to the top of the village went on to the craters of Irazú. The highest house was 7150 feet above sea-level. Looking down on the village gave a picturesque view of the red roofs and white walls of the houses nestling among the green vegetation, while beyond was the valley of Cartago bounded on the south by range after range of mountains. From this point, on some days, San José was also visible. After climbing the Tierra Blanca hill, the road keeps nearly to a level for a couple of miles, dividing then

into two forks, the right going to the highest point of the volcano eventually while the left led to the lower western parts of the mountain. The land on each side of the road was all open, either as pastures or fields of maize; there was consequently nothing to obstruct the view and one could see far in nearly all directions. It is a beautiful country and would be well worth a visit of several weeks.

A number of bright-colored butterflies were flying about this road on July 12. At places were many guitite trees with clusters of tiny pale greenish-white flowers along the smaller branches. These flowers were very attractive to bees, butterflies and some day-flying moths. Among the latter was a handsome species (*Uranidia fulgens*) with wings shaped as in the Papilio butterflies and long tails to the hind pair of wings. The wings are black crossed by bars of metallic green, and the tails just mentioned are edged with white near their tips. Each front wing is one and one-half inches long, each hind one, including the half-inch tail, two inches. The appearance and manner of flight of this moth are so butterfly-like that for long after we came to Cartago I was deceived by it and thought that some of them must be butterflies. There were also humming-birds of several species around these guitites, doubtless feasting on insects attracted by the flowers. Sweet violets, purple and mixed purple and white, were numerous on the roadside banks. In hedges between fields and along the road near Tierra Blanca were a number of shrubs fifteen to twenty feet high, having rather dull green, cordate leaves about six inches long and in April bearing large clusters of soft orange berries one-eighth inch in diameter. The plant was called "Ortiga" in Tierra Blanca, probably the ortiga referred to *Urera caracasana* by Pittier.

By following the left or western fork of the road one reached the Rio Reventado, at that point a small stream

flowing through a grove of oaks (encinos) and other trees. In fact this place was the lower limit of the oak forest here, of which more hereafter, but the oaks must have reached still lower down in former years for on another day I noticed a solitary oak in a field between Tierra Blanca and Cot at 6800 feet. This oak has leaves two to three inches long and with entire edges, but the acorns are one and a quarter inches long in some cases. Associated with the oaks here at the Rio Reventado were at least two species of the characteristic tropical American family, the Melastomes—one a small-leaved tree (*Conostegia*) ten to fifteen feet high, the other an herb (*Miconia*) with larger and softer leaves.

Grasshoppers of familiar forms and colors (*Chortophaga meridionalis*, *Schistocerca zapoteca*, *Dichroplus morosus*) were not rare along the road on July 12, but nowhere could I find a single dragonfly, not even at the apparently favorable crossing of the Reventado. Beyond this crossing, the road ascends steeply for some miles, winding around the hills which form the mountain slope. Indian graves have been found in this vicinity and at Sabanilla, where there are two or three small houses. Señor Tristán pointed out a hole in the road-side bank from which two gold ornaments had been taken in the construction of the road.

On July 13 I went a mile beyond Sabanilla to look for the Laguna del Reventado or Laguna del Dirumbo. Some bars were stretched across the end of the road and climbing over these I entered a field with trees and bushes, ascended to a ridge marked with tall oaks and then descended into a flat-bottomed valley between two great divisions of the mountain (Irazú). This valley is an extinct crater of Irazú, although the Danish naturalist Oersted regarded it as a distinct volcano, that of Reventado. Even from Cartago one can see an immense bare place on the southwestern side of the highest mass of Irazú, and now that I was in the val-

ley I was almost at the very foot of this huge slide—an almost vertical face of yellow rock perhaps three hundred feet high and a hundred wide, not reaching as far down as the valley floor. On one side of the floor was the Laguna del Dirumbo (also called Laguna del Reventado and Laguna de los Derrumbaderos), the source of the little Rio Reventado. The laguna was about eighty feet wide and one hundred feet long, of clear cold shallow water. Here and there beds of grass dotted its area, and its undefined and swampy sides were bordered by trees and bushes. Around the laguna were many oaks both alive and dead, the whitened trunks of the latter giving a curious and mysterious effect, and among the oaks some clumps of bamboo and much grass. Below the laguna cattle were feeding, the part occupied by them being separated by a barrier or fence of dead logs and branches. There were several smaller boggy streams in addition to the Reventado and a second smaller swampy spot. The altitude of this place was 9100 feet by my aneroid. There were very few insects in this valley and to my astonishment and disappointment not a dragonfly could I see. In July, 1906, I had a similar experience at Lake Moraine on Pike's Peak in Colorado, at a not very different elevation. Indeed the highest altitude at which we personally met dragonflies in Costa Rica was below Tierra Blanca at about 6450 feet.

Prof. J. Fidel Tristán visited the Laguna del Reventado in July, 1910, and soon after wrote me that he had seen "three big dragonflies flying on the laguna. They were of a dark color and I tried to catch them but my efforts were not enough." In April, 1911, he was more successful and took a single specimen in a rivulet near the laguna. This specimen, a male of *Argia terira*, a small slender blue and black species, furnishes the present record for the highest altitude for Odonata in Central America.



Salvia involucrata.



Siphocampylus sp.



Stone Image from an Indian Grave near Sabanilla,
one-half actual size.

On one of his later visits (in July, 1913) to Sabanilla and the Laguna del Reventado, Prof. Tristán found on a rotten tree a dead specimen of the brilliant silvery-gold beetle, *Plusiotis batesi*, which he sent to us. This resplendent insect, one and three-sixteenths inches long, is a member of a genus of Lamellicorn beetles "highly characteristic of the Central American region" and always attracting attention on account of their brilliant metallic colors. We did not meet it in our own experiences in Costa Rica.

Formerly the Laguna del Dirumbo was much larger, but in October, 1891, the barrier which held back the water gave way and a great flood poured down the Reventado affecting even Cartago; no lives were lost as the sound of the approaching water was heard in time to give warning to people living near the river. A larger, prehistoric flood is supposed to have broken down the south wall of the crater to its present level, and to have carried and scattered on its course the numerous boulders and rocks now so striking a feature of the landscape around Cartago. Romanes, however, who studied the Cartago region in 1910, thinks that the boulders of lava, especially to the east of the town, represent a single lava flow which has weathered out in place and that this lava flow once formed a dam which held back a large but shallow Cartago Lake.

The sun was shining while I was in the valley of the laguna (11 A. M.) but every quarter hour or so a light cloud swept down from over the summit of the mountain. These clouds increased in density and as I went back to Sabanilla it rained at intervals. After looking in a nearby potato field to see if the plants were attacked by potato "bugs" (*Leptinotarsa*) and finding none, I walked back to Tierra Blanca, much of the way through rain which continued through the afternoon.

In April, 1910, M. Jaime Lacroix, a Frenchman who had lived in Costa Rica for some years and made a business of

digging for Indian relics, brought us a stone image, a piece of pottery and a small jade celt from graves which he had recently excavated near Sabanilla. The image is of a standing man, broken off above the knees, the lower parts of the legs having evidently been lost long ago and not in the recent excavation. The head bears a sort of double-crowned head-dress and has a muzzle like a bat's. The arms are akimbo, the hands being placed on the front of the belly and between them is an ornament represented as suspended from a cord which passes around the neck. Around the hips is carved some sort of garment, possibly feather-work. The piece of pottery is a shallow circular dish supported on three legs, each of which probably represents a tapir's head, and is hollow; a small loose ball of clay inside makes each leg a rattle. The bowl of the dish is decorated in a crude symmetrical pattern of red and yellow and has a single animal's head in high relief on the outside.

Cot, a village a few miles to the southeastward of Tierra Blanca, was connected with it by a single strand of telegraph wire which furnished an easily followed guide. Going this way on July 14, I came to a promising-looking small stream, which I explored for dragonflies but without success, obtaining only a few little Diptera. A little farther on, the road was bordered with flowering guitites and here too were many humming-birds. Across the fields to the northeast was a large house of a style of architecture very un-Costa Rican, having a tall round tower at one end and some other elevation at the other. It was the residence and dairy farm of Don Leopoldo Peralta; the house had a fine situation and must command a beautiful view. The sky was very threatening on this day and relatively few insects were flying, but among them was a handsome yellow and reddish-brown bumble bee (*Bombus ephippiatus*); it was called here *el rey de las abejas*, king of the bees.

In October we visited Cot from Cartago, a distance of seven miles. It is a straggling village except the streets bordering the grassy plaza. The church had no tower, but under a central peak in the roof were two niches in which the church bells hung. This village is an old one, going back to Indian times, while Tierra Blanca is modern, but there is nothing in the outward appearance of Cot to indicate any greater age than belongs to its neighbor. The roads near Cot command extensive views of the Reventazón Valley.

Half a mile east of Cot is a fine waterfall about one hundred feet high, locally called "Ojo de agua" (eye of water) as waterfalls and springs commonly are termed in Costa Rica. The stream is not usually large but the drop is almost sheer and the whole place very pretty. There must be a great volume of water immediately after heavy rains, as the pool at the bottom showed that it had been much larger a few hours before our visit. About the waterfall was much red earthy rock, a volcanic (andesite) ash, discolored by weathering, containing plagioclase, hornblende, glass, iron hydroxide and clay. The vegetation around the fall is quite different from that of the Juan Viñas waterfalls. The mosses and Selaginellas so characteristic of the latter were absent from Cot and instead there were many Equisetums, commelinas (*C. virginica*), *Browallia demissa*, Cupheas (*C. infundibulum*, *C. wrightii*) and phytolaccas (*P. octandra*). The fall was shaded by a handsome tree-composite with bright yellow flowers.

Along the roadsides even below Cot we saw the pretty *Geranium mexicanum*, which we found to be so common in the cinders of the crater of Irazú but it was much rarer at this lower level.

CHAPTER VII

THE VOLCANO IRAZÚ

The volcano of Irazú, highest of the four great volcanoes (Turrialba, Irazú, Barba and Poás) of the central plateau, and, with the exception of Buena Vista and Chirripo Grande, the highest mountain in Costa Rica, reaches an altitude of 11,322 feet (Pittier). It is a huge, "sprawling" mountain with gradually sloping sides and an exceedingly irregular skyline, and with no typical volcanic cone visible from Cartago. The volcano dominated the country and the landscape from San José to Juan Viñas, and a year's residence at its foot caused us to share the mingled love and awe with which the Cartaginenses regarded "El Volcan." The southern slopes, up to 9050 feet, were in 1910 covered with maize and potato fields or cattle farms. Above that level—alas! the line is constantly rising!—are the remnants of the vast oak forests that formerly covered the whole mountain. Above the oaks again are the cinders of the volcano proper. The center of volcanic activity has moved steadily from south to north over the crest of the mountain and there are a number of abandoned, worn-out craters on the south side. A very well-marked one is that occupied by the Laguna del Reventado, described in the preceding chapter.

The last great eruption of Irazú, leaving out of account the steam from the solfataras on the north side, was in 1723. A contemporary writer, Don Diego de la Haya, the governor of Cartago, has an account of it which has been reprinted by Don Cleto González-Viquez. The eruption began on the sixteenth of February, with feathery clouds of smoke

over the summit, and continued intermittently until December of the same year. The smoke was followed by rumblings, flames were visible at night and there were many eruptions of ashes, stones and other burning particles, covering the volcano and its surroundings. The ashes fell upon the streets, roofs and patios of Cartago, the fields and trees of the vicinity and, at times, the finer particles, entering the eyes, nostrils and mouths of the inhabitants, caused sneezing and coughing. On March 3 the governor sent an expedition of ten persons to visit the summit—the first recorded ascent of the mountain. They reported that in the midst of an opening having almost two leagues' circumference was a fire like a pan of tar and "that it ejected from time to time ashes, sand and small stones, the quantity of these that had fallen on all the neighborhood, as well as of larger rocks, being so great that they could load a hundred ships of large size." In the absence of any exact statement as to the size of these "large rocks" it is not possible to determine whether any of the boulders that now litter the slopes of Irazú were ejected in 1723 or (if due to any eruption at all) are to be ascribed to an earlier, pre-Spanish eruption. De la Haya's account mentions the masses of ashes that sifted over the city, while a bombardment of such boulders as these would inevitably have crushed the houses and could hardly have failed of special mention.

There was a series of earthquakes accompanying this eruption, the most violent lasting from September, 1723, to February, 1724, although they did not cause any very great damage.

The ascent of Irazú offered no particular difficulty, as it was possible to ride the entire distance, but it was a fairly long and expensive trip if one wished to do more than make a flying visit of a few hours, and the mountain was so frequently cloud-capped that we did not attempt it as often

as we would have liked. In July, while staying in Tierra Blanca, P. went up on foot, but the day proved so misty that not only was there no view from the summit, but he was really unable to make out more than a few features of the crater. He only found the trail by accidentally meeting a youth who was hunting a strayed mule and was able to guide him, and the mist was so dense that it would have been too dangerous to wander far from the trail. Thanks to this chance encounter P. saw the edge of a deep daughter-crater yawning in the floor of the largest crater and learned that there were many such pits, but he could not see more than a few feet ahead and therefore returned to Tierra Blanca after waiting awhile for the unlikely chance of the mist's blowing out of the crater. While returning over the crater and the cinder cone, the only guide through the mist was his own footsteps in the damp cinders, but he was able to follow these without much difficulty to the path in the forest.

On September 22 we set out for the crater on horseback. Although in the midst of the rainy season, which is not usually a favorable time, the summit had been beautifully clear for several days so that we felt encouraged to make the trip then. Starting from Cartago about seven in the morning, we reached Tierra Blanca at nine, enjoying brilliant sunshine and beautiful views. After the customary baiting of the horses there we pushed on to a point some six hundred feet above the village, where a long stretch of relatively level road follows the terrifically steep hills of Tierra Blanca, and where the road is joined by another ascending from the valley of Cartago but east of Tierra Blanca. This latter was usually known as the "milk road" because it was the one followed each morning by the train of pack-mules from the Jiménez Lechería, and although considerably longer it was far easier to travel, as it skirted the Tierra Blanca hills. We ate our breakfast here, under some roadside guitite trees

laden with fruit, and then resumed the journey. Our first plan had been to visit the crater twice on this trip, going up directly from Cartago so that we would have the afternoon at the summit, coming down to the Lecheria for the night, revisiting the crater at sunrise and then returning to Cartago in the afternoon of the second day. The Lecheria was the only place where one could stay so long with horses, as the last water and pasture were 1500 feet and several miles below the crater. The plan would have been quite feasible if we had had fair weather, but by breakfast time the clouds were gathering rapidly and before we reached the fork of the road, the left leading to the forest and the other to the Lecheria, the rain had begun. We tried the forest a short distance but the road soon became extremely slippery and the clouds were now so thick on the summit that it was useless to go farther, so we turned back to the Lecheria.

This Lecheria was a large dairy farm belonging to Don Ricardo Jiménez, the successful candidate for the presidency. It was situated at the lower limit of the oak forest, at an altitude of 8850 feet, in a beautiful nook between two hills. Many magnificent oaks were still standing near the house. The oaks of this level bore a wonderfully gorgeous parasite, perhaps *Loranthus* (*Psittacanthus*) *schiedeanus*, which Oersted collected on Irazú at 9500 feet elevation in January, 1847. It had large opposite leaves of a dull dark green, and immense tufts of red, red and yellow, or orange flowers. The separate tubular flowers are about three inches long and very slender, one-eighth to one-quarter of an inch in diameter, but the mass of bloom on one tree was often as large as a small house and even in the gray light of cloud and rain was most brilliant.

At the Lecheria we rode into an open, covered milking-shed, having a haymow above and a galvanized roof, and were glad to be under shelter. The "boss" was not present,

but we made ourselves at home to the extent of tying up our horses, loosening girths, taking off our wet coats and hanging them up to dry, while a number of men looked on with appreciative grins at our rather draggled appearance. The pack-mules with the empty milk cans had passed us on the way up and were waiting in this shed to be unsaddled. Presently the manager appeared and gave us permission to have food for the horses and to sleep in the haymow, and one of the workmen now unsaddled our beasts and threw down what looked to our eyes enough hay for four horses. As a matter of fact our steeds ate steadily at it for two hours and a half, but they had surrounded it all by that time. Then they were watered and given a second similar feeding at which they worked all night.

Having arranged the matter of staying, we looked about us while it rained. Our particular shed also sheltered some ox-carts and every now and then an ox or mule wandered in out of the rain, or to pass the time of day with the visiting horses. There were three milking-sheds in all, two of them quite large. We noticed also some American cultivators, harrows, etc., and two huge imported draught horses which made the native horses look like toys. The sheds themselves and their surroundings were very like such places at home where the owner has not been stirred by the modern ideals of cleanliness—neither worse nor better than hundreds of barnyards in the eastern United States. The house was a curious mixture of boards, bamboo, adobe, galvanized iron and other scraps. It seemed to have three rooms, a bedroom on the right, a recessed room in the center having a little covered, earth-floored porch before it and apparently containing sacks, seeds and other supplies and on the left a large kitchen.

We reached the farm about 1.30 P. M. At 2.30 the cows began to come in from the fields, large handsome creatures



Botrychium obliquum.



Geranium mexicanum.



Castilleja irasuensis.



Spirea argentea.



Flowers and Entire Plant of *Chionolena lavendulacea*.



Leaf, Inflorescence and Entire Plant of *Gunnera insignis*. (White cloth in upper view is 35 inches wide.)

that looked as if they could really give an appreciable quantity of milk. (Most of the cows here give very little, and if the calf dies, or is removed, the cow goes dry immediately.) We did not make an exact count but there were about sixty. The cows were fastened by stanchions and fed with hay and then the milking began. The milk was strained through cloths and then dripped over pipes, through which cold water was constantly running, directly into the cans in which it was carried to Cartago. The milk cans were of the familiar type with a copper label on the shoulder stating that they were made in Bellows Falls, Vermont. Some time after milking the cows were set free again and returned to the pastures, being milked only once a day.

The rain stopping about four o'clock, we walked around a little admiring the views, the huge oaks and beautiful flowers and enjoying the antics of a number of frisky calves. A little after five we were invited into the kitchen to have some hot coffee and warm ourselves by the fire, an invitation we were glad to accept. The kitchen was a large room with a door and one small window in a corner. Its walls were board on one side, mud and bamboo on the others, while the floor was earthen. For furniture it had two or three benches against the walls, a long rude table, a rack of hooks holding white enamel cups, another rack full of white enamel plates, a swinging shelf on which some edibles were kept—I saw the cook take down one of the usual cakes of brown dulce—a tall wooden coffee strainer, some pots and kettles and in the center a modern cookstove, which however had no chimney connections. But although the stove was modern, the cook was not and the entire front and sides of the stove were wide open and obviously warped and rusted beyond the possibility of ever shutting again. The sticks of wood were twice as long as the fire box and were pushed in as the ends burned. From a kettle on the stove the cook

ladled up a big dish of rice for us and also lent us one tin spoon with which we took turns; later we had each a cup of coffee and although we had brought plenty of provisions we were pleased to have these hot things. We sat on one side on one of the long benches and in other corners were half a dozen peons eating black beans, rice and tortillas. There was little light from outside and that rapidly waned, while within was only the firelight, so that the dark room with its dusky figures and the cook moving about among the shadows made a picture suggestive of Rembrandt.

As soon as we had finished our supper, we retired to the haymow, spread out our shawls and blankets and went to sleep. The nights here are often very cold but fortunately for us there was no wind that night so we slept comfortably in the open-sided hay shed. Below us, horses and mules stamped and munched at what seemed to us an endless supply of hay. The peons climbed into the other end of the haymow and settled down after some giggling and the whole Lecheria was in repose shortly after dark. Somewhere in the very small hours an alarm clock buzzed and after some sleepy groans and rustlings we heard the pack train, each mule with two big milk cans, start down the mountain for Cartago. With the first glimmer of light we climbed down with our outfit, saddled our horses and were off to the summit. The morning star still glimmered, the sun was just touching the highest peaks when we rode away from the farm and anything so beautiful as that morning ride I have never seen. As the sun rose and the mists dissolved, range after range of hills and mountains appeared and soon when we came to a clear place in the road, we could see the valley containing Heredia and Alajuela, and still more to the west the Gulf of Nicoya and the Pacific Ocean, the islands in the Gulf and the hills of Nicoya beyond. South of us rose the Cordillera of Talamanca, looking immensely

high. Other turns in the road showed us Cartago far below, the white fronts of its houses making conspicuous white lines as the sun shone on them.

A mile or so after leaving the farm we entered the forest and here began the really hard part of the climb for the horses, as the trail is steep and there are many projecting roots to climb over—or stumble over if the horse is careless. It is a singularly impressive forest. The oaks composing it are of great size, very spreading and are covered with gray-green lichen so that they look almost unreal. In places the shade was dense, in others the sunlight filtered through and its warmth was quite welcome. There were many beautiful flowers. Along the roadsides from the Lecheria up to the upper timber line we saw numbers of a pretty blue flag-like plant and great quantities of tall forget-me-nots with the usual blue and pink flowers. In the forest shade we particularly noticed the handsome *Siphocampylus regelii* and *Cavendishia veraguensis*, both having conspicuous red blossoms. The air was sweet with the fragrance of flowers and the glorious freshness of the mountain air. Many birds were singing, their notes nearly all different from any we heard at Cartago.

After about a mile and a half of this forest path we came out abruptly on the cinders of the cone. There is no gradual diminution in size in the oaks; on the contrary they end suddenly so that it is possible to draw a line on one side of which are large trees, on the other none. This line is of course very sinuous but there is no difficulty in tracing it. In the forest the soil is black volcanic ash, while on the cinder cone the particles are much coarser. The trails over the cinder cone look like artificial cinder paths, winding through the bushes and flowers. The vegetation growing on the cinders, while quite abundant, is not uniformly distributed but grows in patches or "islands," so that Irazú

here shows an intermediate stage between the bare cinders produced by an eruption and the fully clothed summit of a long-extinct volcano. Such vegetable islands are due to the accidental lodging of some individual of the pioneer species by whose roots the cinders are held together so that other and different seeds can sprout and obtain a foothold in the shelter of the first. Standing in the cinders and among the growing plants are a great many small dead trees, all about the same size and all bleached quite white. These dead trees are not oaks; they were seen in January, 1847, by Oersted who mentioned them as *Comarostylis rubescens* (now termed *Arctostaphylis lædifolia*), one of the heaths. One of the most common and, because of its numbers, conspicuous plants of these cinder gardens was a pretty little geranium (*Geranium mexicanum*). Its flowers are one-half to three-quarters of an inch across, from a pure white to a deep pink in color, daintily veined in purple. It starred the slopes wherever grasses had obtained foothold and then it reminded us strongly of our own "spring beauties." It grew through the huckleberries and myrtles and opened its delicate blossoms among the glossy leaves of the stronger plants. Another common plant, growing several feet high, was *Spiræa argentea*, with stiff, thick racemes of small, inconspicuous but very fragrant white flowers. A curious little fern (*Botrychium obliquum*) was growing among the geraniums. Dr. H. Christ, of Basle, wrote of our specimen of this fern, "that it does not differ in any respect from those from the north of the United States and that this species plays in Costa Rica the rôle of a glacial relict ("reliquat glaciaire")."

At the very summit nothing grew—probably the wind was too strong. It took us a long time to reach this point as the trailing in the cinders is slow and tiresome, but at last we turned down into the crater itself. Looking north from

the summit we saw the blue-green expanse of the forest-covered plains of Santa Clara with the silver line of the Rio Sucio winding towards the Sarapiquí. The Atlantic Ocean we could not see at any time and now the clouds in the valleys cut off any view of the Pacific. We were less fortunate than Stephens in early February, 1840, or Hoffmann, on May 7, 1855, who record having seen both oceans from this volcano. Clouds were gathering near Irazú even before we made the summit, faint thin wisps of stratus clouds that were not promising. We rode over a wall some four hundred feet high, down into the largest crater and dismounting there at 8.45, tethered the horses to a bush.

The floor of this crater is almost perfectly level, of fine ash and cinders strewn with huge boulders and in it were growing a few bushes, a pale yellow *Gnaphalium* (*G. attenuatum*) and many plants and patches of the showy *Castilleja irasuensis*, its red leaves and flowers looking even brighter against the gray cinders. The cinders and small stones were to a great extent covered with a gray, thick powdery lichen, which gave a strange and deceptive appearance of softness to the crater floor; there was also a quantity of *Chionolæna lavandulacea*, a low, much-branching Composite plant with gray scale-like leaves and an immense root system. In a few spots we saw a small Alpine saxifrage. There were many patches of the huge *Gunnera insignis* established especially on the walls of the steep-sided secondary craters. The red-veined, roughly circular leaves of this plant measured over a yard across and were borne on thick stout petioles two to three feet long. The stem, ribs, and to some extent the whole surface were covered with short, sharp, recurved spines. The inflorescence was a showy, crowded spike of little red flowers, eighteen inches long. Although the conditions were highly unfavorable, we

photographed a leaf and flower stalk in the crater, as they were much too big to carry down to Cartago.

There were several kinds of birds flying in and around the crater. Insects were present, in small numbers; we saw a green lace-wing fly, a few small Diptera, one large fly, a small fly or two and one or two specimens of a small species of may-fly. In the mists of the crater on July 15, P. saw a few moths of fair size but was unable to catch one, for they were speedily swept out of sight by the wind. Their wings seemed to be of a dark color with a pale patch on the middle of the front pair.

The stratus clouds that promised so badly were unfortunately true to their promise. Shortly after nine o'clock the crater began to fill with mist which blew in from the east. It lifted three or four times, so that we were able to secure some photographs in spite of the moisture on the lens, but each time returned as a denser cloud, cutting off the view of the craters completely and rendering any circuit of them quite useless. We knew by this time that after the summit was once thoroughly cloud-capped it was almost certain to remain so for the rest of that day, and so with great reluctance, we started on the return journey about eleven. Before we were halfway across the cinders actual rain commenced and was soon very heavy, continuing so until we were far below the forest. The clouds were low, and the dead trees and gray cinders looked pale and misty but we had no difficulty in retracing our path, and absence of wind made the low temperatures not uncomfortable. If the forest had looked unreal in the bright sunlight it was positively unearthly in the gray clouds, the lichen-covered trunks standing up like the ghosts of trees. The rain made the trails very slippery, in places really dangerous, and all of us—horses and riders—were thankful when we passed into the clearer, wider high road.

The rain stopping for a short time, we turned aside at a branch road 1400 feet above Tierra Blanca, where there is a little stream, and watered and fed the horses and refreshed ourselves. But all the rest of the way down there was a steady and exceedingly hard downpour, and although we followed the longer milk road to avoid the Tierra Blanca hills, the road was steep and so slippery with the rain that even our surefooted little horses could do no more than crawl. It was consequently a long and tiresome ride down to Cartago, but we managed to keep the cameras and plates dry and in spite of the rain we were glad we had made one ascent in the wet season.

Our next visit to the volcano was in the dry season, when we carried a tent and camped two days in the crater itself, and in spite of some unfavorable weather were able to make a much more complete examination of the volcano. Leaving Cartago in the morning of March 31, with a guide and a packhorse, we rode directly up to the crater, only pausing in Tierra Blanca a few minutes to speak with our friend Señora Brenes. In great contrast to our previous visits to the top of Irazú in July and in September was the dryness of the road for the whole distance, even through the forest. This made our ride easier, speedier and more agreeable. In the forest, we were sorry to see that a number of large oaks by the roadside had been felled or burned since our last visit, a destruction which has doubtless been in progress for many years.

About halfway in the forest we turned aside to fill our water cans at a small and beautiful spring known as Chicoa. Its altitude is probably near 9700 feet and it is the nearest water to the crater, distant three or four miles.

Not until we were about to begin the descent into the crater did the first clouds roll over us, producing intermittent mist and rain. We selected a level spot, on the floor of the

great crater near its eastern edge, for our tent, where it would be protected by low trees and bushes from the prevailing easterly and north-easterly winds. At this place there is a wide stretch of smooth, bare, black volcanic sand bordered with gray and reddish mosses on the edge toward the inner slope of the crater wall. We pitched the tent where sand and moss met and had no reason at any time to regret our choice of a location. The altitude here was about 10,890 feet. The tent went up readily, all three taking part in its erection. As soon as it was up all things brought with us were placed inside, including the saddles of our two horses and of the packhorse; these formed an unexpected but welcome addition to our "furniture" while the saddle cloths served as pillow and foot-coverings at night. The guide then mounted his horse and started on his return to Cartago, driving the other three horses before him. So at two o'clock in the afternoon we two were sitting in the tent eating our mid-day meal, alone in the great crater, six or seven miles from the nearest human habitation.

It rained or misted at intervals, while we arranged things in our tent, and gathered firewood, stacking it inside in the hope that it might dry a little. While doing so we noticed various kinds of footprints in the sand near the tent, chiefly of four-footed creatures. There were small prints in groups of fours of a size suggestive of skunks and larger ones which were probably made by a big cat such as a puma, but although we especially feared the visits of skunks we were not troubled by any sort of animal at any time during our stay, nor did we see any quadrupeds even when we went out of the tent in the night. Some small noises we heard but they soon passed into the stillness that reigned whenever the wind ceased blowing in the trees above us.

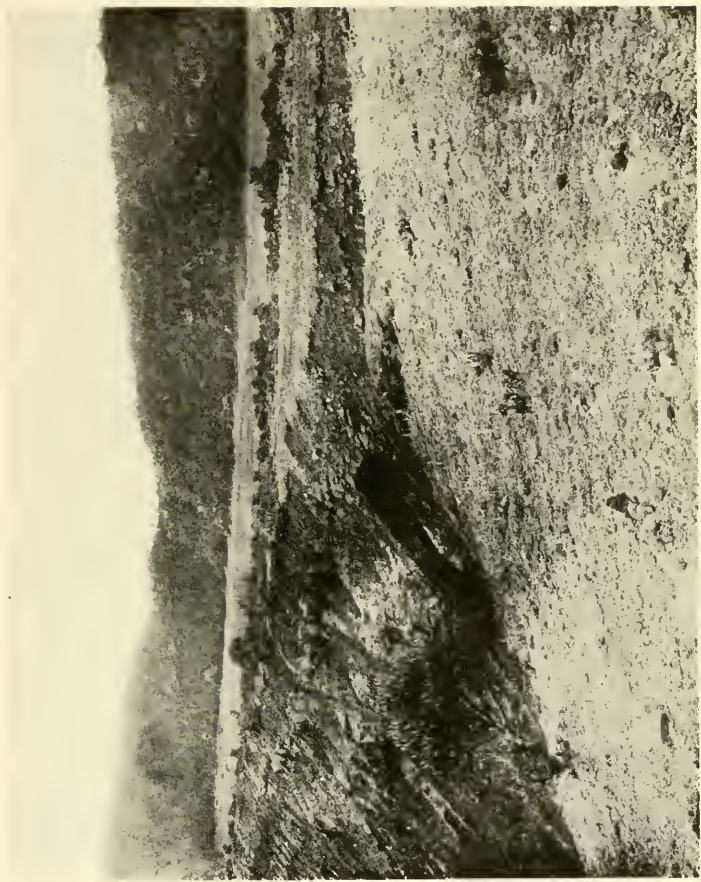
Shortly after five the clouds cleared away and we went to the edge of the large daughter-crater north of our tent to



Oaks at the Upper Limit of the Forest, Irazú.
Dead Trees on the Inner Slope of Crater, Irazú.



Western Daughter Crater (III) of Irazú from the south, showing Granddaughter Craters G, B, E—D, H, F.
(Photo. by Rudd.)



The Floor of the Mother Crater (D) of Irazú.



Grand-daughter Craters B, F—D, F, of Irazú.

look down into its depths at its own daughter-craters within. We could look far north of Irazú also and see the windings of the Rio Sucio through the forest plain, and to the west parts of the volcanoes Barba and Poás were visible. Our bed was made by laying the tentsack and newspapers on the soft dry moss, upon them the rubber poncho, on that an old shawl, then ourselves in winter clothing and rolled up in blankets, two each. We were cold at times during the night but we slept, even if not continuously.

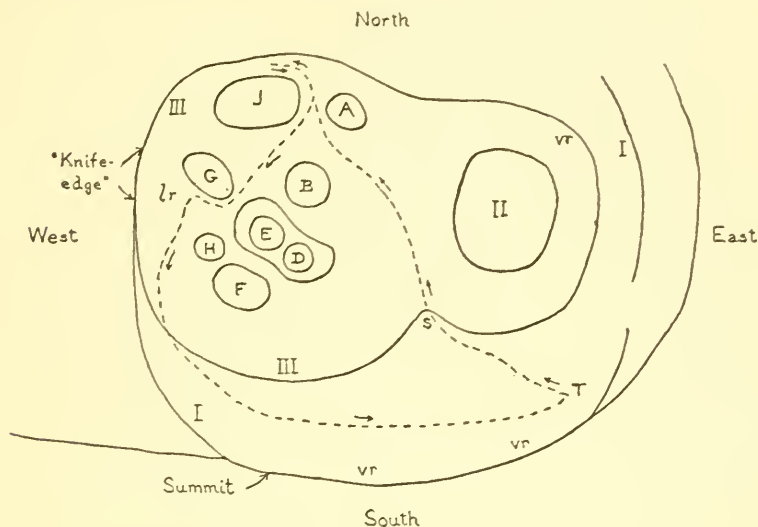
The lightness of the tent astonished us even before the moon rose, and at times when the stars were temporarily covered with clouds—at all times during the nights it was almost light enough to read our watches. The tent was fourteen feet long; it had belonged to Mr. Schaus and had been especially waterproofed by having a coat of lard, paint and linseed oil rubbed into it and then while still moist treated with white paint and it proved perfectly water tight.

At five the next morning the moon and stars were shining most brilliantly and we felt that one of the reasons for camping up here was fully justified, for the early morning is usually the clearest part of the whole day. We took a bite and set off at once westward from our tent across the main crater, which is nearly a mile in diameter, and then climbed up a ridge of ashes and cinders to the summit of Irazú, which our aneroid made 11,300 feet. As we climbed a very strong wind blew from the east, but from time to time we passed a low tree or small shrub and although the branches and foliage of these were not dense they afforded an astonishing amount of shelter from the cold wind. On reaching the summit we saw a thick layer of cloud all around the mountain several thousand feet lower down, blotting out Cartago, San José and the other towns. Only the extreme upper tips of Barba and Poás (which are 9524 and

8786 feet high, respectively) were above the clouds and the same was true of the highest peaks which we could see to the south, including presumably the highest mountains of all Costa Rica. To the northeast Turrialba stood up splendidly and was about as much free from cloud as Irazú—Turrialba being 11,224 feet high (Pittier). Westwardly we could look down the valley of the Rio Grande de Tárcoles, which was not cloud-obscured until near its mouth, but to the north we saw only great masses of white clouds, beautiful to look upon as the rising sun shone on them. As there seemed no reason for thinking that the cloud masses below us would clear away we left the summit at 6.30 and returned to the tent for some breakfast. About eight o'clock we set out to make the round of the daughter-craters.

The volcano proper of Irazú consists of a large incomplete crater, here called the mother-crater (I of the sketch-plan) which has a diameter of the greater part of a mile. Within this are two daughter-craters whose combined east-west diameters are nearly as great as that of the mother-crater but whose north-south diameters are less, so that on the south side a considerable area of the floor of the mother-crater is left between its south wall and the south rims of the daughter-craters. The southern rim or wall of the mother-crater is of unequal height from point to point, one of these peaks being the highest part of all Irazú, while there is another high point at the eastern side of this mother rim. The two daughter-craters are in plan somewhat the shape of a figure eight, the smaller loop or crater being east, the larger west. The smaller eastern crater (II of the sketch) contains no secondary or "granddaughter" craters, the larger western daughter-crater (III) contains eight distinct granddaughter craters (A-J of same sketch) but two of these latter (D and E) might be called twins. These eight grand-

daughter craters are of different depths; thus the floors of J and A appeared to us higher than those of all the others, while G and H seemed the deepest.



SKETCH-PLAN OF THE CRATERS OF IRAZÚ, April 2, 1910

from point S on the edge of the rim where the ∞ -shaped "daughter-craters" meet. T, location of our tent on the floor of the "mother-crater," 10,880 feet above sea-level.

I, "Mother-crater," II, Eastern "daughter-crater," III, Western "daughter-crater," A-J, "granddaughter craters" in the larger, western daughter-crater.

Dotted line shows our route of April 1, 1910.

vr, Bare faces of vertical rock are exposed here.

lr, Laminated rock, the layers more or less horizontal. A piece of this rock collected in April, 1910, was identified as tuff from a hardened mud-flow of the volcanic ash (probably).

Floor of mother-crater, especially in its eastern part near T of fine black sand, and on this floor at least the yellow grass-like plant is chiefly associated with fine sand. The western part of this floor consists of coarser cinders interspersed with large and small boulders of angular outline. A subcubical block about 3.5 centimeters on an edge, brought

from this place July 15, 1909, proved to be porphyritic basalt lava with small plagioclase phenocrysts, while other fragments, one centimeter and less in diameter, from the same place and date, are volcanic lapilli of scoriaceous lavas, basalt and pyroxene andesite apparently. The *Arctostaphylos*, lupine, myrtle, and Ericad are more partial to the coarser parts of the floor. In craters G and H there are bare vertical rock faces, but with these and the exceptions noted above under *vr* and *lr*, the walls and floors of the craters are of loose cinders of varying size.

The only other published sketch-plan of the craters of Irazú of whose existence we have been able to learn is that of Dr. Karl Sapper (1901). As may be seen by comparing his much more detailed plan with ours, the two differ considerably, yet are sufficiently alike to enable one to identify the various craters represented. No doubt Dr. Sapper's sketch is more accurate than ours, in spite of his description of his own as "eine approximative Veranschaulichung." We have left our sketch as it was originally drawn except that we have changed our lettering of the different craters to conform with his. Dr. Sapper considers granddaughter crater J to be really a part of the floor of the western daughter-crater (III), granddaughter crater E to be younger than D, and G and H to be the youngest of the granddaughters.

Two sections through the craters of Irazú have been published by Prof. Tristán in his 1910 paper on the volcano.

We add a list of approximate altitudes from Dr. Sapper's paper, "Die südlichste Vulkane Mittelamerikas" (1901).

Designation	Diameter	Altitude of Rim	Altitude of Bottom
I (Urkrater)	1200	3414 and less	3320
II (Ostkrater)	500×400	3230-3380	3185
III (dritter.	800×700	3230-3320	3185
Hauptkrater)			
A.		3170	3160
B.		3160	3150
C.		3170	3160
D.		<3160	3150
E.		3150	3140
F.		<3190	3180
G.		3200	3140
H.		3200	3140

} enclosed
by a rim
3160

Designation	Diameter	Altitude of Rim	Altitude of Bottom
J.....		3170	3150
L.....		3160	<3160
("knife edge").....		3330	

C and L are still smaller craters not shown on our sketch-plan.

All dimensions are given in meters.

The course which we followed is shown by the dotted line on the sketch-plan. From time to time the mist blew in so heavily as to blot out everything from view. At such times we sat down in the lee of a bush, covered ourselves and especially the cameras with the poncho and waited, sometimes half an hour, until the mist cleared away and then resumed our walk. In spite of these drawbacks we were able to get some photographs while making this circuit. All of the craters, mother, daughters and granddaughters, have more or less vegetation on their walls, floors or both. A plant looking like marsh grass, growing in tufts, is characteristic of the crater floors and the dead yellowish stems gave a sulphurous appearance to them when seen from a distance; some of this grass too has a decidedly salty odor, which increases the superficial resemblance to a salt marsh.

Several species of birds were not uncommon in the craters—a thrush not unlike a robin, some small sweet songsters and humming-birds. Little gray spiders (*Pardosa* sp.) ran over the ground, a handsome red and yellow bumble bee, apparently of the same species (*Bombus ephippiatus*) as occurs also around Tierra Blanca, occasionally flew by, small gray moths and flesh flies were abundant. We stopped to photograph a group of beautiful Bromeliads growing on the ground beneath the branches of small trees and now in flower; the inflorescence was red and green, the leaves were streaked and spotted with red. On pulling one of these apart we found, in the water between the leaf-bases, live mosquito larvæ (*Aedes* near *Ae. aureostriatus*) and other

dipterous larvæ (Chironomids allied to *Tanypus* and *Culicoides*), a weevil (*Anchonus coarctatus*) previously recorded only from Cerro Zunil in Guatemala, and small planarian worms (probably the young of *Rhynchodemus bromelicola*).

The northern rim of crater III falls away on the north side perfectly vertically, to a depth of one hundred and fifty to two hundred feet, to a valley filled with luxuriant vegetation. So sheer is the precipice and so narrow is the rim that it is difficult to see how the wall has been retained on this side.

Crater G is one of the latest of these vents of Irazú. We saw a slight quantity of steam or vapor issue from it. Its walls are very steep and we did not risk a fall into it in order to see the deepest part. Some sulphur coats part of its walls and floor, as is the case with the north wall of crater II also. Professor Pittier reported sulphur vapors issuing from G or H in 1888, but both Dr. Sapper and Professor Tristán assert that since that time no activity has been observed in any of the craters. Our observation just mentioned, of steam or vapor issuing from G, stands in contradiction to these statements.

The really active part of Irazú, in recent years, is on the north slope of the mountain, at an elevation of about 9250 feet, outside of all the craters. In December, 1888, and January, 1889, Professor Pittier found the entire slope in activity with blue clouds of sulphurous smoke and hot water flowing. Dr. Sapper, on February 28, 1889, found only a few fumaroles but no hot water springs. This locality, termed "boca nueva" or "volcancillo" by the Costa Ricans, we did not visit.

We returned to the tent level by climbing the trail through the cinders on the inner (eastern) slope of the western rim of daughter-crater III. This western rim seems to belong to both daughter and mother-craters or else the western rim

of the mother-crater has disappeared. But to whichever it belongs, it forms a very narrow sharp ridge several hundred feet high, which falls away steeply both to east and west, so that it fully justifies the name of "knife-edge" we gave it both now and in our September visit. Ascending this trail and walking on the top of the knife-edge we were again exposed to the strong easterly wind which, bringing mist and rain once more, made traveling very difficult and wet us with uncomfortable thoroughness before we reached our tent again, about 1.30 P. M.

The rain and mist continued all afternoon and more or less all night; whenever we woke we heard the roaring of the wind over the crater top, but very little reached us in our sheltered nook. It was dark and rainy in the morning and we stayed rolled up in our blankets, as the warmest place, until nearly seven o'clock. At intervals the mist lifted a little, occasionally even leaving the craters quite clear for a few minutes. We employed these intervals in hunting for beetles under stones in the black sand, in making a sketch of the various craters from the rim we visited the first night and in gathering plants for identification.

The beetles found proved to be three small species of Carabidæ, all chiefly black in color. The largest, one-third of an inch long, *Amara costaricensis*, is shining, with eight striæ on each elytron, antennæ and legs reddish-brown, the tibiæ of the first pair each with two distal spines which are longer and stronger than those on the other legs. *Anchomenus 10-punctatus*, one-quarter of an inch in length, has a satin-like luster above but is shining below. Its elytra have each eight striæ but the legs are black except for the reddish-brown coxæ. *Bembidium rogersi* was the smallest of the three, one-sixth of an inch long, shining, also with eight striæ on each elytron but the four striæ of each wing-cover nearer the middle line of the body are more

strongly marked than any of the striæ of the two preceding species; the legs and the first antennal joint are reddish-brown, the remainder of the antennæ darker.

The crater was almost as much of a flower garden now as in September. Immediately about the tent there were few plants on the crater floor except the yellowish grass-like plant, which was ripened into a sort of standing hay, some moss and the gray-leaved *Chionolæna lavandulacea* so common over the whole crater. Its pretty white flowers were now abundant. On the slope of the crater wall behind us were small trees and bushes of *Spiræa argentea*, not now in bloom, also many young and medium-sized bushes of *Arctostaphylos ledifolia*, a plant with stiff leathery leaves that forms the greater part of the woody vegetation on the cinders both inside and outside the crater and is growing up around the dead trees as if replacing them. The dead trees are found on the outside of the cone in fine sand where there is much living vegetation and in coarse cinders where there is little; they are as common on the inside of the mother-crater rim where they are half buried in young trees. They are of uniform height (about fifteen feet) and shape, very widespread for their height and with stiff gnarled spray. It looks as if they had been killed all at once, possibly by some gaseous eruption, and in the mist their bleached skeletons give a strange and ghostly aspect to the scene. Among the trees and bushes on the inner slope were many plants of *Senecio oerstedianus*, composites with loose clusters of yellow flowers and large coarse entire leaves whitish below.

On parts of the crater floor more distant from our tent there were a few individuals of *Castilleja irasuensis* in bloom and many young plants of this species were growing up. In September they were flowering abundantly. Some scattered Gnaphaliums were still in flower now also. Where the yellowish grass did not hold sway there were in many



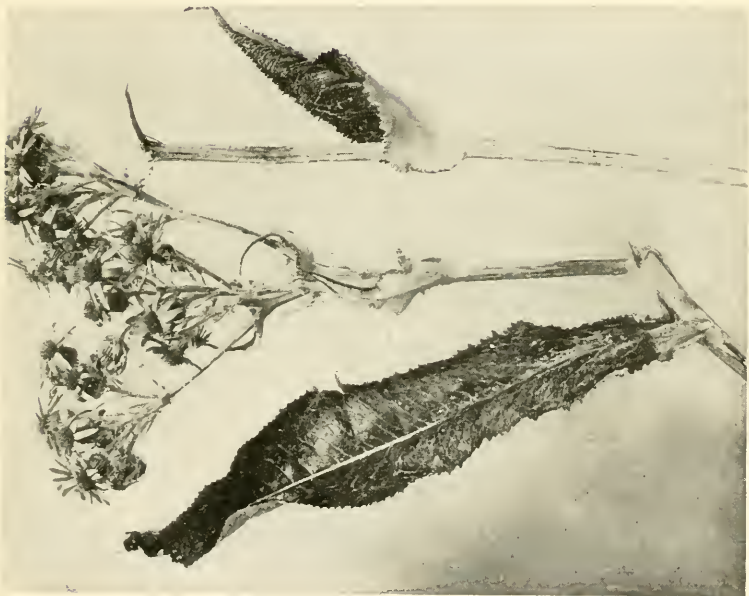
The "Knife-edge" of Irazú, from the Summit.
Granddaughter Craters of Irazú G, F, E—D and B, "Knife-edge" in
Background.



A Natural Garden in the Crater of Irazú.



Senecio multicaulis.



Senecio oerstedianus.



Bidens irazuensis.



Myrtus oerstedii.

places great quantities of an exceedingly pretty little lupine (possibly *Lupinus aschenbornii*) with dark blue flowers and a compound leaf compressed into a rosette of leaflets. The younger leaves are quite reddish and having a velvety "pile" they gather and hold the mist so that they frequently look as if strewn with jewels, a pretty sight when the sun shines on them. The plant is a compact little hemisphere about a foot across, with a single thick taproot bearing numerous nodules. We saw also a few blossoms of a yellow *Hypericum*; it was mentioned by Oersted as resembling *H. brathys*, having brilliant yellow flowers, and as being often covered with black fungus (*Scorias robinsoni*).

On some of the slopes of the lesser craters, in little pockets more or less protected from the wind, we found veritable flower gardens containing the handsome Bromeliad already mentioned, ferns (*Elaphoglossum lingua*, *E. revolutum*, *Polypodium moniliforme*), thickets of *Pernettya coriacea* with its reddish new leaves and beautifully delicate little pink or white bell-shaped flowers; the yellow *S. oerstedianus* and *Myrtus oerstedii*. One such garden we photographed under its canopy of dead branches thickly covered with *Usnea* and other lichens. In some of these gardens we found a plant, probably a *Gaultheria*, with stiff leathery leaves and sprays three to four inches long of small waxy coral-red blossoms. There were plants of *Gunnera insignis* in almost all parts of the crater but, except in the green, vertical-walled valley north of the craters, their huge prickly leaves were brown and shrivelled and we saw none in flower.

The only human being we saw in the crater was a man who rode up to our tent the first morning to ask if we had seen any cows. We had not, the only traces of cows being old ones, and he rode on past our tent to the east and along a trail that ran up a little gorge between two high parts of the crater-rim, through a green and leafy part of the crater.

So far as we could see from the tracks in the sand—and they lasted surprisingly long—he did not return past our tent. How he went back we have no idea. To follow that trail was one of the things we were eager to do, at least far enough to see into what sort of country it led. Certainly there must be some green and attractive pastures or the cattle and horses would not wander there as they seem to do. But for us this trail will be forever shrouded in mystery, for we could not follow it through the thick mist nor would we have been able to see anything if we had attempted it.

About eleven o'clock we were pleased to hear the thumping of hoofs as our guide and horses approached the tent—pleased because we had supplies for two days only and it was impossible not to speculate on the uncomfortable situation we should be in if for any reason the guide did not return. However, he came, and almost on time, and as soon as he had eaten something we began to pack up. It did not take long to saddle our riding horses and arrange the full saddlebags and blanket rolls. Then we took down the cozy little tent, stuffed it into its coffee sack, loaded the packhorse and started home. During most of this performance it rained more or less heavily. P. and I had on raincoats and as soon as the tent was down—the last thing I could help with—I mounted my horse so that my poncho would cover the saddlebags containing the cameras and plates. The guide also had a rubber coat which he did not put on but left carefully spread out over his saddle to keep that dry. He worked with us for an hour in the hard rain, frequently remarking “*Mucha agua*”; then he rode for an hour longer through the mist and rain, still unprotected. Finally he shivered, said “*Mucho frio*” and put on his raincoat! By that time he looked well drenched and we were much mystified by his proceeding.

From the level crater floor we first climbed steeply up the

southwestern wall of the mother-crater and then followed a long zigzag up a steep cinder slope where the path was simply a ledge trampled by horses' hoofs. This slope, lying outside the crater, was the north side of a ridge running westward from the summit of Irazú. We were too completely shrouded in mist to see what lay at the bottom of this slope—whether it really had a bottom or continued down directly into wooded slopes. As we rode we looked down on a white sea of clouds some hundreds of feet below. There is little vegetation here; the cinders are coarse and loose with some larger fragments, so that the horses sink to the fetlocks at every step. We now climbed over the crest of this ridge and down on the outside of the cinder cone. We soon began to ride over somewhat finer and harder cinders and as we descended vegetation grew more abundant. The *Spiræas*, *Myrtles* and *Arctostaphylos* were not now in flower here, and there were few flowers on the geraniums, but *Hypericums* and a white composite resembling *Ageratum* were blooming freely.

Owing to the rain the trail was much more slippery on the way down than it had been on the ascent but even with the cloud the forest was lighter than in September. Then the light was dim and mysterious and the wonderful gray-green trees stood up like ghosts in the dark green gloom. Now it was possible to see long distances through the beautiful forest glades. Part of this difference, particularly near the trail was due to recent cutting, but most was the result of the oaks being in a transitional state between new and old leaves. Many of the old leaves had already fallen or else were dead or shrivelled on the trees, while the new ones were only an inch or so long and a beautiful pink above, whitish below. The mature leaves are dark olive-green, stiff and leathery and about four inches long. We noted only one *Cavendishia*, so abundant in September, but *Sipho-*

campylus regelii was still flowering freely. There were numbers of a pretty plant with glossy dark green leaves and violet-blue flowers an inch and a half long (*Cestrum irazuense*). Here and there, a small delicate composite with pretty feathery leaves, *Bidens irazuensis*, lifted its single terminal flower head, resembling a yellow (and yellow-centered) daisy. Beginning above the forest and continuing to several hundred feet below it, were draperies of *Bomarea*, a vine (one of the Amaryllidaceæ) with pendent clusters of beautiful dark red flowers. A few weeks earlier we saw these vines in the forest near the Orosi falls, where the flowers had the inner sides of petals and sepals richly blotched with black, while those we examined on Irazú showed only clear red. In clearings in the lower part of the forest and on roadsides below it were clumps of a truly magnificent composite, *Senecio multivenius*, which reminded us of our own golden-rods. It grows eight or ten feet high, and bears a golden-yellow mass of flowers more than a foot across—the individual heads are small but the aggregate is immense—which have a sweet and delicate perfume.

When we were some miles below the forest the rain ceased, the mists gradually lifted and the roads from this level down to Cartago were much drier. Above Tierra Blanca, as we were jogging along a piece of road with high banks of clay, washed by rains and cut by road menders into irregular pockets and gullies, our guide, who had been watching the banks carefully, suddenly pulled up, put his horse half up the bank and began to dig in the friable soil with his fingers. In a minute or two he loosened a curious little object of red pottery—a flattened ball about two inches in diameter with a ring-like handle on one side. The ball is hollow, containing some small hard objects which rattle when it is shaken, and on the flatter side opposite the handle is a number of irregular little holes such as might have been

made with a pointed stick when the clay was soft. Our guide, who was used to looking for buried pottery, noticed the rounded end sticking out of the bank. Of course we have no clue to its age; although the use made of it cannot be certainly stated it is probably a ceremonial rattle. The guide presented it to me and it forms an interesting little souvenir of our volcano trip, as well as an Indian relic of whose genuineness we need have no doubt.

CHAPTER VIII

LOWER NEIGHBORS OF CARTAGO

Cartago lies near the northwest corner of the valley of Guarco. West and north of the town where the land rises rapidly into the flanks of Carpintera and Irazú, it was devoted to maize or potatoes, or to pastures in which great numbers of cattle were raised. In other directions the (downward) slope is more gradual and although there were large pastures below the town much of the lower land was occupied by coffee. The valley drains into the Agua Caliente River which flows eastward close to the hills forming the southern wall. The attractive little village of Concepción de Cartago lay about a mile south southwest of Cartago. Its plaza was a triangular grassy open space bounded on the east by the road from Cartago to San Isidro del Tejar, on the west by the road to Tobosi, these two roads diverging at Concepción. The yellow-plastered church of Concepción de Cartago was particularly neat and pretty, one of its two towers having a good clock, while the priest's house next to the church had a well-tended flower garden. Throughout Costa Rica the effort was made to have the public schoolhouse the best building in each little hamlet or village and here in Concepción de Cartago it was exceptionally attractive, well built of adobe and plaster, neatly painted and in good repair. We rode and walked around this plaza often, on our way to the more distant villages of San Isidro and Tobosi, always with pleasure.

San Isidro del Tejar lay at the extreme south edge of the valley on the Tejar River, one of the many tributaries of

the Agua Caliente, and was some four miles from Cartago. The San Isidro road had the valuable peculiarity of being sandy (most of the others near Cartago being of clay) and consequently remained in good condition when the clay roads were sometimes girth-deep in mud. In some of the fields bordering this road—locally known to the foreign residents as the “Beehive” road—were depressions filled with rich little pools of water throughout the rainy season and which furnished us a number of larvæ and exuviae. In September we particularly noted the abundance of a leguminous plant with yellow flowers and curious appressed stipules—*Zornia diphylla*—and a pretty *Hypericum* (*H. fastigiatum*) in these wet spots. San Isidro itself was but a tiny hamlet, but its surroundings were charming. The hills of the south side of the valley were close to the Tejar and after fording the stream the road climbed at once and forked into two branches. The left fork descended after a few miles to the river level, reforded the Tejar and led back again, through wide grassy lanes bordered with rivulets that proved good collecting ground, to Concepción de Cartago. The right fork led directly into the hills.

Tobosi, another small village, lies in the extreme southwest corner of the valley where the hills close in on all sides except the east. On one side of the road thither a laguna (at times only a swampy place) furnished us another collecting ground. While walking to Tobosi on June 20, 1909, P. saw one of those flights or migrations of butterflies so frequently observed in tropical America.

I had already noticed the great abundance of a certain butterfly (*Timetes chiron*) of about two inches wing-spread, having on the upper sides of the wings alternate stripes of dark and light brown parallel to the body. The light brown is replaced on the under side by silvery-white, pale violet and light rusty-red. Each hind wing has two tails on its

hind edge, an outer, one-half to five-eighths inch long, an inner one-eighth inch. I had often seen the species before but it was not until I reached this laguna about noon that I appreciated that numbers of this butterfly were traveling all in the same direction. I was in a grassy lane about forty feet wide, so I sat down to count the individuals which should pass where I was, within this lane only, in a given time. Between 12.07 and 12.12, I counted one hundred and forty-four and I may easily have missed some. They came, not continuously and at regular intervals but singly or in groups of two, three, four, five, six, or almost any number up to fifteen. They flew along at varying distances above the ground, but all in the same direction—generally eastward—and against the wind, which, when it blew a little stronger now and then, gave them much trouble to beat against. They did not stop to visit flowers or gather any other kind of food but continued unceasingly their undulating flight to the east. A few individuals of other species, as a bright orange *Callidryas* or ally of *Callidryas*, seemed to accompany the migrating species occasionally. To be able to identify the species in the future, I caught three specimens, but the first two had badly battered wings and I released them. When set free they seemed disconcerted and started off in new directions but within a minute or two changed their flight to eastward. The condition of their wings implies that the insects had not recently transformed from the chrysalid state. As the butterflies flew toward me, when I faced westward, it was impossible to foretell the exact path which would be taken by any one individual, so great was the lateral undulation in flight.

When I left the spot where I had made the count, an hour and a half later, there seemed to be no decrease in the number of the flying butterflies, so that 4320 of them must have passed through that narrow lane while I was in its neighbor-



Pernettya coriacea.
Limnanthemum humboldtianum.



Schoolhouse in Taras, near Cartago.
The Reventazón River at Orosi.

hood. As I walked back to Cartago, every now and then, looking over wide open fields, I could see the same species in apparently equal numbers flying toward the east, none returning. How wide the area of flight was I do not know, but it was certainly not less than half a mile and may have been much more, as I have no reason to think that the narrow lane was specially favored by them. Half a mile and the count I made would give 285,120 butterflies for the hour and a half during which I specially noticed them, and they were flying both before and after this time, for my route back to Cartago led across their path to some extent, until I reached coffee plantations surrounded by high hedges so that further observation was impossible.

On June 23 we went to Juan Viñas and almost every day that we were there we saw large numbers of the same species of butterfly. On June 30 they were particularly numerous between 11 A. M. and 2 P. M. although not confined to those hours. At Juan Viñas also they flew eastward *against* a wind (which was strong enough at times to give the butterflies much difficulty to make their way against it) and went on without stopping for flowers or other objects on the way. At times they were so numerous that they resembled brown autumn leaves swept along by wind. By actual count 394 of this one species passed an imaginary line between our cabin and the railroad station during the five minutes between 12.30 and 12.35 P. M., the distance between these two points being about one hundred feet. This means 14,184 butterflies for the three hours alone, within this one hundred feet, as we have no data on the total area over which the insects were flying. We have already mentioned, page 105, seeing this same species in migration at Tierra Blanca on July 10.

On most of the roads leading southward from Cartago we saw many brickyards. The clay was mixed in a circular

pit some ten feet across and one to two feet deep. The actual mixing was done by two horses (occasionally oxen) which walked round and round in the pasty, sticky mass of mud and water, trampling it until it reached the proper consistency. The beasts were tied together, the second to the tail of the first, and led by the brickmaker. In addition to making the square flat tiles used as paving bricks, the long curved roofing tiles, the ollas and smaller pots for domestic purposes, there was a thriving industry (so we were told) in the manufacture of "antique" pottery to be sold later to tourists as relics from Indian graves. Here and there was a square brick oven, eight feet high and five feet on a side, for burning the tiles. These ovens were usually under sheds.

In the southwestern part of the valley little coffee was grown, most of the land being in large pastures where horses and more particularly cattle were raised. Many of these fields were badly infested with ticks. These creatures have the habit of resting on grass, leaves or twigs with the first pair of legs extended (there are three pairs in the young, four pairs in the adult) ready to grapple any rough surface that brushes the plant. In this way they get upon their normal hosts, the cattle grazing in the field, and they can equally well attach themselves to human beings. On one occasion in May after walking through a field where cattle often grazed, A. looking down on her khaki skirt and canvas leggings found hundreds of the young of a species of tick (probably *Amblyomma cajennense*) crawling over them. By scraping the ticks off at once with a knife and later bathing with carbolic soap disagreeable consequences were avoided. But no one who has not lived in the tropics can fully appreciate what a pest the ticks may be and the precautions we took against them, such as always wearing high shoes and never going out into the fields without leggings, were fully

justified by the resulting freedom from annoyance. How abundant the adult ticks may be on cattle is shown by our count of ninety on one side only of one ox in a Cartago street on July 11; many were as big as marrowfat peas, gorged and swollen with blood, and dark brown in color. A fair-sized black bird, the "tijo-tijo," "garrapatero" or "zopilotillo" (*Crotophaga sulcirostris*) is frequently seen about cattle in pastures. It has a stout bill, with which it picks off and devours the ticks ("garrapatas") infesting these animals. It is a member of the cuckoo family.

In general Costa Rican cattle were amiable and rarely resented the intrusion of two foreigners with insect nets into their fields. But a few days after our settling in Cartago, as A. was walking alone on the Beehive road, a man suddenly clutched her by the arm and with much Spanish and excited gesticulation led her to a gate in the wall of an exceedingly dirty little yard. An old woman, toothless, combless and dirty, hurried down to the gate and added her excitement to his. I looked in bewilderment from one to another, for my Spanish was unequal to this sudden demand upon it. Evidently I was desired to go into the yard, but why? The sky was clear, the road looked as usual, no more people seemed to be out, what could be wrong? Meanwhile the woman lowered the bars and the man almost pushed me over and the bars were up again before an English voice said "bad cattle coming." And in another minute they came, half a dozen huge bulls which objected to my umbrella even across the fence so that I retreated to the house and closed the offending sunshade. A very small dog at once leaped over the lowest bar and challenged the threatening bull (which could have taken him in like a pill if he had so desired) and the monster moved on. Some men with coils of rope were driving the beasts, while others walked ahead to warn unsuspecting travelers like myself and two

horsemen, who flattened themselves ignominiously against an angle of the fence opposite to me to allow the cattle to pass.

About two and a half miles south of Cartago and three hundred feet lower, lay the straggling little village of Agua Caliente, on the north side of the Agua Caliente River. The church had but a single tower and the two bells, large and small, hung not in this tower but over a wooden platform built between two trees by the side of the church. Much coffee was grown in the neighborhood of Agua Caliente and there were also numbers of clay-pits and ovens for burning the tiles.

Across the river, quite close to its south or right bank, were the hot springs that gave the place its name. A large wooden bath house had been built over them, equipped with seven or eight enamel-lined tubs piped for hot and cold water, and at one time the whole place had evidently been well fitted up. When we knew it, however, the establishment had been much neglected, cold water pipes were out of commission, the tubs chipped, the window glass broken and furniture of the scantiest. Nevertheless there was a caretaker of a sort and many people, both Costa Ricans and foreigners, resorted to Agua Caliente for the hot baths, the water having the reputation of possessing great remedial powers. As we saw it, the water was very brown and was usually extremely hot, and in the absence of cold water to mix with it the bather had either to parboil himself or wait until the bath cooled down to a bearable temperature, which consumed much time. Consequently we did not bathe here often.

The water of this spring, or Hervidero de Agua Caliente, was analyzed by Luciano Platt and a report presented to the President of Costa Rica in 1865. It has recently been reprinted by Don Cleto Gonzalez Viquez in his *Temblores*,

etc. Señor Platt found that the water as it issued from the calcareous rock had a constant temperature of 50 degrees Centigrade and contained in each ounce of water two grains of solid material, consisting of chloride of sodium and potassium; carbonate and sulphate of lime; carbonate of iron; chloride, carbonate and sulphate of magnesia, arranged in order from greatest to least in quantity. The gases which are set free are principally carbonic acid. A more elaborate result was obtained in 1887 by Dr. C. F. Chandler (quoted in Biolley's *Costa Rica and her Future*, page 17), the one and one-half grains of solid material from each ounce of water being composed of sodium chloride, bicarbonate of lime, sodium sulphate, bicarbonates of sodium and magnesium (in the order named from greater to less) with smaller quantities of other salts.

Behind the bath house the hills rose abruptly; about half a mile downstream they lie so close to the river that there was no room for a path or road, which was therefore carried over the hill. The Agua Caliente River at the bridge is pretty, with little islands here, overarching trees festooned with *Tillandsia* there, with stretches of smooth water alternating with boulders and ripples. It was never very productive of dragonflies, however, so that we spent little time by its banks. By turning south into the hills we came upon a charming grassy lane crossed by a rivulet trickling from a swampy spot. Higher up, this path grew steep and in wet weather slippery, through red soil with masses of disintegrating feldspar, and higher still entered low second-growth woods, where the first Gomphine of the expedition (*Epigomphus subobtusus*) was captured on May 20.

The general group of hills lying south and east of the bath house on the right bank of the Agua Caliente River was called the Jocosál. There was quite a network of roads over the Jocosál, most of them surprisingly good in spite of their

steepness, and the upper parts of these commanded magnificent views. On a morning in the rainy season, before the daily clouds rolled up, the panorama included the hills south and west with Barba showing through a gap between Irazú and Carpintera, the huge expanse of Irazú itself, the Cartago slope and at our feet the Agua Caliente Valley with its shining river, while to the east lay the beginning of the Reventazón Valley with Cachí nestling among the coffee farms. The roads themselves, particularly through the second-growth woods, were exceedingly pretty because of the abundance of flowering trees and bushes. On February 11 we especially noted red and pink Melastomes, tree composites with large yellow flowers resembling sunflowers, many other less woody species of the same family, the beautiful blue sage or "Jalacate," the red and orange orchid (*Epidendrum radicans*) and lantanas similarly colored, Bryophyllums and long sprays of blackberries just turning from red to black. At this time many of the trees had young leaves or buds most brilliantly colored in red and yellow-bronze, quite equal to our autumn tints. Some of the fields on the Jocosál seemed to be abandoned entirely to the Santa Lucia in its most exquisite colors.

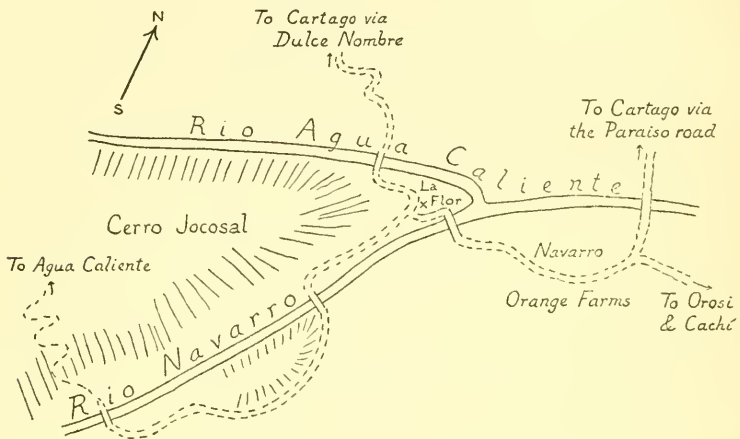
On February 28 we rode over the highest part of the Jocosál (according to our aneroid 5250 feet while Agua Caliente was 4460), following a winding road which was now a wide and well-beaten track, then a narrow footpath and in general grew less distinct as we descended on the other side. It was soon evident that the horses were on unfamiliar ground and P.'s decidedly objected to the descent, for the road degenerated into a slippery zigzag down a steep hillside. We knew there must be a river at the bottom and presently we heard it, but it was a long time before we could see it, for the second-growth woods were thick on both sides of the trail. On the lower parts we saw tree-ferns and here

and there tall *Tillandsia*-draped trees evidently left from the original forest covering. At last, slipping and scrambling, we came out on a slope, quite cleared of brush and planted in places with cane, which fell away sharply to the level river bottom some hundred and fifty feet below. In almost all these valleys the change from the flat river bottom to the hill slope is extremely sudden and abrupt. Almost at our feet lay the Navarro River, with some meadows, a hacienda and outbuildings and plantations of cane. Our progress down this bare slope and across the meadow to the stream to water our horses aroused much interest in the people of the house and there was quite a gathering when we rode up to the gate to inquire about the road to Orosi. They courteously invited us to enter the house and rest, but this we had not time to accept, so after obtaining the necessary directions we rode on through a small stream and across the Navarro on a rude log bridge and then followed that river until we reached a place on the road where there was food and water for the horses and a shady wall for us to sit on. It was a pretty spot, where a small stream crossed the road and passed over a thickly shaded, rocky bed to join the foaming, roaring Navarro. Our aneroid made this place 3950 feet high.

After our breakfast we went on towards Orosi. In general the road followed the river although at times it climbed up over a hill and down again, where there was no room for a road at the river level. When we had ridden several miles we saw again the valley of the Agua Caliente, now enlarged by the Navarro. Its flat and fertile bottom was about half a mile wide and contained many coffee plantations and some oranges. As we first rode over the little crest that hid the valley from us, we saw spread out at our feet the thousands of young orange and grapefruit trees of "Navarro," an experimental farm of the United Fruit Company, with

range after range of hills beyond the river and its valley. Indeed we lingered many times along this road and on the Jocosál to admire the lovely views. Past "Navarro" we rode on to the iron bridge spanning the united Navarro and Agua Caliente Rivers on the left fork of the road while the right fork goes on to Orosi.

On April 12, 1910, with two guests from the hotel, A. rode over the Jocosál by another road, which followed a little



Sketch Map of Junction of Navarro and Agua Caliente Rivers.

side valley and commanded even finer views. In one sheltered "pocket" was a perfect thicket of tree-ferns, the most luxurious growth of them that I saw anywhere in Costa Rica. This was a particularly clear brilliant day, even the tops of the distant Las Cruces mountains being visible for a while. Great numbers of the dragonfly *Heterina cruentata* were flying in the road, their glittering metallic bodies and the blood-red spots on the wings flashing in the sunshine. There were swarms of them, in places, and as we rode along they lit upon the horses' manes and ears as fearlessly as flies.

At about the highest part of this road we came upon a

man resting by the roadside, who was taking two large sacks of oranges to market. He seemed delighted to lessen his load by some sixteen oranges, at a good price (nine cents) and we were equally delighted to have the fruit. After an hour's further riding I suddenly found ourselves on the road over which P. and I had gone a few weeks previously and it was not long before we began the steep, narrow zigzag down to the farm lying by the Navarro River.

We reached this farmhouse at 1.30 P. M. and rejoiced in the prospect of food for ourselves and our horses for we had brought no breakfast. There was no trouble about the first—the old woman was glad to sell us beans, tortillas and coffee—but there proved to be a difficulty about the beasts. Corn there was none. Cane was growing close to the house, so I asked next if we could buy enough cane for our horses, their ordinary food in the stables being chopped sugar-cane. “Si, Si, con mucho gusto,” and the boy was sent for “enough.” But before he started to cut, a fourth rider appeared and put his horse in the trapiche shed along with ours but at a manger where chopped cane was ready. And that ended our prospect of buying cane. The farmer now told us that he could not sell us any as it was not his own cane but the patron's. Yes, he had some himself but it grew very far off, too far to send the boy and he—the farmer—was sick, as indeed he looked. If the patron was, as we strongly suspected, that fourth man, we could not see why the farmer did not ask his permission to sell cane then and there, but evidently there was more to it than appeared on the surface. At all events the poor horses had only such grass as they could pick up by the roadsides during our numerous halts, and as a result were not anxious to travel fast; in fact we had difficulty in getting them above a walk most of the way home.

Although I knew the place perfectly well, I did not recog-

nize the man, for we had only stopped to ask the way on our previous visit and I had not noticed the farmer particularly. It was evident, however, that he had noticed me. I saw him studying me long and carefully, then looking at Mr. M. Finally he said to me, "You were here two months ago, no?" "Yes." "Yes, you are the same, but the man is different!" We all laughed when I translated that and Mrs. M. exclaimed, "That is *my* man!" Of course the farmer did not understand the words but her gestures were unmistakable and he said at once, "O, *su* esposo" with an air of enlightenment. Then he looked at me again in a way that plainly said, "But what the dickens are *you* doing here?"

A longer and much prettier route than the straight road to Agua Caliente ran through the neat and attractive little village of Dulce Nombre, south and east of Cartago. It was quite closely built along the line of the road, with the beginnings of a brick church which promised to be very fine if it ever reached completion. Dulce Nombre was on the little Rio Toyogares, and the banks of this stream bore quite the largest thicket of *Datura arborea* that we saw anywhere. From Dulce Nombre one road led west to Agua Caliente. Another ran east and south through the region known as "Las Cóncavas" and past the hacienda of the same name, descended by zigzags to the level of the Agua Caliente River crossed this river on a suspension bridge and at "La Flor" joined the road from the Jocosál and ran on past "Navarro" to Orosi and Cachí.

The usual route to the village of Orosi, lying in the valley of the Agua Caliente east of its junction with the Navarro, was to follow the Carretera east through the barren red gravel of the Paraiso country almost to that town, where a road branched south into the valley. There was a small laguna by the side of the latter road which looked promising, but we never found many species of dragonflies in or near it.

On February 28 *Utricularias* and *Limnanthemum humboldtianum* were blooming freely in the laguna and "cirujanos" were flying over it. "Cirujano" (surgeon) is the Costa Rican name of one of the rail-like birds (*Jacana spinosa* or *Asarcia variabilis*) about eight inches in length, with glossy greenish-black head and neck, reddish-brown body acquiring something of a purplish tinge below, and pale lemon wings edged with brown. Each long black leg has four toes, each of which is two and three-quarters inches long. The most remarkable external feature is a sharp-pointed, pale yellow, horny spine (carpal spur) one-quarter inch long, on the front edge of each wing near its junction with the body. Such spines are possessed by a number of birds and are regarded as weapons,¹ but we know of no observations on their use by our "surgeons."

Orosi itself was a rambling, unkempt village with an unusually large, grassy, weedy plaza and a single-towered, blue-washed church, which is said to be the second oldest in Costa Rica and to date from early colonial times. It lies in a rich coffee district with several *beneficios* near it, and the surrounding country is most beautiful, but did not prove productive for our purposes, so that we did not visit it regularly or frequently. On October 26, 1909, A. rode there with a party from the hotel, chiefly to see the great cataract, which was not seen, however, as the guide proved entirely ignorant of the road. There are in fact two large cataracts near Orosi, one of which we saw on February 28 from the top of the Jocosál and which we afterwards located as being on the road from Paraiso to Cachí. The other, much larger, lies deep in the forest several hours south of Orosi. The small boy who acted as guide had apparently never heard of either of them. I noticed on this day that great quantities

¹ In the article by F. A. Lucas in the Report of the U. S. National Museum for 1893, pp. 653 et seq.

of the wickedly thorny four-sided vine called "Rabo de la Iguana" (*Mimosa velloziana*) were growing in the valley.

On the way down we all noticed a colony of large insects on a Croton leaf, our attention being attracted to them by the brilliant metallic reflections as the wind shook the leaf in the sunlight. As we returned we stopped and secured the leaf. The insects proved to be real "bugs" (Hemiptera) about half an inch long and three-eighths wide, with long beaks stuck into the leaf, on which they were packed as closely as possible. They were beautiful creatures. The legs were metallic blue, the bodies metallic bronze-green, bronze-blue, bright blue and red, all glittering and sparkling in the bright sunshine, and the effect of the whole colony was dazzling. They had as yet but the rudiments of wings and belonged to the family Pentatomidæ; they may possibly be the young stages of *Arocera splendens*, the adult of which we took at electric lights in Cartago on July 3.

Four miles east of Cartago, just south of the railroad, lay a pretty boggy pool, in part thickly overgrown with a sedge (*Eleocharis* sp.) in which the dragonfly *Æshna luteipennis* laid its eggs, in other places covered from October to June with the lovely little gentian, *Limnanthemum humboldtianum*. The heart-shaped leaves of this plant float like those of water-lilies, while the starry white flowers with their delicately fringed petals are lifted above the water. Although it occurs throughout Central America and the Antilles, *L. humboldtianum* had not been reported in Costa Rica before our collecting it, except in the district of Talamanca. The subsoil about this "Limnanthemum pool" was a red gravel and in April great quantities of the common red and yellow terrestrial orchid *Epidendrum radicans*, were growing in it. This handsome orchid seems to prefer red gravel and exposed, eroded banks, and near Cartago at least we always found it in such situations.

A little beyond the *Limnanthemum* pool the railroad entered Paraiso, the first village and station east of Cartago. We rode to Paraiso on horseback several times, the road being a fairly good one, but we found little of interest as it ran through pasture and farm land on rather poor soil. On one of these rides, on December 6, we noticed many hawks, large and small. Paraiso was a much smaller town than Cartago, its streets paved roughly with stone. It was chiefly remarkable for the large church on the Plaza, with a single very tall tower, which unusual feature made it a landmark for miles.

In March, 1910, we spent a week with Mr. and Mrs. C. H. Lankester at Cachí, a small village in the midst of coffee farms and *beneficios* on the south side of the Rio Reventazón; Cachí is three miles northeast of Orosi and three miles east of Paraiso—in air-lines. It is most easily reached from Paraiso, whither we went by train on March 3. Mr. Lankester sent horses to meet us and we started down at once, for Cachí is about “an hour and a half” from Paraiso in good weather. We followed a road, whose windings over the bare reddish hills of Paraiso we had often watched from the train, descending steadily, as Cachí lies 1000 feet lower than Paraiso. The ride was both beautiful and interesting. On the last hill we passed the ruins of the old stone church of Ujarrás, which is said to date from the sixteenth century and to be the oldest Spanish church now remaining in Costa Rica.

Cachí is now a small hamlet, but before the railroad was built it was of some importance and had a large native population. Much coffee is grown in the main and side valleys about Cachí and in shipping season long trains of ox-carts wind up the hilly road and Paraiso is a busy station. There is no other occupation, however. The village consists of two or three roads with lines of houses straggling along

one side. There was a post office and telegraph station, a neat though small one-story wooden schoolhouse and a church consisting of a galvanized iron roof supported on wooden uprights, two tower roofs likewise supported in front, no walls to towers or to "nave" except at the back of the "chancel," and a plain board-walled diminutive "arm" of a "transept" on each side. The wooden pulpit was in full view from the road and the cows wandered to its steps, nibbling at the sod.

Behind Mr. Lankester's house, that is, south and south-east, the chief road led to Peña Blanca. The path we usually followed led successively through a coffee field, a potrero with some deserted houses, and then into a second potrero growing up again into woods. This clearing was bordered by thick tall timber and through it ran a charming brook, a branch of the Sordí, which was often beautifully shaded and full of rocks and deep nooks. It seemed a highly favorable place for dragonflies of certain kinds, but we saw almost none at all. Here in fruit were many trees of "Vainilla" *Cassia spectabilis* which we had previously known only in flower, at Alajuela. The fruits are slender pods some twelve inches long, packed with numerous close-set beans flattened against each other like gum-drops. Many composites were also blooming in this potrero. A curious and conspicuous plant had fruits about an inch long of a deep purple-black, borne on vividly red, fleshy receptacles two to three inches in length. There were numerous "Guacamayos," papaveraceous plants with large irregular leaves and a big conspicuous fruit cluster which hangs lopsidedly out of the apex of the plant. Croton trees were abundant, both *xalapensis* and *gossypiifolius*.

The main road to Peña Blanca ran up the valley of the Naranjo, of which the Sordí is a tributary. There was much swamp land in this valley bottom, which was perhaps

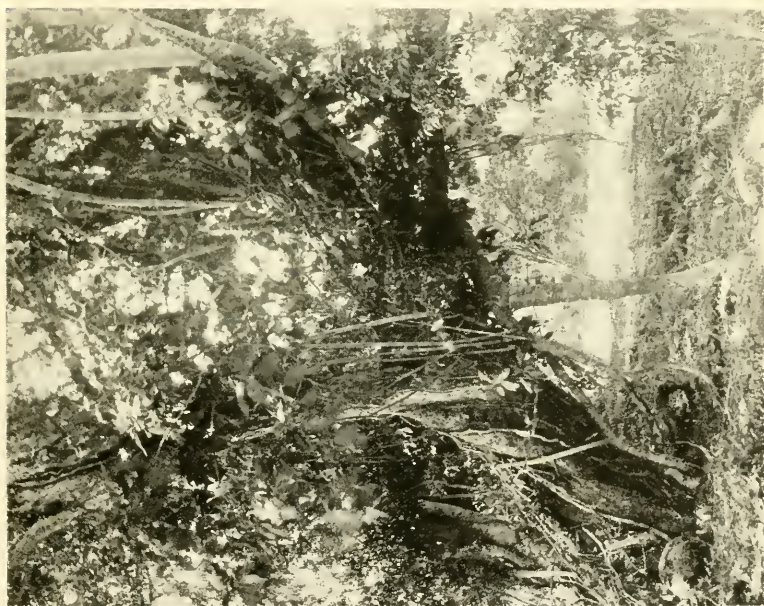
a quarter of a mile wide and was hemmed in by abrupt cliffs and hills. Peña Blanca is a group of particularly high cliffs rising several hundred feet above the meadows at their bases, with steep often vertical faces but broken into ledges here and there giving foothold to a luxurious vegetation. The cliffs are quite white in color and are most picturesque in their bold outlines and the contrast between the bare gleaming rock and the dark green of the forest capping them and clinging to every ledge. There is a little amphitheater hemmed in by such cliffs. Beyond Peña Blanca the road dwindles to a trail leading into the hills, past other cliffs of darker rock.

On the right (east) side of the Naranjo a cart track led up into the wooded hills not far distant and on March 9 we spent the morning there. A tiny stream tumbling out of the woods and shaded by some crotons offered an inviting resting-place when we tired of fruitlessly searching after dragonflies. In the more level meadows nearer the stream were many large trees loaded with epiphytes, which had been left standing—probably to give partial shade to the cattle—when the forest was cleared away. We carefully explored some large and accessible bromeliads growing in great numbers on a fine *Inga* with glossy leaves—probably “*cuajiniquil*.” This did not prove fruitful of dragonfly larvæ, a result we had indeed expected, for the tree stood in the open sunlight because of the cutting of the surrounding forest. There were enough brown cockroaches (*Blattella bruneriana*), spiders (*Cupiennius coccineus*, *Selenops mexicana*), and earwigs to add excitement to the search. In the cleared fields at the upper end tree-ferns ten or more feet high were standing isolated in full sunshine.

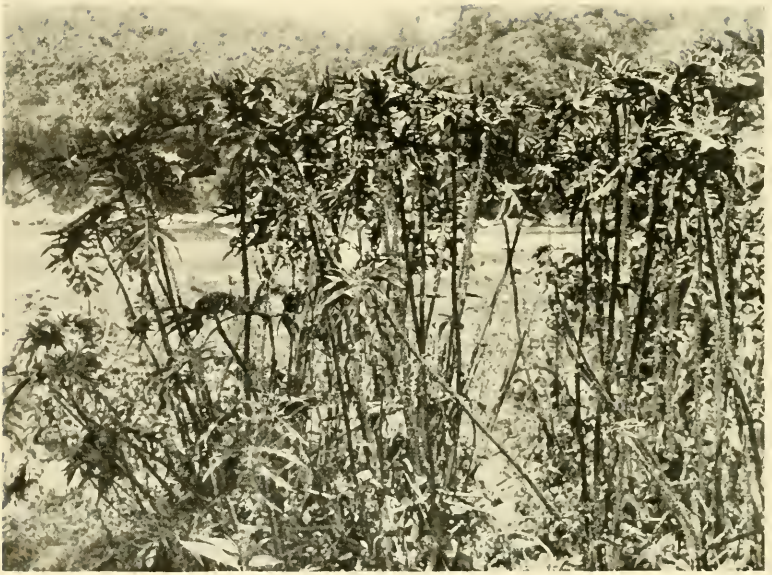
One afternoon was spent in the valley of the Rio Oro a short distance west of the village. We rode up between cafetales and potreros, then leaving the horses we descended

into a potrero from which a path climbed up into the forest closely paralleling one of the many small branches of this river. Scattered in this forest were tree-ferns of at least two distinct kinds, one with a trunk three to four feet high (*Athyrium* sp.), the other with a trunk fifteen to sixteen feet high (*Cyathea basilævis*), together with many Philodendrons, Monstera and other Aroids, but few Bromeliads. Insects were scarce, partly because of the general cloudiness of the afternoon, perhaps.

Mr. Lankester's house was beautifully situated half a mile from the Reventazón River and about a hundred and fifty feet above it. It was not a typical Costa Rican residence for although built of adobe it was two-storied and had no patio. A wide veranda or "corridor" ran across the entire front both on the first and second floors, charming places, for they were set with plants and hung with baskets of orchids, some of which were in full flower when we were there. The veranda was draped with a magnificent "Ve-gissima," a vine bearing masses of pink flowers; at the time of our visit it was in fruit. From the upper corridor especially the house commanded an extensive view of Irazú and Turrialba, although the latter was frequently cloud-covered as early as eight o'clock in the morning at this time of the year. The river was not visible from the house because of the many trees. It could be reached either by following the tributary Rio Zapote through the potreros or by a road through the cafetales which led to a place where an iron bridge had spanned the Reventazón. This bridge had been carried away in one of the periodical floods the preceding winter and as a consequence the carts carrying coffee were obliged to go some distance upstream to the next bridge, greatly increasing the hauling. Forging with carts was impossible, for the river is full of boulders here and the current swift and strong. A temporary suspension bridge for one



Constrictor Trees and Hosts, with Epiphytes, on the bank of the Reventazón River at Cachi.



Purple-leaved *Urera*,
Telanthera mexicana and Epiphytic *Ficus* sp., on the Reventazón
banks, Cachi.

or two passengers was formed by a box hung from a pulley sliding on iron cables. The box ran to the lowest part of the cable by gravity and the passengers pulled themselves the rest of the way by a rope working over pulleys on shore. The bridge was rebuilt more strongly and with a longer span in 1911.

There are three well-marked river terraces at this part of the Reventazón. In the potreros of the upper terraces we saw many trees, mostly poró, which had been felled to kill the mistletoe—matapalo—with which they were infested. This was not to save the porós remaining but because the birds eat the mistletoe berries greedily and so distribute the seeds to the coffee trees, to which the parasitic mistletoe does great damage. The lowest terrace is a fringe of beautiful flat meadows not much above the usual river level, which extend half a mile or more along the right bank. They contained numbers of fine large old trees, which were amazingly rich in epiphytes. Some of these we had not seen before, such as *Phyllocacti*, a small bromeliad with beautiful pink flowers but wickedly barbed and spiny leaves, new begonias, mistletoes and an amarantaceous plant (*Telanthera mexicana*), which although not truly a vine grew among other stronger plants and dangled its long, weak, slender stems with their little heads of whitish flowers high above the ground. Although we examined a number of bromeliads for dragonfly larvæ we found none here. Mr. Lankester told us the trees on this terrace were mostly legumes of various species, but they were thickly overgrown with many kinds of figs (*Ficus* sp.) which have the "constrictor" habit. The seeds of such plants germinate somewhere on the host tree and their roots and branches grow about the host so closely that the latter is strangled and ultimately dies. In time the original tree-trunk rots away and the fig, a marvelous tangle of thick roots and stems,

stands alone. Most of the trees in these meadows were in the intermediate stage, with the original tree still living. Growing in patches near the water was a striking Urticaceous plant (*Urera* sp.) having stems as thickly set with prickles as they could be placed and large, spiny, deeply incised leaves whose upper sides were a very dark, shiny green, the under sides a rich and beautiful purple.

Walking downstream we came to a small patch of tobacco with the grower's hut in the middle, went through a cane-brake where the wild cane was several times higher than our heads and finally reached a little back water left by the river in the last flood. Here a few dragonflies (eight species) were flying and were captured. Several times we stopped at some little sandy beaches on the main stream to dredge and were fortunate enough to find six of the curious flattened sand-grubbing larvæ of a Gomphine.

Some of the back channels of the river contained incredible numbers of black tadpoles about an inch long; there were many places a foot wide and two or three yards long that were literally covered with them as thickly as they could be packed, looking like black cloth on the gray-white sand of the bottom.

Farther upstream, in place of these enchanting meadow strips, the river winds through a stretch of cobblestones and sand, in several channels. Some of these seemed likely places for dragonflies, for the channels contained but little water which flowed much more slowly than that of the main stream. I explored them carefully and minutely, but in vain, although grasshoppers (*Heliastus venezuelæ*) colored like the sand except for their red hind wings and red tibiæ, were present here. A little farther back from the water and five or six feet higher, were patches of tobacco, and between these and the cafetál was a boggy spot which yielded some insects of several groups. Many small streams cross

the road and at one of these, constantly alighting on the muddy border, were beautiful butterflies (*Timetes marcella*) with a wing-spread of two and one-eighth inches. The fore wings are chiefly orange, dark brown at tip, paler brown at base, the latter brown crossed by four or five darker brown lines parallel to the body. Each hind wing has on its hind edge two tails, the outer longer (one-half inch as compared with less than one-eighth inch for the inner tail). The hind wings are chiefly brown of nearly the same intensity as that of the base of the fore wings, bounded with orange on the anterior half of the outer wing-margin, and having a patch of pale purple or reddish-violet in the middle third of the wing, almost from wing-base to near the base of the tails. The under sides of the wings are chiefly buff crossed by lines or narrow stripes of white parallel with the body.

Much coffee, sugar-cane and tobacco are now grown in the bottom and side of the main Reventazón valley and of its side valleys, in the neighborhood of Cachí. Mr. Lankester said that practically all the cultivated land around the village was forest twenty-five years earlier. The opposite, north or left bank of the river is the site of an older settlement known as Ujarrás. Cachí has been a favorite spot for entomological collectors. Here in 1877 came H. Rogers gathering specimens for Messrs. Godman and Salvin's *Biologia Centrali-Americana*, but the exact date, in months, of his visit is unknown. Mr. Lankester told me that none of the present inhabitants of Cachí remember him. The late Prof. Paul Biolley collected at Cachí in May, 1905. Messrs. Schaus and Barnes were here at least twice, their latest visit being in September and October, 1909. Owing to the larger extent of forest at the time of Rogers' sojourn here, the insect and other life of the region must have been quite different. Our meager results, so far as dragonflies

were concerned, may have been due to the season of the year, or to the amount of cloud and rain.

On March 6, with Mr. and Mrs. Lankester, we left "Casa Grande" about ten o'clock for Orosi and if possible Orosi Falls. Our road led west along the valley of the Rio Grande or Reventazón, crossed the Rio Macho on the long iron suspension bridge and south through Orosi village with its picturesque old church. About half a mile from the village the road passed a small hot spring. The water, which was hot enough to steam vigorously and had a strong sulphurous smell, bubbled up in a circular walled-in enclosure and ran away down the roadside ditch. It is supposed to have some medicinal properties. This seems to be the "Herivero de Orosi" whose waters were analyzed in 1865 by Luciano Platt, whose report has been mentioned on page 148. We continued south, taking in general the left branch of each fork and passing many coffee farms. By the roadside we saw a huge rock fifteen to twenty feet high, which was flat-topped and bore a most wonderful mass of ferns and the red and orange orchid (*E. radicans*) often referred to in these pages. The road finally led us to a bridge closed at the far end by a gate and we were then in the property of Señor Tomaso Gutierrez. There was a number of peon houses, chiefly on the right side of the road, and some men passed us carrying a large rodent two feet long with brown and white spotted fur and a short tail. This was the "tepezcuintle" (*Coelogenys paca*) which is greatly esteemed as a game animal and considered delicious eating. The hacienda stood on a steep hill near these houses and Mr. Lankester rode up to ask permission to pass through and for directions to the falls, as he had never been all the way himself. Permission was readily granted, but reports of the road were not encouraging as the trail was said to be completely overgrown and impossible to find or follow unless we could get a peon

from the last settlement to cut it out for us. We rode on through a boggy potrero with fine trees here and there. Among these were some magnificent fig-trees which instead of growing on other trees had sprouted on the tops of large boulders, sending their roots down around the boulder as constrictor figs do around their hosts and completely embracing it. The effect of such a tree standing so high above the general level of the field was extraordinary.

The potrero bordered the Rio Macho and gradually became more wooded as the valley grew narrower. There were many beautiful flowers; a short distance within the timber we gathered a splendid *Columnea* draping a big tree. This vine has small fleshy opposite leaves and long, tubular, bright red blossoms. In another place we passed bignoniaceous trees with large trumpet-shaped flowers, in color creamy white shading gradually to rich lemon yellow and exquisitely perfumed, the delight of bees and humming-birds. Here were large-leaved melastomes with peach-pink blossoms an inch across, there small-leaved melastomes with clusters of delicate waxy rose and white blossoms. On the trees we saw the usual epiphytes and new ones with rosy pink blossoms and strange begonias. Looking at the hillside across the valley, the trees were astonishingly like an early autumn hillside at home, some being dark green, some light green, some yellow and others almost orange, but here the colors other than green were due to the new leaves, not to the dying foliage. Certain yellow trees with well-rounded heads were identified by Mr. Lankester as "tirra," a tree whose botanical relations have not been determined. They are often left standing when other trees of the forest have been cut away because the wood is so hard and tough and difficult to work.

Through some bars we entered a little strip of close woods arching over a road leading to a brook with an awkward

ford; then it passed the last houses on the way where we tried to get a peon to cut the trail. The man refused and probably thought he would force us to turn back. We went on nevertheless and he must have thought better of it, for when we left our horses to begin the climb on foot he had caught up with us and was ready to show us the way. From these houses we rode over the shoulder of a hill with sides sloping sharply down to the river. The road here occupied a ledge cut on the hillside and often wear or slides had narrowed it, sometimes to a mere foot-track. It was quite steep, and our horses being fine vigorous animals objected to slow climbing and on every hill broke into a gallop and went tearing up at a pace that took one's breath away until one grew accustomed to their method of hill-climbing. Beyond this hill an unexpectedly new and good gate let us through the last fence and we soon reached the foot of the first really bad bit of road, where we left the horses tied under a beautiful "San Miguel" tree.

Starting on foot at one o'clock we climbed first up a very steep, rocky, clayey road, through rather scattered and open woods. There were many crotons and figs and in sunny spots ageratums and yellow thistle-like composites, in others ferns and caladiums. After a hard pull up this hill of about half a mile we came on a more level boggy place where some cattle were feeding. It was here that we found the gorgeous amaryllid (*Bomarea* sp.) with long pendent clusters of black-spotted red flowers each one and a half to two inches long.

After this the forest grew denser, the trees constantly bigger and grander, with the most luxuriant epiphytic drapery and festoons of lianas. There were many fine tree-ferns also, some with the fronds uncurled, others in varying stages of unfolding. The roar of the falls was now constantly in our ears, filling the dark forest with its thunder.

We soon climbed over a small ridge where the guide's work with the machete was indispensable, for the trail wound about among huge clumps of "Hoja de Pato," an undescribed Aroid with gigantic arrow- or heart-shaped leaves and strong, partly recumbent stems three to six inches thick. These had overgrown the trail completely and had to be cut away at each step so that we could follow. The rich black soil was soft and deep, often excessively slippery and the trail was a difficult one to travel. At last, at three o'clock, we came out upon a ledge commanding a fine view of the upper part of the falls and a few minutes later reached a large rock near its foot, from which we could see the whole of the cataract. The aneroid recorded 4950 feet at this point.

The waterfall was magnificent and it was singularly impressive to come upon it in the midst of the solemn grandeur of the tropical forest. The drop was almost perpendicular over sheer rock faces and about one hundred and fifty feet high. In the rainy season it must carry an immense volume of water, for the "winter" channels were visible beside the present cataract, and even now in the dry season it was a large stream. It fell into a deep pool, which showed that it was much larger in "winter" and, turning at a sharp angle, rushed away down a steep, rocky bed in a series of rapids. A constant cloud of spray rose from the falls and the force of the water was too great and too direct to allow of vegetation clinging to the rock walls. These were polished and smooth in many places and bare wherever the water ran. The spray and the rain, which had been intermittent ever since we left the horses, added considerably to the photographer's difficulties. The water felt intensely cold and we saw no dragonflies near the fall nor indeed in this forest. In sheltered places among the rocks near the falls were patches of *Gunnera insignis*, the spiny plant with huge cir-

cular plaited leaves which we saw in the crater of Irazú. The constant spray and the evaporation from the cold water no doubt keep the temperature of this place much lower than that of the surrounding forest, enabling such a mountain plant as *Gunnera* to live here.

The day was unfortunately cloudy most of the time, with drifting masses of cloud and mist in all the valleys so that we were quite unable to photograph the beautiful vistas of hills and valleys. This we regretted very much as it is unlikely we shall ever be along this road again. It is a difficult trip from Cartago and we would not have seen these falls except for Mr. Lankester's kindness. The Orosi Falls are well worth any labor required to reach them and our trip thither was one of the finest and most beautiful we had in Costa Rica.



The Laguna or old Crater and Railroad Station at Juan Viñas.



Nests of Oropéndolas, Juan Viñas.



Ojo de Buey—*Mucuna mutisiana*—about one-twelfth natural size.

CHAPTER IX

JUAN VIÑAS—AROUND THE LAGUNA

Juan Viñas was, of all places in Costa Rica, the one at which our most interesting scientific observations were made. This was partly because of its situation, at about 3300 feet (1100 meters) above sea-level on the Atlantic slope, where bits of the original forest still existed, and partly because we were able to find accommodation here on repeated visits, thanks to Mrs. Clyde Ridgway. Many an excellent locality for the naturalist in Costa Rica is unavailable because of the difficulty of obtaining shelter and food, unless the traveler has the means to transport such necessities to the place where he would be, an undertaking involving much expense. We visited Juan Viñas for periods of varying length in June, July–August, September–October, December, February, March and April–May, so that we were able to note changes during the year in greater detail than in any other locality except Cartago.

The cañon of the Reventazón is here quite narrow and about 1500 feet (450 meters) deep, with precipitous sides. The Atlantic Railroad, following the left (north) bank, occupies a shelf or cutting which at Juan Viñas station is 800 feet (245 meters) above the river. The station lay near the southern side of what seemed to be the floor of an old crater. The southern wall of this crater, lying between the railroad and the river, was very low. On all other sides its height was much greater and in places reached 700 feet (213 meters). The north and south diameter of this depression was greater than the east and west diameter and the floor was nar-

rower at the northern than at the southern end. The stretch of railroad track within the crater was rather less than half a mile long. From the station a cart road descended by a series of zigzags to an iron bridge spanning the Reventazón and continued downstream to the Indian settlement of Tucurrique. Another road from the station ascended the sloping sides of the crater and, reaching the rim, traversed more level country to the village of Juan Viñas distant about two miles from the railroad. There were thus three easily accessible levels, that of the railroad at 3300 feet, that of the village at 4000 feet (1220 meters) and that of the river bottom at 2500 feet (760 meters). The vegetation of these three levels differed much, the region around the village being largely under cultivation, that of the river bottom most undisturbed, with of course corresponding differences in the fauna. It is logical therefore to group our observations in connection with these levels.

Alongside the railroad station stood the restaurant managed by Mrs. Ridgway, an American, where the train leaving San José each morning for Limón stopped about 11 o'clock for breakfast. Here we too had our meals. We usually slept and worked, when not collecting, in a little cabin across the tracks from the station and some fifty feet above them, on the low southern rim of the crater. It contained two tiny rooms, not communicating but having each a door to a little porch, and looked like a cozy doll's house as it nestled close to a huge tree whose branches partly overhung it. Behind were two more trees, heavily draped with *Tillandsia*. These trees had nothing like the spread of branches of some of our oaks or sycamores but they were immensely tall, the stem being bare of branches for many feet above the ground—a condition due to the crowding in the forest and the effort each tree must make to reach light and air. Now that the forest had been cut down around

them the trees were too old to send out more branches. The cabin stood in a little garden enclosed by barbed wire. On one side was a patch of plantains mingled with palms, cane and a number of Maranta-like plants. On the other were a few huts made entirely of scraps of corrugated iron, where some peon families lived. In the space between these houses and the railroad was a perfect thicket of the handsome small milkweed with brilliant red-and-orange blossoms (*Asclepias curassavica*) so common in Costa Rica.

Our first stay at Juan Viñas in the latter days of June found the ground about our cabin dug up ready for beans to be planted. At the end of July the beans were one to two feet high. By the last of September, the crop was mature, the vines dried up and a negro was at work clearing the ground for a new crop to go in in a week or two, for already there was an amazing growth of weeds and bushes. Guitites that had been cut to the ground in June and again in July now showed stalks as high as one's head and an inch thick, and the guitite fence posts,—really bare posts at our August visit—were bushes almost as high as the cabin.

On the evenings of September 30 and October 1 we noticed some luminous insects creeping over the soil immediately in front of our cabin, where the beans had been cleared away. We obtained a few specimens each night and kept them alive in a vial for two days or so before preserving them. They were beetle larvæ of the Elater family—that of the common spring- or click-beetle of the United States. In daylight these larvæ were pale yellow in color and presented no remarkable difference from other larvæ of this family, but at night they were very attractive from the glow which they produced. Their lengths ranged from 4 to 22 mm. when resting quietly, but they could stretch out to a little more than these dimensions. Their light-producing organs were arranged in eleven pairs as follows: 1,

occupying all of the head; 2, the anterior end of the prothorax; 3-11, the nine abdominal segments, one pair in each segment, that of the last segment being the largest of the abdominals.

Pairs 1 and 2 were much more constantly in activity than the others. The number of the abdominal luminous organs in activity varied from time to time. In some individuals there was only one luminous area on a given abdominal segment, i. e., the right or left organ was absent altogether, functionally at least. Usually when these larvæ were crawling over the ground only pairs 1 and 2 were luminous; when we attempted to pick up the insect the abdominals also became luminous as the larva ran to escape the fingers. The color of the light produced by all the pairs of luminous organs was the same—green. These larvæ could run very fast. We could not detect any odor from them nor on the fingers after handling them. The use of this light to the larvæ is problematical as in this stage of development it cannot serve as a sexual attraction. Unfortunately, we did not attempt experiments to determine whether the larval light might aid in catching prey.

Fireflies (*Lampyridæ*) were conspicuous also on these evenings at the beginning of October, usually high, or otherwise inaccessible; we noted their presence here in March also. The light they produced was green.

In June we had some bright moonlight, the moon being in the second quarter; but several times, between seven and eight o'clock, the mist stole in as a slender finger from the eastern end of the crater, where the railroad entered through a deep cut. Rapidly the mist filled the entire crater, blotting out its edges all around and cutting off the direct moonlight.

The floor of the old crater, which our cabin faced, was in great part swampy and had been much wetter in earlier

years before any attempts were made to drain it and hence was locally known as the *laguna*. At the time of our first visit, two ditches had been dug across it. One of these was near its eastern edge, the other crossed it from northwest to southeast approximately, in continuation of a small brook descending the crater slopes. The first ditch was begun about October, 1908, Mr. Cochenour said; at its northern end it received the waters of the Rio Naranjo, which on leaving the crater at the southeast edge formed a waterfall in a narrow gorge and rushed down to the Reventazón. Between July and October, 1909, a third ditch bordering the laguna on its southern edge had been dug. The result will, of course, be that the swamp will become dry land, eventually to be planted in maize and then in coffee, and plant and animal life will be greatly changed. Part of its area was used for grazing cattle during our visits. From the collector's point of view the ditches made the inner parts of the laguna more accessible and to that extent at least were an improvement.

In February and March the south and west ditches were bordered with great quantities of *Eleocharis* and other water plants, while the water itself contained in places much stonewort (*Chara* or *Nitella*). Toward the center of the laguna was a large patch of handsome mallows (*Hibiscus* sp., near *uncinellus* but distinct) with vivid dark red flowers and a spiny stem very evil to handle. March also showed many red-stemmed, pale pink- or white-blossomed begonias, which with some clumps of low spiny-stemmed tree-ferns were perhaps relics of a previously wooded condition. Whenever we went into the laguna we usually found some new object of interest; on October 5 it was the curious plant *Monstera* with its lacerated leaves, also a forest dweller by nature. In the same visit the edge of the laguna showed the red torches of the gorgeous-flowered *Odontonema flagellum*,

one of the Acanthaceæ. At other times we noted quantities of *Piper hirsutum* and a vine with bright red flowers, *Vitis rhombifolia*. Along the western edge of the laguna were large groves of guayabo trees (from whose fruit "guava" jelly is made), full of fruit which in July was still unripe. In the narrower, northern part of the laguna was a large vegetable garden cultivated by a Cuban, who showed us some pieces of pottery, broken but quaint and interesting, that he had himself dug out of old graves in clearing the land for his garden.

Large portions of the sloping crater-walls enclosing the laguna on the eastern, northern and western sides were planted in coffee, the cultivated area on the west side being much less than on the other two. On June 27 we wandered through the western coffee patch, which was on a steep slope of very loose soil so that we had to be constantly on our guard lest we lose our footing and roll down. The coffee here was shaded by plantains and a few large scattered forest trees left standing. P. caught a lichen-imitating katydid (*Lichenochrus* sp., probably *marmoratus*), whose markings exactly resembled the mottled green-gray lichen on the tree-trunks. Its body was 18 mm. (three-fourths inches) long; it had projecting knobs on head and thorax and a row of knobs along the middle of the upper surface of the abdomen; the wings were but 3 mm. long, indicating its youthfulness, as the adult insect has the organs of flight well developed.¹ Later we watched a large red and black solitary wasp working at its burrow. There was a limp green katydid lying outside the burrow when we first saw it and the wasp was fussing around the entrance. She soon went down, head first, and after an interval backed out with a pellet of earth in her jaws. This she passed between her legs from pair to

¹ See the figure by Rehn in the *Proceedings of the Academy of Natural Sciences of Philadelphia* for 1905, p. 816.

pair to the hindermost when she gave it a hard kick and sent it flying. This excavating was repeated about a dozen times, and sometimes the pellet was kicked a distance of three to four inches. The wasp then seized the katydid in her jaws—I think grasping it by one antenna—and backed in with it. She stayed down several minutes and a great humming went on; probably she laid an egg on the katydid but that we did not see. Coming out head first she ran to the loose earth she had carried up and kicked a little pile toward and into the burrow. Turning round she shoved down with her head such particles as were caught on the edge of the tunnel, then ran in head first and probably rammed the earth hard with her head; at least that is the usual procedure. This she repeated ten or twelve times, then came out and flew away leaving the mouth of the burrow open and unprotected. We waited for her nearly half an hour, but in vain, so we shall never know whether she abandoned the burrow or was unlucky in her hunting trip.

Among the coffee on the eastern slope of the crater stood a tree with hanging nests of a yellow-tailed oriole or "oropendola." As we could approach very near to these nests we decided on June 30 to photograph them with—if possible—one or two of the birds themselves on the nests. So everything was made ready and we waited three-quarters of an hour for the birds. But although they sat on nearby trees and finally actually visited the nests, their entrance to the nests was so skillful and their stay so short that our pictures although good of the nests do not show a single bird. There are two commonly found species of oropendolas in Costa Rica. This one at Juan Viñas was the upland and Pacific species (*Zarhynchus wagleri wagleri*); its average length is fourteen inches in the male, ten and one-half in the female. The lowland oropendola of the Atlantic slope (*Gymnostinops montezuma*) is larger, nineteen and one-half

inches long in the male, sixteen inches in the female, on the average. Both species are glossy black and dark chestnut with mostly yellow tails. Technically, *Zarhynchus* has the bill much swollen basally, forming a broad rounded frontal shield whose width is decidedly greater than the distance from the nostril to the tip of the maxilla, while in *Gymnostinops* the basal portion of the bill is less expanded and the frontal shield is less than half as wide as from nostril to tip of maxilla (Ridgway).

The chorus of bird-song around our cabin before sunrise each morning was always a pleasant feature and we regretted that we were not ornithologists to appreciate it fully. These mornings alone were enough to refute the popular misstatement that "birds in the tropics have no song." In March the drumming of the tree-frogs was incessant after nightfall, accompanied by a two-noted scream which, so far as it went, suggested a whippoorwill and which could be heard at intervals all night and after daybreak although it ceased before sunrise. In April we occupied a room in Mrs. Ridgway's eating-house instead of our cabin. This room had unglazed windows, guarded by solid shutters of galvanized iron with a wooden frame, so that when closed to keep out rain both light and air were also excluded. Above the shutter was an open scroll work designed probably to admit a trifling amount of air when the shutter was closed. One day as we sat inside this room two wrens, after alighting on the top of a shutter, flew to these small openings and peeped in at us. Their little brown heads and round black eyes were very amusing as they were thrust through hole after hole in the scroll work, and the owners thereof scrutinized us carefully first with one eye then the other. The birds continued this for about ten minutes before they finally flew away.

A handsome woodpecker with a large crest of flaming red feathers frequented the laguna in the last of July. He had



Guarumo Trees (*Cecropia* sp.), one with wasps' nest.
A Trail of Leaf-cutting Ants on a vertical bank.



Pieces of Leaves Collected by Leaf-cutters, with Some of the Ants, Juan Viñas.

Openings of a Nest of Leaf-cutters, near Las Cóncavas.

a single sharp note followed by a long flute-like trill on several lower notes. It was interesting to see him look sharply at the tree-trunk he was standing on, with his head first on one side then the other, then with head drawn back, utter his loud song and as he finished the last note give a few resounding taps to the tree.

Toucans were not often observed near our cabin but on April 26 one flew across the road close enough for his immense green bill to be seen plainly. As it flew with the grotesque bill held straight out it looked for an instant like a bird which had stuck a banana on its beak end-wise and was flying away with it. We could not get very near, but the bird perched on a bare tree where it showed clearly against the sky.

The railroad offered a means of walking about in all seasons of the year, especially in wet weather when the cartroads were deep in mud, and we used it very frequently. It afforded fine views of the Reventazón cañon both up and downstream after passing out of the crater. Along it, here and there, occurred "guarumo" or *Cecropia* trees, which have rather sprawly, "candelabra-like" branching and whitish trunks, each branch tipped with a cluster of large, deeply divided palmate leaves. They are highly typical of tropical America. The hollow stems are divided by cross partitions at the nodes which show on the outside of the trunk and are often, but not always, inhabited by belligerent ants of the genus *Azteca*. Although it has been held that the foliage is protected by the presence of these ants, Wheeler (1913) "after examining hundreds of young and old trees" has come to the conclusion of von Ihering and of Fiebrig that the "Cecropias have no more need of the Aztecas than dogs have of their fleas." One of these Cecropias, to the west of the crater, had a large pendent paper-covered wasps' nest on one of its branches and so became a definite land-

mark for us. Noted on our June and August visits, the nest at the end of September was still the home of an active colony of wasps.

On September 29 we gathered, along the track, some flower-clusters of a leguminous vine, the "Ojo de buey" (*Mucuna mutisiana*) which was then in full bloom. The vine clammers high over trees and rocks, dangling its inflorescences like plummets at the end of thread-like peduncles two to three feet long. We had noted these inflorescences on earlier visits when they were younger and the peduncles consequently shorter. The papilionaceous flowers are waxy, greenish-white in color and about two inches long, with a keel very long in proportion to the standard. The pedicels are about the length of the flowers, which are arranged radially owing to the crowding of all the flowers into the last inch or two of the peduncle. Such an inflorescence may be eight or nine inches in diameter, and presents a most curious appearance as it sways in the breeze or hangs motionless in some breathless little nook. The flowers are followed by large flat pods eight to ten inches long and almost two inches wide. These when ripe open along both sutures disclosing a few large round flat beans nearly an inch and a half in diameter, which adhere alternately to one or the other valve. To their shape and rich black color the plant owes its popular name of "Ojo de buey"—Eye of the ox.

Numerous flowers grew along the track. In October we saw blooming *Castilleja communis*, much less showy than the *C. irazuensis* we found in the crater of Irazú, a passion flower with curiously truncated leaves (*Passiflora lunata*) and the red-flowered *Russelia sarmentosa*. In early December the most abundant wild flowers here were the red-flowered *Isoloma wagneri*, whose blossoms suggest those of our monkey-flowers (*Mimulus*), *Browallia demissa*, a small Solanaceous plant with blue flowers, and a yellow-flowered

composite with heads two inches in diameter. The blossoms of the *Isoloma* were attractive to the large black and yellow swallow-tail butterfly *Papilio thoas*, whose wings at this time were much torn. Both in December and February we found a species of *Siphocampylus* blooming on the railroad banks, where also grew an odd little Urticaceous plant (*Pilea microphylla*) and a handsome small poke (*Phytolacca decandra*) with bright purple flowers. Among the cinders of the roadbed were small Euphorbs (*Euphorbia nutans*).

Nests and paths of the leaf-cutter or "parasol" ants (*Atta*) were common about the laguna and railroad. These insects derive their English names from the habit of cutting bits from leaves or other parts of plants and carrying them in their jaws, balanced over their heads or bodies, to their underground nests. Thomas Belt, during his four years' stay in Nicaragua, and independently Fritz Müller in Brazil, ascertained that on these leaf-fragments in the nests grows a fungus, which is used by the ants as food; the leaf-fragments themselves are subsequently abandoned as refuse. Alfred Moeller, working in Brazil, found that the parts of the fungus used by the ants are pale white corpuscles, .25 to 1 mm. in diameter, which he called "kohl-rabi clusters" and which, he believed, are due to culture by the ants, as they are not formed when the fungus is experimentally grown apart from the influence of the ants.

On some firmer ground on the west side of the laguna was quite a large nest with many openings and well-defined and hard-trodden ant paths leading to it. On October 1 we found ants (*Atta cephalotes*) carrying pellets of refuse material out of several of the openings but very few, almost no, ants carrying leaves or other burdens into the nest. Among the ejecta was an Aphodiid beetle (*Atenius strigicauda*) 5 mm. long, shining blackish, although the strongly knobbed antennæ

are reddish; the head and thorax have irregularly arranged punctures, each elytron has nine grooves containing punctures. This beetle probably acts as a scavenger. At one large opening were perhaps a dozen big worker or soldier ants, with enormous heads, apparently being dragged out by much smaller workers; others of the soldiers seemed to be fighting among themselves. Something was evidently amiss. We examined the ant-paths both near the nest and at a distance; where in July were hundred of workers each bearing its piece of leaf, fruit or flower, were now only one or two, laden as usual but lonely.

Alongside the railroad west of the crater was a wonderful path worn by the tiny ant feet along the face of a steep bank. It could be clearly traced as a hard bare streak for fifteen to twenty feet and was one to two inches wide. The bank was thickly clothed with grasses, ferns and other plants and this bare ledge was plainly visible from the opposite side of the railroad cut. About 8 in the morning of July 22 the ants were only beginning to work and few leaf-fragments were being carried. When we passed about 10.30 the sun was hot and there was tremendous activity among the leaf-cutters and at 3.15 they were still carrying leaves into the nest although it was raining. Across one ant trail there were three columns of small black ants, which caused some interruption and excitement. Leaf-cutters without burdens met and crossed antennæ with the blacks, but there was no actual fighting. On September 28 these trails were abandoned and at the mouth of the nest only one leaf-cutter was seen. These ants travel great distances, it is said as much as half a mile, to the plants whose leaves they cut up, and it is quite possible that this large nest sent armies to the coffee plantations on the crater side, thereby drawing upon itself the wrath of the planter. There is constant warfare upon the leaf-cutters by the latter, who fights them

with ditches of running water which the ants are unable to cross, by flooding the nests and by exploding them with carbon-bisulphide. The latter is said to be the most successful method yet devised. On December 2 the leaf-cutters were crossing the railroad west of the crater and another busy column was marching along the horizontal roadway.

A third nest was under the road ascending from the station toward the village and had several openings in the road-bed and from these, on August 2, ants were emerging, some carrying pieces of leaves which had been previously taken into the nest. These pieces were carried five or six inches from the openings and dropped on the pellets of earth which were likewise brought up by the ants in much greater number. I examined two of these leaf pieces under my lens but could find no cause for their rejection. Reasons mentioned by Belt in his account of this action (*Naturalist in Nicaragua*, 2nd edit., p. 82) did not seem to apply, as no rain had fallen during the day, nor did the pieces appear in the least withered; one had what looked like fungus marks acquired while on the tree, but the other did not.

Still another rather small nest was alongside of the railroad tracks within the crater but east of the station. On passing it on September 29, I noticed two blue-black wasp-like insects running over the top of the nest, one of which entered an opening and entirely disappeared from sight. In a short time it came up, walked about a little and went down again, not to reappear as long as I watched. Two leaf-cutters came out of this opening at intervals after the visitor had gone down the second time and were apparently unconcerned. Later I caught the other of these two blue-black insects, which proved to be a fly (*Eristalis scutellaris*), whose manner of walking, of flying and of folding the wings down over the back of the abdomen is like that of a

wasp. It was a female, five-eighths of an inch (16 mm.) long, shining bluish-black with a bright yellow spot on the scutellum (hind part of the thorax) and a pair of yellow spots on each of the second and third abdominal segments. The head was relatively large, hemispherical and chiefly occupied by the eyes. The wings were smoky. This species is found also throughout much of South America. As the larvæ of *Eristalis* (a genus occurring throughout the world) are known to live "in decaying vegetable matter, manure or in soft mud impregnated with decaying vegetable matter" (Williston), possibly the larvæ of *E. scutellaris* may feed on the decaying leaf-fragments gathered by the ants.

A few yards from the beginning of the zigzag road down to the Reventazón were, in June and late July, two streams of numerous leaf-cutters crossing the road, but on September 29 there was only one stream composed of very few individuals. At this time of year, therefore, there seemed to be a marked decrease in the ants' activities in a number of nests at Juan Viñas.

Without having given special attention to the distribution of the leaf-cutters in Costa Rica, our notes mention them as occurring not far from a swamp near Paraiso, where were two nests near the railroad track at about 4400 feet elevation. Into one of these, on October 11, the ants were carrying many more bits of plants than was the case at Juan Viñas twelve days earlier. Again, south of the Paraiso road and nearer to Cartago, we came, on October 26, upon a large leaf-cutters' nest directly in the road, which was in process of being moved around the nest by trails made by horses and mules to avoid it. A.'s horse shied and showed uneasiness until he was safely past, evidently fearing the ground would crumble or his feet sink into holes. This colony was vigorous and flourishing, to judge from its size and the trails leading to it, and was located less than 500

feet lower than Cartago. On March 14 we rode east of Cartago primarily to capture ant pictures, but we saw few active trails except in deep shade or confused with vegetation. On the road near Las Cóncavas we photographed a large nest with half a dozen conical openings like little volcanic craters, over a foot high. We attempted a picture of a bridge composed of sticks and branches by means of which the ants were crossing a little rivulet. But every attempt to clear away intervening vegetation and let in more light caused the ants to slip over to the darker side of the bridge, so that their "bashfulness"—(or negative heliotropism?)—kept most of them out of the pictures. On the Pacific side, a large and active column of leaf-cutters was observed on the carretera nacional between El Alto and Tres Rios at an altitude of 4650 feet, on March 17, and we have specimens from Alajuela dated September 9. These last two lots represent another species, *Atta* (*Acromyrmex*) *octospinosa*, whose differences from *cephalotes* may be seen very easily from the accompanying photographs.

CHAPTER X

JUAN VIÑAS—ABOVE THE LAGUNA

The road leading upward from the railroad station to the village of Juan Viñas ran up the west and northwest sides of the crater and gave a good view of the laguna, its vegetable gardens and grazing cattle. The glossy leaves of the coffee on the sloping sides looked very pretty; in June the green berries were about half an inch in diameter. The coffee trees were planted in regular rows five to six feet apart, and the soil kept well cultivated and free from weeds, a peculiar form of machete being used by Costa Rican gardeners for weeding and "hoeing."

Although this road was a "Government" road, it consisted of earth and loose stones, and after rains it became deep mud, into which, as our diary of July 29 records, "we frequently slipped to the ankles even in the best spots. It soon began to rain again and worse looking objects than we were by the time we reached our cabin it would be hard to find! Our shoes were so thoroughly soaked that it was torture to get into them next day." Another memorandum, of December 2, concerning this road, reads, "it was liquid mud to a depth of a foot or more, as estimated on the legs of a horse which went plashing through it."

The road crossed several small streams; over the largest, the Rio Naranjo, was an iron bridge on cement piers. It was a picturesque stream ten to twelve feet wide, tumbling over the rocks in little falls. On June 29 we found a rather uncommon insect on a long, freely-hanging vine in the deep shade of this little ravine. It was *Colobopterus trivialis*, an



Leaf-cutting Ants.

1. Workers of *Atta octospinosa* from near Tres Rios (x2).
2. Workers of *Atta cephalotes* from Juan Viñas (x2.8).
3. Male of *A. cephalotes* from Cartago (x2.6).



1, 2. Army Ants, *Eciton predator*, Agua Buena Creek. $\times 4$.
3. The Larva of Dragonfly, *Cora*, Juan Viñas. $\times 3\frac{1}{3}$.

Ascalaphid related to the ant-lions but differing from them in having antennæ as long as or longer than the body, and knobbed at the tip. This individual presented a most stretched-out appearance, for it had arranged itself with antennæ, body, wings, and hind legs held parallel to the vine to which it clung, the wings being folded over the body in roof-wise fashion.

The current of the Naranjo was swift but there were quieter pools in it here and there, owing to the numerous stones in its bed forming partial dams. At one of these pools, about 3 P. M. on August, 2 P. saw a male dragonfly (*Brechmorhoga pertinax eurysema*) poising with rapidly fluttering wings over a certain limited area. By gradually lowering the net to within a few inches of the insect and then bringing it down into the water as fast as I could, I captured the specimen. No other dragonfly was nearby. About 3.30 in precisely the same spot, another male of the same subspecies was poising in the same place and was caught in the same manner on the same square foot of water. About 4 o'clock a third male of the same subspecies was behaving similarly in the same spot, but this one I failed to take; it was alarmed by the attempt, flew away and I saw it no more. What was there in this spot which had such an attraction for this subspecies that three individuals took up their station there—not on some stick or stone but hovering in the air?

We found three species of *Brechmorhoga* at Juan Viñas and its vicinity, all of which possess eyes which in life are a beautiful metallic bluish-green or greenish-blue. This color is found in the eyes of many swift-flying dragonflies but is not correlated, as far as I could see, with the habit of life as regards quantity of external light. *B. pertinax eurysema* on the upper Naranjo was in deep shade, *B. vivax* on the lower Naranjo near its junction with the Reventazón in less

shade, while at Quebrada Honda, on August 1, another species (*B. rapax crocosema*) was active in bright unshaded sunshine.

At three places along the Naranjo, above, at and below the laguna, at altitudes of 3500, 3300 and 2500 feet, respectively, we found in August dead-white plaster-like disks 18 mm. in diameter, which were attached to the surfaces of rocks or trees a few inches to three feet above the water's surface. Each disk consisted of hundreds of elongated eggs, in contact with each other on their long sides; one end of each egg was applied to the rock or tree-trunk while the free ends were coated over with a layer of the white substance, which served as a protection. We brought one or two of these egg-disks into our cabin and to Cartago, but the eggs hatched and the larvæ died before we knew—owing probably to the absence of the water into which they would have fallen under normal conditions. These eggs were laid by one of the Sialidæ and belong to the same genus (*Corydalis*) as the "hellgrammite fly" of the United States. It was possibly *C. crassicornis*, which we took around the electric lights in the Cartago streets in May.

In May brightly colored butterflies of the tropical American groups Heliconidæ and the genus *Anæa* were visiting the flowers on the roadside bushes. In March the whole road was redolent with a faint sweet perfume, suggesting both vanilla and mignonette, produced by a white-blossomed Verbenaceous shrub (*Lippia myriocephala*) ten to fifteen feet high. At this time the roadside was bordered with Santa Lucia of varying shades of blue, with what appeared to be a white-flowered *Ageratum* which was always taller than the other (three to four feet as compared with one to two feet), and another white-flowered composite with flowers resembling the *Ageratums* but with alternate leaves.

About half an hour's easy climb up this road brought one

to the edge of the crater, where the road bent to the left opposite a little cabin which formed a conspicuous landmark. The country at this upper level was, in elevation and characteristics, not unlike that around Cartago, being used for grazing and agricultural purposes, so we seldom came up here—in fact only four times in all. On three of these visits the clouds obscured the distant panorama, but on the fourth, on March 22, the day was beautifully bright, and when P. reached the rim of the old crater and looked northward the huge masses of Irazú and Turrialba volcanoes were very little hidden by cloud. It was the first time I had seen them from this place. The whole eastern and southern horizons also were filled with mountains, range after range, the farthest and highest, almost due south, lifting their peaks above a thin layer of white cloud. Seldom have I seen a grander view. In the foreground were the delicate greens of sugar-cane or the darker glossy greens of plantains or coffee; the nearer mountains were clothed with forest of a still darker green, the more distant mountains softening into blue.

Beyond the crater's rim, a short distance before reaching the village, stood a large two-storied wooden house with spacious verandas, enclosed with glass sashes, on each story. It originally belonged to Don Federico Tinoco, but at the time of our visit was occupied by the Messrs. Cochenour, two Canadians who, in coöperation with the Messrs. Lindo, were engaged in the raising and preparation of sugar and coffee. We enjoyed their hospitality on two occasions, when they showed us their garden, sugar-mill and coffee beneficio. The garden was begun by Don Federico, who imported a number of trees such as palms and northern willows. One of the handsomest plants was an apocynaceous shrub with glossy leaves and large yellow trumpet-shaped flowers, tinted outside with red-brown.

The sugar-cane plantations occupied the relatively level plateau out of which the deep cañon of the Reventazón and the crater of Juan Viñas station have been cut. They extended to the edge of this cañon, the sloping sides of which were covered with forest and dense undergrowth or, on the crater sides, with coffee and some maize. The sugar-cane was planted in rows five to six feet apart, the plants in each row being only six inches to two feet apart. On June 29 the cane was higher than a man's head. In appearance sugar-cane is not unlike maize but the main stem is shorter and the leaves are given off much nearer the ground. A so-called wild cane also grows in Costa Rica, reaching a height of ten feet, and is used in the construction of native huts and houses. This is possibly the "caña blanca" (*Gynerium saccharoides*). It is easily distinguished from sugar-cane because its leaves are definitely two-ranked so that in "end" view the plant looks very flat, while in sugar-cane the leaves are several-ranked, the bases forming a spiral around the main stem, and in no view does the plant appear flat.

A small narrow gauge track ran from the sugar-mill through the plantation, so graded that the loaded cars went down by gravity to the mill but were hauled up by mules when empty. On September 30 we saw the cane brought in these cars to the mill, dumped at the head of wide slow-moving belts and fed to the crushers, where the juice ran down into vats while the almost perfectly dry fiber was removed to serve as fuel in the preparation of the sugar. The juice was boiled with a little sulphur vapor to purify it and the brown molasses was run into the centrifugal refiners, where we watched it turn paler and paler. First, second and third class sugars were made here—and none of it was beet sugar. All the sugar was used in Costa Rica, freight charges being so heavy and excess production so slight that it did not pay the producers to ship outside. The molas-

ses was all used in the government fabricas, where it was made into alcohol and alcoholic liquors, the making of which was a government monopoly.

It was at the Messrs. Cochenour's house, on May 31, that we first met Mr. William Schaus and Mr. John Barnes, then in their three years of collecting Costa Rican Lepidoptera. During this period they obtained 1081 species of butterflies and 4000 species of moths, 409 and 3350 more, respectively, than were previously known from Costa Rica. Mr. Schaus regarded Costa Rica as the richest area of all Mexico and Central America, a conclusion to which his papers in the *Annals and Magazine of Natural History*, describing some hundreds of new species, bear ample testimony. These Lepidopterists were now gathering the nocturnal moths attracted by the electric lights at this house and mill and at El Sitio, 405 specimens having been the yield of the preceding evening. To these two friends we were indebted for many suggestions which guided our own footsteps in Costa Rica.

The village of Juan Viñas was invisible from the railroad but could be well seen when one had reached the crater's rim. It lay on a small hill in the center of a roughly circular valley. P. visited it only once, on March 22. The streets were lighted by incandescent electric lamps with reflectors, the current being supplied from the Cochenour power plant, but were unpaved and had either no sidewalk at all or only a slightly raised earthen path. There was a number of two-story houses, built chiefly of wood and corrugated galvanized iron; the two-spired church was also wooden. There were two schools, telegraph and post office, shops, etc.

A road led north out of the village toward Turrialba volcano, passing first between cafetales and then potreros with cattle; half an hour's walk brought one to a pretty brook which issued from a woods at the left, and after uniting with a similar brook at the road was crossed by a bridge

with stone abutments. I ascended the first brook for a short distance, and spent about two hours (11.30-1.30) searching for dragonflies here, but with little success.

When I entered the valley of this rivulet, Turrialba volcano was still in full view; when I came out on the road again, its whole upper part was hidden by the clouds. After twenty minutes' walk this road bent sharply to the northeast, descending into a valley in which lies the settlement of El Sitio, another of the Lindo coffee and sugar estates. I however followed a path running on north, which after some irregularities brought me to the top of a sudden descent of some hundreds of feet, at the bottom of which I could see the whitewashed houses and red roofs of El Sitio. Beyond El Sitio the ground rose again into a high forest-covered hill and beyond that to the slopes of Turrialba itself. At the edge of the hill was the two-storied white house of Señor don Juan Humana and farther to the right, on Turrialba's slope, the houses and white-towered church of Santa Cruz. We were told that at these houses on the lower slopes of Turrialba the grumblings of the sleeping volcano were frequently heard.

CHAPTER XI

JUAN VIÑAS—THE WATERFALLS

West of the crater along the railroad the wall of the cañon of the Reventazón rose to a height of 700 or more feet above the tracks, in some places perpendicularly, in others in a series of varying slopes and terraces. Brooks from the upper country on their way to the river formed cascades or waterfalls over the cañon sides. Two of these, accessible from the tracks, were often visited and yielded some most interesting insects. In our own conversation and diary we designated them as the "nearer" or "high" and the "farther" waterfall from our cabin.

The nearer waterfall, which had the larger volume, slipped over sheer rock faces two to three hundred feet high. Wherever there was sufficient slant the adjacent wet rocks were draped with mosses, maidenhair and other ferns, Selaginellas, Commelinas, Tradescantias and a Streptocarpus-like plant. At about a hundred feet above the railroad track (which occupied a narrow ledge cut out of the cliff face), the water usually disappeared beneath a mass of boulders and flowed underground through loose soil to reappear on the slope far below the track. Up over these boulders we climbed to the foot of the actual fall with its vertical rock-face. The amount of water over and among the boulders varied with the rains. On our first visit in June the water did not extend to the rails as a surface stream as it did on December 2, while on February 14 the waterfall was as full, if not fuller, than on December 2. On February 18 there was so much less water coming down that it was again possible to climb

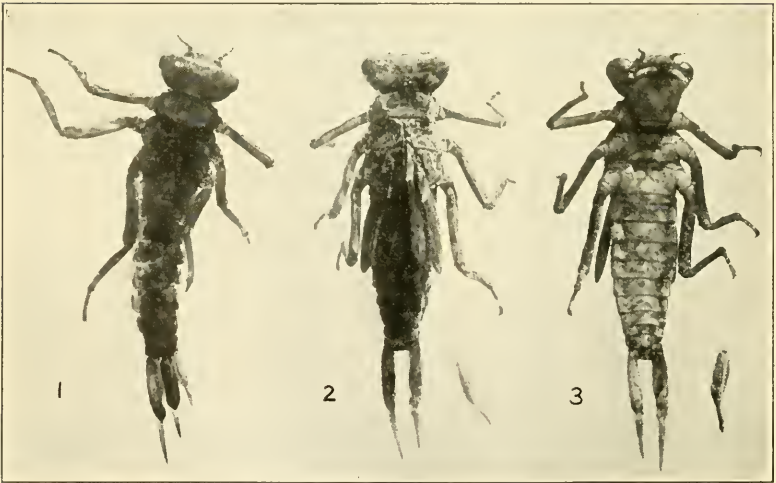
to the foot of the perpendicular fall, and with no more than wet feet and slightly splashed clothing; we could see that the floods of the rainy season had changed the positions of many rocks and logs. On March 23 the quantity of water was less than in February, while on April 26 it had increased again in consequence of a rainfall unusually heavy for this month. These fluctuations, trivial as they may seem, in the volume of a stream which at best was relatively small, had their effect on the aquatic insect and other animal life inhabiting its course, the greater extent of surface water below the fall tending to carry such creatures to lower levels than the fall itself and so render them more accessible to us.

The farther waterfall was not more than thirty feet high in its last stretch and fell into a little basin five feet above the level of the railroad, whence its waters made their way in a shallow ditch along the tracks for a quarter mile before finding their way toward the Reventazón. Unlike the open nearer fall, this waterfall was enclosed in a little recess well shaded from the sun. Growing around it were begonias, ferns, a delicate little Caryophyll (*Stellaria ovata*) and Urticaceous plants including a species of *Pilea* and a coarse big-leaved *Myriocarpa*, which we found blooming September 29. The flowers of the *Myriocarpa* are borne in foot-long catkins in the axils of the leaves. The stamens are curled on themselves and when ripe straighten out suddenly so that the pollen is violently discharged in a little cloud to a distance of several feet.

On climbing to the top of this fall over the steep bank of crumbling soil, one could, with the eye, follow the stream in a series of low cascades. Two brooks in fact united just above and descended through a tiny, dark moss-lined gorge. Here, on August 1, a pair of the delicate dragonfly *Heteragrion chrysops* was egg-laying in the gloom produced by the



The "Farther Waterfall" at Juan Viñas.



The "Nearer Waterfall" at Juan Viñas.

The Larvæ of Dragonfly, *Thaumatoneura*. 1, female, x2. 2 and 3, male, x1.8.

overhanging vegetation. The fluctuations in volume of this fall were very slight.

It was in or at the foot of one or other of these two waterfalls that we found the transforming larvæ of certain dragonflies,—*Thaumatoneura*, *Argia talamanca*, *Philogenia carrillica* and *Palæmnema*—of whose habits and early stages nothing had been known previously. From our observations here and elsewhere in Costa Rica it appears that *Thaumatoneura* and this *Argia* are exclusively waterfall-dwellers, but that *Philogenia* and *Palæmnema* live in other situations also.

Standing at the bottom of the nearer waterfall on June 24, and looking up, I could see the males of two supposed species of *Thaumatoneura* fluttering through the spray, chasing each other or alighting upon the rocks or plants. One species (*inopinata*) had a blackish-brown band across the middle of each wing, the other (*pellucida*) had uncolored wings. So heedless of the spray were they that it gathered in little drops on the wings or hung suspended from the hind end of the body.

On this and following days we observed the mating of *Thaumatoneura*. The female had not hitherto been known; it has the *tips* of all the wings black and hence can be easily distinguished from the male even at a distance. Both sexes are large and conspicuous insects, having a wing-spread of four inches. While mating the male held its wings horizontal and expanded, those of the female being vertical and folded together. At the end of ten minutes the male released the female and at the same instant folded his wings together into the vertical position. The female, losing her attachment to the male, assumed a position a little below him on the same twig or rock. Subsequently she flew away to begin egg-laying.

We watched supposed egg-laying in three or four cases.

The female made the usual abdominal movements seen in the Zygopterous dragonflies generally, that is, those for inserting the eggs into plant substances by means of a sharp-pointed ovipositor on the under side of her eighth and ninth abdominal segments. Some of these movements, however, were over hard wet rock so that it seemed unlikely that any eggs were placed on it. At other times the movements were made against moss and roots, the female occasionally burying her abdomen for half its length in the wet mass. We had suspected such a habit even before we had seen the living female, and had carefully examined some of the wet moss, for larvæ, but found none. The ovipositing female is not accompanied or followed by the male. Indeed once a female flew close to a resting male without attracting any response from him. Males at least often remain on the same spot half an hour or longer without moving. Females seem less persistent, but one timed was ten minutes on the same twig. Except in pairing males, the wings of both sexes, when at rest, are held in the vertical position folded together, but every now and then an individual will open and close its wings once or several times in succession.

Owing to the habit of *Thaumatoneuras* of spending most of their time over these vertical wet rocks, their capture was often only possible by climbing up on the rocks themselves, or by hanging with one hand to some long dangling root or vine and sweeping the net with the other.

Up to July 30 the males which we observed in the pairings of *Thaumatoneura* were in every case *inopinata*. On that day P. saw a male *pellucida* and a female fly to a dead branch on the side of the railroad cutting just west of the farther waterfall and about twenty feet above the tracks. There was no doubt that they were pairing, so it was highly desirable to capture them both. The steep bank was composed of reddish soil with loose stones and soft rock, wet

from recent rains. I climbed up as far as I could, until the steepness was too great to furnish a foothold, but the insects were still beyond the reach of my net handle. I descended and hastily attempted to improvise an additional joint but one stick after another broke, so I used my umbrella and again climbed the bank. But the soft earth gave way and collector, net and umbrella slid swiftly—and separately—down to the tracks. A second attempt had the same result. A third, made more cautiously, was so successful that the net with its handle supported on the umbrella was thrown over the accommodating pair, which had lingered for at least ten minutes on the same branch, and by gently dragging it down over the bank I at last got the insects safe in my hands. Then I saw that this female was so like the females we had seen and taken pairing with *inopinata* males that a minute comparison would be necessary to determine whether there was any difference between them or not; yet the males were very different. We saw no other *pellucida* male pairing at any time during this visit to Juan Viñas, but on October 1, at the same fall, A. spied a pair of *pellucida* mating, which we were able to secure.

The detailed comparison of the single female taken pairing with *inopinata* male and two females taken pairing with *pellucida* males, with each other and with nine other females taken singly, has failed to reveal any external features by which they may be distinguished.

On June 26 a few larvæ were found at the farther waterfall in among the roots that hung in front of the rock face and were constantly bathed in the water. We suspected them to be *Thaumatoneura* but not until ten months later did we obtain the proof that they were so. These died very quickly when placed in still water so that we were unable to rear the adults from them. The next day we found one large larva of the same kind but older, crawling up out of the water

on to a big rock. This being a hopeful indication of near transformation we carried it back to the cabin, where we rigged up an ingenious and home-like stream for him in a dish aided by a stone and a bottle. We subsequently took him to Cartago but the ungrateful little beast seemed unappreciative and died July 25 or 26. In March the supposed *Thaumatoneura* larvæ were not rare on the rock face of the nearer waterfall, where there was a thin layer of organic mud subjected to only a moderate amount of spray. No doubt the larvæ are often carried by the dripping water lower and lower down from the roots in which the eggs are laid. But none of these March larvæ transformed in our possession. On April 24 at the same fall we found a score of the exuviæ or skins of these larvæ shed at the time of transformation to the adult, while smaller larvæ than those indicated by the exuviæ were crawling over the rocks. On April 26 the long search was crowned with success by finding two larvæ in the act of transformation into *Thaumatoneura* adults.

One of these larvæ was hanging on the wet slippery face of the fall in such a position that a small projection above it gave it shelter from the direct spray. The wings, while they hung limp and wet, in fact until they were full size and dry, were green. The body of the dragonfly was brown and green and as the creature hung on the rocks, the body and wings giving the little trembling jerks that usually accompany the growing or "filling out" of a transforming insect, the likeness to a green leaf on a stem trembling in the breeze was very marked. There was much small-leaved *Commelina* on the face of the fall as well as some delicate grasses, both of a bright pea green, and we ourselves frequently confused the *Thaumatoneura* with one or other of these if we happened to move our eyes from it. It certainly seemed to be a good case of protective coloring. Other full

grown larvæ of *Thaumatoneura* were found a few days later which, transforming, confirmed the evidence as to their identity.

The males of both *inopinata* and *pellucida* were obtained from the transformed larvæ and a minute comparison of the exuvixæ from which they respectively issued has shown no differences that cannot be considered as due to slight injuries received by each. This fact, together with the lack of observable differences in the females caught pairing with the males of *inopinata* and *pellucida* respectively, seems to point to the conclusion that there is but one species of *Thaumatoneura* after all, a species in which the females are all colored alike, although showing a certain range of variation in size and in the proportions of the hind wings, but with two forms of males whose wings show the very marked difference in coloration which originally led to their being given distinct specific names. These are still useful, of course, in distinguishing the two forms. That this view as to the relations of *inopinata* and *pellucida* is correct can only be definitely determined when, from the eggs of known parents, both *pellucida* and *inopinata* offspring are reared to maturity.

The case of *Thaumatoneura*, on this interpretation, is relatively rare, but a parallel is afforded by the North American butterfly *Lycæna* (or *Cyaniris*) *pseudargiolus*, the jumping spider *Mævia vittata*, and certain Lucanid and Staphylinid beetles. The reverse case, where in a given species, there is but one form of male and several forms of females, occurs more frequently in insects, as for example in the dragonflies of the genera *Ischnura*, *Neurothemis* and *Erythrodiplax*, and among butterflies of the genera *Papilio*, *Colias* and *Pamphila*.

Thaumatoneura, as far as known, is confined to Costa Rica and Panama and appears to have no very close rela-

tions. The other exclusively waterfall-dwelling dragonfly that we found at Juan Viñas, *Argia talamanca*, belongs to a genus distributed from Canada to Argentina. Many species of *Argia* occur in Costa Rica, but only *talamanca* appears to have adopted this peculiar and restricted place of abode throughout its entire life. A. found a pair of *talamanca* attempting to oviposit in the mud on the hard rock face of the nearer waterfall on July 27. On August 3, an exuvia of this species was found on the vegetation to one side of the main stream of the same fall, but on the perpendicular face where there was constant dripping, and immediately above and resting on it, was the male which had just emerged. Single males were found at or near one or the other of these two falls on June 24, September 28 and December 2. Larvæ which corresponded with the exuviæ of August 3 were obtained in March.

Argia talamanca is a slender dragonfly one and three-eighths inches long, whose clear wings extend about two inches. The male has a pale blue thorax with a black line down the middle of its back and two black stripes on the sides, while the abdomen is chiefly black with pale blue at both ends. The female tends to replace the blue with more violaceous tints, the middle black line of the thorax is widened into a stripe and the pale blue near the hind end of the abdomen is limited to one segment (the eighth) instead of covering three. Another species of *Argia* was met with at these waterfalls but was not restricted to them. This was *A. underwoodi*, slightly larger than *talamanca*, resembling it in colors but differing in details of structure and in the male having the middle black stripe on the thorax wider so that black predominates there. We did not obtain the larvæ of *underwoodi*, so we know nothing of their habits.

The habit of dwelling in and around waterfalls and cascades does not appear to have been mentioned for any other

dragonflies. Yet it is likely that such a habit will be found to exist in some other members of this group of insects, especially in the tropics of the Old World, where topographic and climatic conditions similar to those of Costa Rica prevail. In countries where frost occurs low temperatures may prevent the survival of Odonate larvæ in waterfalls of small volume, where the water is spread out in a thin sheet as is the case in those falls which *Thaumatoneura* inhabits. On the other hand, the force exerted by a large volume of falling water may be too great to permit Odonate larvæ to dwell therein.

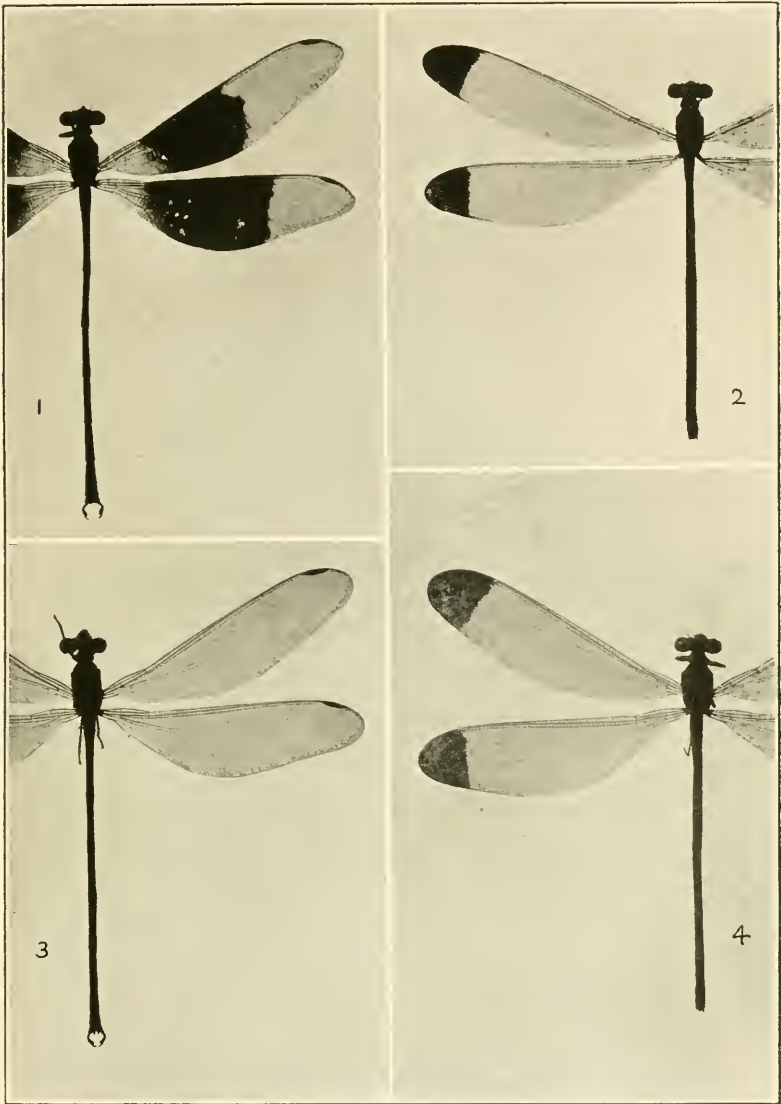
In addition to the two waterfalls here described we found *Thaumatoneura* at only one other—a small cascade in the bottom of the Reventazón valley. We were puzzled by not finding these insects also at other streams under generally similar conditions. An explanation of their absence from one of these, the little Rio Naranjo, is suggested in our diary: "At the Naranjo I saw a number of lizards from two inches to a foot in length and these possibly keep down the number of insects. At our two waterfalls [i. e., the 'nearer' and the 'farther'] we have seen no lizards."

A structural peculiarity of the larvæ of *Thaumatoneura* and of *Argia talamanca* which greatly interested us when we came to study them after our return to the United States was the condition of the three so-called "caudal tracheal gills" with which the abdomen of all members of their suborder (Zygoptera) terminates. In the majority of species thus far known, these "gills" are thin, expanded and leaf-like; supplied with branching air-tubes, or tracheæ, they are believed to absorb, through their thin walls, oxygen from the air which is mixed with the water in which they live and the tracheæ carry this oxygen to all parts of the body. The larvæ of *Thaumatoneura* and of *Argia talamanca* have these "gills" relatively and absolutely thickened and narrowed to

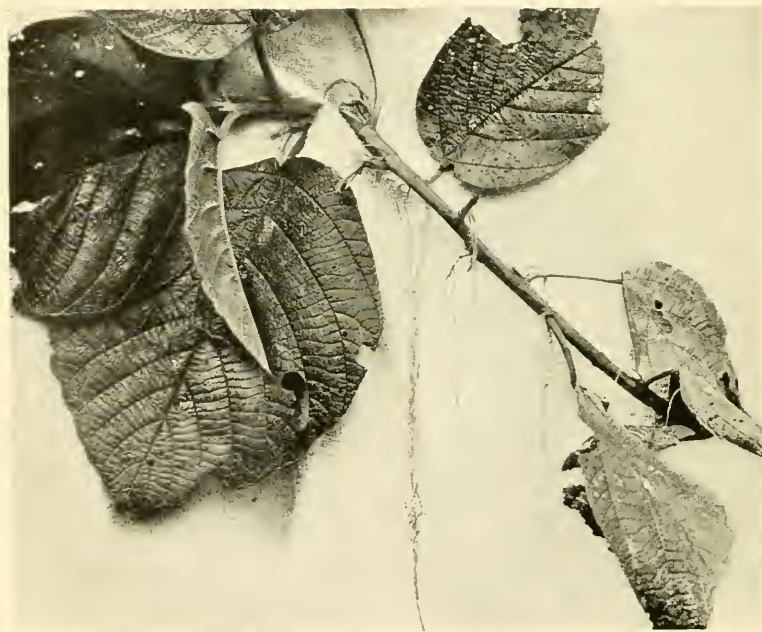
such an extent as to suggest that they may not be very efficient respiratory organs. Examination of the hind part (rectum) of their intestine shows the presence of a few longitudinal folds which thereby increase the surface of this organ. In the other suborder of dragonflies (Anisoptera), the larvæ breathe by drawing water into the rectum where numerous folds and a rich supply of tracheæ absorb the needed oxygen. The folds and tracheæ of our *Thaumatoneura* and *Argia talamanca* larvæ are by no means as highly developed, but their presence is at least suggestive of a similar, if less intensive, function.

While examining the larvæ and exuviæ of *Thaumatoneura* we found great numbers of diatom shells attached to them. A single leg, which had been detached from an exuvia, was sent to Professor Albert Mann, Custodian in charge of the Diatom Collection of the U. S. National Museum at Washington, who wrote: "I should say that there were at least 500 diatoms [representing sixteen species and varieties¹] on the small leg of this larva. The most of these are forms that grow attached by a transparent jelly-like stipe; but several of them are free and free-moving,—for example the different species of *Navicula*. The finding of these forms on this aquatic larva is of importance because it helps to throw light upon a difficult problem connected with the distribution of diatoms. It has always been more or less of a mystery how isolated pools and bodies of water of recent origin become stocked with a rather extensive diatom flora and frequently within a very short period of time. Some light has been thrown upon this distribution by supposing these organisms are carried on the feet of wading birds, but this method of transportation is plainly very inadequate. If, however, we add to this transportation by aquatic insects, many of which have the power of flying, we have a means of

¹ For list, see *Entom. News*, Vol. XXVI, p. 299, Philadelphia, July, 1915.



1, 2. *Thaumatoneura inopinata*, male and female $\times\frac{3}{4}$. 3, 4. *T. pellucida*, male and female $\times\frac{3}{4}$.



Pilea sp.
Myriocarpa sp.

transportation that goes a long way to explaining the sudden appearance of large numbers of diatoms in new localities. I therefore look upon this rather abundant flora on the minute leg of this aquatic insect as of some scientific importance. Of course in this case the power to fly does not exist until a later period of development, but many of the water beetles and other insects are doubtless coated with living diatoms in the same way." Professor Mann's letter led to the scraping of the legs and bodies of our adult specimens of *Thaumatoneura* and in this minute quantity of "dust" he found about sixty diatoms, thus confirming his conjecture as to the part insects play in spreading these unicellular plants.

Other insects lived at the waterfalls. At one, on June 24, we secured an extraordinary little creature, something like a leaf-hopper, equipped at its hind end with a long thick brush of iridescent hairs, which could be spread open. The brush was half an inch long, the insect itself only one-quarter inch. When A. first saw it, it had alighted on her knee and exactly resembled a pappus-crowned fruit like that of dandelion or of thistle. Such she thought it was and put out her hand to brush it away when the supposed seed leaped into the air and settled in another place. It proves to be a member of the family Fulgoridæ. Very likely the brush of hairs (which are really secreted waxy filaments) do serve the same end as the hairs or pappus of the fruits of the Compositæ—distribution by means of air currents.

On the rocks below the waterfalls—and in other rocky streams—were many tiny crickets known as *Rhipipteryx*. The most common species (*R. biolleyi*)—and it was very abundant in the situations mentioned on August 3—was about 7 mm. (.28 inch) long, with body and wings black, prothorax and front wings edged with cream-color, some white marks on the head, but the legs orange-red, so that

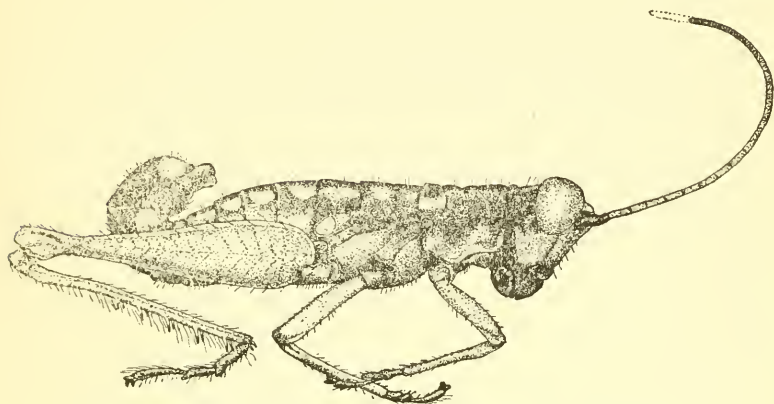
in spite of its smallness the insect was conspicuous. Its jumping powers were very great, but we never saw it fly. We observed it in August, late September, early October, early December, February, March and late April, on which last occasion it seemed scarcer. On December 2 it was also found in (to us) new surroundings—in little cavities, slightly larger than the crickets themselves, in earth occupied by a nest of small black ants. The crickets were sometimes in holes below the surface of the earth so as to be only partially visible. The ants apparently did not regard them with any hostility.

Another, larger, species of *Rhipipteryx*, *R. limbata* (11 mm. long) found on rocks below the waterfalls on August 3, but less abundantly, had the legs black with a whitish line on each, the rest of the body colored similarly to *biolleyi*. On February 14 two of them were seen flying, a mode of locomotion new for them in our experience. After that I tried to make *biolleyi* fly, but it always jumped, although it has well-developed wings. The legs of *Rhipipteryx* are curiously modified, the tibiae of the first legs being deeply grooved lengthwise, presumably permitting the tarsus to be folded back into the groove, and the tibia of the third leg gives the appearance of possessing three terminal and two anteterminal claws.

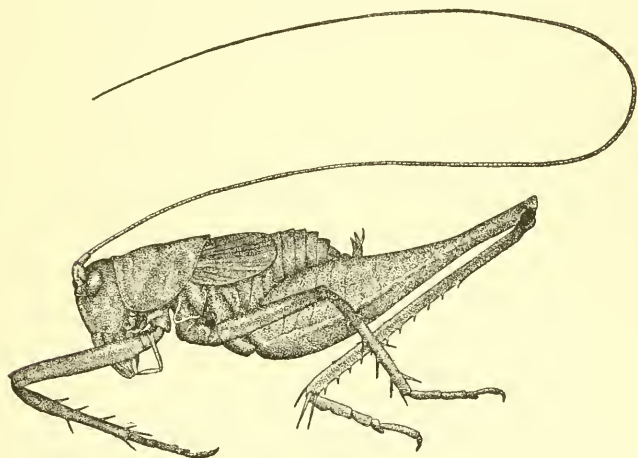
On the rocks below the falls and also in the dripping vegetation on the rock faces at the side of the waterfall were some somber-hued grouse-locusts or Tettigids (*Allo-tettix peruvianus*), whose leaping powers were not as great as those of *Rhipipteryx*; they were 10.5 mm. long, and were noted in August and in February.

On September 29 several brown pink-winged walking sticks (*Pseudophasma menius*) flew up under our feet, and we took an oddly colored small grasshopper (*Dellia miniatula*) 15 mm. or $\frac{3}{5}$ inches long, which had much *metallic*

green on its back. In a little clump of vegetation at the foot of the nearer fall we captured, on April 24, a large



The grasshopper *Dellia miniatula*. (From the paper by Rehn.)



The cricket-like katydid *Anabropsis costaricensis*. (From the paper by Rehn.)

cricket-like katydid 42 mm. long (*Anabropsis costaricensis*); its wings were abbreviated (only 8 mm.), but the length of

its antennæ (100 mm.) and maxillary palps (12.5 mm.) was extraordinary. At the farther waterfall were a number of medium-sized "spiny-bellied" spiders (*Edricus tricuspis*, *Acrosoma inæqualis*, *Gasteracantha kochi*) whose abdomens presented a great variety of odd shapes, armed with relatively large spines.

A large fresh-water crab, over four inches across the carapace and with most formidable pincers, was at the farther waterfall on April 27. He sidled through the stream and up the bank, climbing better than one would expect from so clumsy a creature, and backed into a hole under the roots of trees bared by the water, keeping his pincers out and ready for action. At a little stream still farther on were the very antitheses of this monster—little crabs less than half an inch across.

About half a mile west of the farther fall was a third fall or rather cascade reached by a little trail through a bit of exceedingly thick damp woods, full of wild ginger, Heliconias, ferns and caladiums. The place was extremely pretty and ought to be a favorite haunt of many forest-loving species. Here on May 2 we came upon the body of a fair-sized armadillo some time deceased. After long hunting among the fallen leaves and stones of this brook on April 27, P. found a dragonfly larva with a pair of finger-like gills on the ventral surface of each of the second to the seventh abdominal segments. Nothing like it was known for any member of this order of insects inhabiting the Americas, but since similar conditions had been described thirty years before for certain Indian Calopteryginæ, we at once suspected that this larva might also belong to this subfamily and possibly to the genus *Cora*, the adults of which we knew to live here. The larvæ found on this day and also on April 29 had lost their three caudal gills, which although forming part of the proper equipment of Zygopterous larvæ, seem to

be of indifferent use and value. Many larvæ lose them by accident or by the bite of a brother or other enemy and yet pass their larval existence as tranquilly, and accomplish their transformations as successfully, as their brethren which, like the foxes in the fable, retain their brushes. Three of these peculiar larvæ found May 2 in the outflow from the farther waterfall possessed their caudal gills which were most odd-looking. They appeared as if cut off straight across at the tip, instead of tapering as usual, the straight edge then scalloped into three points. Each inflated-looking gill was one-fifth as long as the short "pudgy" body, giving the larva a "tail-heavy" appearance. When first taken into the hand these three larvæ remained motionless, "playing 'possum" as it were, for a minute or two, and then took to their legs with some speed. In spite of their double equipment of gills these larvæ did not frequent a different abiding place from others less richly "engilled," their fellow inhabitants being larvæ of *Heterina*, *Argia* and common types of Libellulines.

These larvæ died before transforming but were preserved in alcohol; a microscopic examination of their rudimentary wings showed so close a correspondence with the veins of the wings of the adult dragonfly *Cora chirripa*, captured at the same waterfall, as to leave no room for doubting that these larvæ are of that species. It is the presence of the ventral gills that gives these larvæ their great interest, for breathing organs in such positions are rare in dragonfly larvæ generally, although common enough in may-fly and Sialid larvæ. It has been suggested that they correspond to the legs of the hind part of the body of centipedes and their allies, which some consider to represent the ancestors of insects. The adult *Cora chirripa* has a body one and seven-eighths inches long, the thorax pale greenish or bluish with black lines on its sutures and a broad black stripe on

its middle, the abdomen chiefly black; each wing is one and one-quarter inch in length, slightly yellowish and densely veined.

West of Juan Viñas the next station on the railroad was at Quebrada Honda, a side ravine emptying into the Reventazón valley on the north. At the time of our first visit here, August 1, 1909, there were only a few native huts and one more pretentious house, the Hacienda Maria. That morning was cloudy and threatening. We took the road which led upstream. The hillsides were planted with yuca (manihot), maize, squashes, beets, onions or garlic, the neat rows of which often occupied such steep slopes that we wondered how plants and soil retained their positions when it rained hard—as it often did. The land was formerly forest-clad and it still was so at the top of the hills. Here and there some tiny streams descended to swell the volume of the little Rio Quebrada Honda. The valley has some historic interest as being the position occupied by the Spanish governor Juan Lopez de la Flor in 1665 to resist the attack of French and English pirates and buccaneers under Mansfield and Morgan, who, landing at El Portete, near the site of Limón, advanced as far as Turrialba but retreated on learning of the resoluteness of the governor. Again in 1681, Governor Sáenz Vázquez intrenched troops at Quebrada Honda to await the pirates who had disembarked at Martina with the intention of attacking Cartago, but who did not carry out their plans.

At the little streams we found a few small leeches (*Semiscolax glaber*) and planarians, a small fresh-water crab with a carapace one inch across (*Pseudothelphusia richmondi?*) and some dragonflies. Five slender columns of army ants (*Ectaton hamatum*) were crossing the road, but the cloudiness was not favorable to the appearance of many insects.

When, later, the sun shone and more insects were on the

wing, we were interested in the general similarity in color pattern and in manner of flight shown by two widely different dragonflies—*Epigomphus subobtusus* and *Brechmorhoga rapax crocosema*—flying over the same brook. They were of approximately equal size (two inches long), each had the abdomen widened at or near the hind end, the seventh segment thereof bore the most conspicuous pale marking of the entire body (which was in general dark brown with bluish or greenish stripes) and the eyes were blue or bluish-green. Many differences in detail there were but the general resemblance was of the kind that has been called mimicry. There was nothing in this case, however, to suggest that the resemblance offered a means of defense to either species against enemies.

As we ate lunch on the steps of the unoccupied Hacienda Maria, we watched a lizard, nearly a foot long, hunting insects on the ground below us. Occasionally he would cautiously approach a blue dragonfly (*Argia extranea*) several of which were here and there on the ground, but unsuccessfully as far as we saw. There were two lines of leaf-cutting ants crossing the range of the lizard's activities but these he did not molest. Finally we saw him with a fat cricket or katydid in his jaws, nearly choking him, but needless to say it eventually disappeared down his throat.

On February 14, 1910, P. went again to Quebrada Honda. Insects of all kinds were scarce, especially dragonflies and butterflies. The exception was *Rhipipteryx biolleyi*, plentiful at the waterfalls and often along the tracks, and a few of the black species (*R. limbata*) were also in evidence. Leaf-cutting ants were at work again where we had seen their paths on previous visits. Water was standing in the ditches at the sides of the roadbed and flowing in the small streams. The vegetation on the hillsides was everywhere green, in striking and well-known contrast to the condi-

tions prevailing at this season on the Pacific slope from which I had recently come. At Quebrada Honda chayotes were being harvested from the steep slopes. Patches of blue sky began to appear and by four o'clock very few clouds remained, but the bright sunshine brought little increase in the insects. Never had Juan Viñas appeared so poor in this respect; only two species of dragonflies, *Argia extranea* and *Anisagrion allopterum*, could I find, and these two are abundant at Cartago throughout the year. "By six o'clock clouds were gathering again and at seven a strong easterly wind was blowing, and the candle flames by whose light I write these words, although sheltered within 'our' little cabin, flicker uncomfortably."

Our acquaintance with our friend the "nearer waterfall" terminated most unexpectedly. On April 30 we went up the railroad tracks to visit it again but found that a landslide had occurred changing the rock bed from the tracks up to the foot of the fall very greatly. We climbed up a short way to reconnoiter, saw that some small trees had fallen across the bed blocking our usual path and that rocks larger than one's body had been rolled down and many of them left in very unstable positions. In fact the changes since our last visit four days before were far greater than at any time during the ten preceding months in which we had known this fall and we found it impossible to ascend. On inquiry we learned that on April 28 two distinct falls of rock had been heard in the direction of this waterfall, with the crashing of branches and the odor of newly disturbed forest earth. Never again were we able to reach the foot of this waterfall. But we had our *Thaumatonera*; and it was our good fortune that we had found so many treasures here before the landslide occurred!

CHAPTER XII

JUAN VIÑAS—THE REVENTAZÓN VALLEY BELOW THE LAGUNA

The little Rio Naranjo, arising on the southern slope of the ridge connecting the volcanoes Irazú and Turrialba, made its way to the northwest side of the crater rim of Juan Viñas, descended to the laguna, left it at its southeast side passing under a short, low railroad bridge, and plunged down 200 to 300 feet in a series of falls and cataracts; finally in a bed of gradually decreasing steepness it reached the flood plain of the Reventazón and glided gently into that river. The government road from the railroad station to the Reventazón left the laguna only a few yards west of the Naranjo cataract, but soon bent sharply westward in the first of a series of zigzags by which alone a cartroad can descend such a steep slope or "cuesta." The upper zigzags afforded magnificent views of the cañon and also enabled one to look into the tops of very tall trees whose bases were many feet below. Before this cartroad was constructed an old Indian trail or path led more directly down this slope. Much of it was still distinct and in spite of its steepness often used by pedestrians because, cutting across the zigzags of the road, it shortened the distance very greatly; it was also in deep shade. Much forest remained on the cañon sides, so that one plunged from the hot sunny cartroad into the grateful protection of tall trees loaded with beautiful epiphytes, and climbed among palms, ferns, arums and many plants allied to bananas and marantas whose gaily colored bracts lit up the green depths with brilliant red or orange flames. The lowest of the zigzags descended from west to east, and

on its left bank there issued from the hillside a spring of clear water where we often refreshed ourselves, in the shade of the roadside trees and bushes. The descent ended at a ford through the brown waters of the Naranjo where that stream reached the flood plain of the Reventazón. The road then for rather less than half a mile gradually approached the latter river and crossed it by a good iron bridge.

The Reventazón here was a stream some seventy-five feet wide, rather smooth just at the bridge but full of boulders and foaming rapids above and below it, and with a very swift current. It is subject to tremendous floods, as it drains a large mountain territory. Its elevation at this point was 2500 feet by our aneroid. Above the bridge was a well-wooded island a hundred yards or so in length. The greater part of the river flowed on the south side of this island so that the water in the northern arm was shallower and less turbulent. The river banks where they were not steep cliffs or slides were boulder-strewn, and in the crevices grew small palms and maidenhair ferns, while stretching above them were large begonias resembling the "beefsteak" variety but having stems four to five feet high.

A few yards before reaching the iron bridge there was, on the left side of the road, a waterfall about thirty feet high. Near it a trail led up the steep bank to the stream above the fall. The woods here were very thick and this trail extremely narrow, steep and slippery. In these dark shady nooks we took *Palæmnema*, *Cora* and other interesting dragonflies, and at the waterfall itself *Thaumatoneura*.

After crossing the Reventazón the road led into a thick plantation of "pejibaye" palms with long feathery leaves and bands of sharp black spines on the trunk. In July, plantains, maize, tobacco, pineapples and yuca were growing with the palms. Yuca (*Manihot palmata*) resembles

its near relative the castor oil bean but is feebler in growth and more reddish in color. Tapioca is made from its roots and the root itself is used as a vegetable, boiled like potatoes, and has already been mentioned as forming part of the bill of fare at Tierra Blanca.

Under the palms on one side was a hut in a little clearing trampled hard and bare and enclosed in a bamboo fence. The walls of the hut were cane stems set side by side as closely as possible and bound together with plant fibers. The roof, which ran up to a high peak, was thatched with leaves. There was no window or opening for smoke, which crept out through cracks in the thatch at one end. It was a picturesque bit, and we usually stopped to enjoy it. One day late in July as we passed, we met an exceedingly handsome Indian woman bearing a huge load of green tobacco leaves on her shoulders and back. Later we met her again returning to the river fields for more and had some conversation with her. By this time the clouds were gathering and she told us the rain was coming soon and would be very heavy. As it turned out, however, the rains did not come until after dark, so the native Indian does not invariably read the clouds aright.

An Indian family of father, mother, boy and two girls met us in the river bottom on June 28. The first was very friendly, took much interest in our collecting paraphernalia and captures and explained them to the others. We met them again as they were returning from the corn-fields which covered much of the flat land here and indeed some of the steep slopes also, each carrying a heavy sack of husked corn. The father presented us with several ears and would take no money, although he made no objection to our presenting each of the children with a little silver piece. The gifts made, the father added a few more ears, shook us each by the hand and we parted with profound "Adios." We

gave the corn to Miss R. who cooked some for us, but it was rather hard and not particularly sweet. Miss R. told us it was impossible to grow sugar corn here because as soon as it came above ground each shoot was cut down and carried off by the leaf-cutting ants.

The road to the Reventazón was much used by ox-carts and pack animals, but traffic was often interrupted by landslides, especially on the zigzags, and places where carts had passed one day were often impassable for them on the next. We first knew the road in June, but in July, December and February, slides blocked it, often in more than one zigzag. Sometimes the soil slipped down leaving clean rock but so gently that the bushes and young trees were undisturbed, still standing green and flourishing, in their normal vertical positions. Sometimes the destruction was wrought by slipping masses of soft rotten stone which uprooted huge trees and sent them down the slope like battering rams, ploughing through the lower zigzags and tearing up still other trees. On the upper zigzags it was often possible to climb over the displaced material blocking the road, but on the lower ones the whole roadbed was sometimes swept away, leaving gaps that were quite impassable for horses and both difficult and dangerous to cross on foot. Occasionally our feet dislodged stones and masses of earth and pebbles that went bounding down the hillside in an unpleasantly suggestive manner. The worst slide we saw was in February and was between two and three hundred feet high. The road was frequently repaired, however. When we went down on April 27 expecting it would be very bad as a result of rains and earthquakes (and remembering its condition on our preceding visits) we found the road cut through the slides. There had also been much clearing and cutting of trees on the sides so that the road was better than it had been for months previous.

There were also other trails, leading from the valley bottom up to the railroad east of the laguna. One of these began about two hundred yards west of the iron bridge and led up into fine forest. Still higher it left the woods and passed through low shrubs and tall herbs, at the same time becoming very steep although well-marked, until it suddenly brought me to the edge of a comparatively recent landslide with precipitous walls. However, it was easy to cut a way through the same sort of vegetation up to a point where the forest began again. This forest was for the most part not filled with dense undergrowth but there were ferns and low palms. There was no definite trail here and what looked like men's paths may have been natural openings. However, I had simply to keep going upward and was sure to reach the railroad. Finally after many steep climbs through the woods I came to a bank of strong coarse grass higher than my head, and pulling myself on top of the bank found that I was on the top of a very deep cutting through which the railroad passed. The high grass prevented my seeing well, but soundings with my stick showed that on all sides this bank was almost vertical. After making attempts on three sides and consuming the greater part of an hour I finally reached the tracks. Once I stopped for some purpose and momentarily let go of my stick, which immediately sank out of sight through the grass. I was unable to find it again, and I concluded from what I could feel with my feet and what I could see after I reached the track that the stick must have dropped down the precipitous side of the bank away from the tracks and that I had been on a narrow ridge only a few inches wide at the top and with nearly vertical sides thirty feet above the tracks and much more down to the forest on the other side, but whose precipitous character was concealed by the dense mat of grass. I reached Juan Viñas station just in time to prevent Mrs. Ridgway's send-

ing *the* policeman to hunt for me since it was growing late and dark—it was, indeed, no less than 6.45 P. M.!

Although there were patches of cultivated ground in the valley bottom, at other places the forest was still untouched and its appearance was very tropical, with its palms, big coarse ferns, wild plantains, lianas hanging from every tree and incredible numbers of perching epiphytes. Many big trees had huge buttresses. In places the earth had washed out from under the supporting roots, which writhed over the ground like monster snakes.

There were always many dead leaves on the ground. Our diary for September 29 expressly records that on that day there were yellow leaves on some trees, occasionally even a bright red one, but the great mass of vegetation was strongly green, with many tender green shoots on shrub and tree; the coffee plants showed their glossy dark green foliage and most of their berries were still green though some were reddening. On the other hand, the fields of maize were brown and withered.

On February 15 we noted that many of the large trees in the Reventazón cañon, particularly those bearing much *Tillandsia*, were leafless and putting out tiny young leaf buds. This gave the cañon sides a very different appearance from that of six months earlier, and the views of the river were more extensive than we had ever seen them. Both the Naranjo and the Reventazón were extremely full and correspondingly noisy. Along the road down the cuesta—indeed everywhere nearby—were wonderful gardens of begonias. In places the flowers formed masses yards across so that the cañon side was tinted white, pink or coral red with the profusion of blossoms, a most beautiful and striking floral display. There were at least four species in great abundance and all seemed to be at the height of their flowering at this time. At the end of April the num-

ber in bloom was noticeably less. Another beautiful February flower was a purple composite (*Vernonia* sp.) which bore long compound racemes of delicate feathery purple flowers. It grew six to eight feet high and was rather rank and coarse, but the blossoms were as delicate and dainty as could be. Growing in a little wet place near the Naranjo was the same red *Hibiscus* we had gathered in the laguna.

Almost at the bottom of the valley in a patch of forest rich in small palms our attention was attracted by a tree about fifteen feet high (*Symphonia globulifera*) with curious red flowers. We gathered some and on our return a peon on the road told us the tree was called "jorquito." The corolla of this flower is thick and fleshy, and completely fused; it has the peculiarity of falling off from the ovary as a complete, depressed ring about three-quarters inch across, with an opening of one-quarter inch. The coral-red buds were round and fleshy and looked like berries.

There were many birds in the Reventazón valley, some of which we heard without seeing. The dropping, three-toned call of the ant thrushes, heard on our first visit in June, became ever associated with this place. In June, and in still greater numbers in late July, swallow-tailed kites (*Elanoides forficatus*) were conspicuous—we have counted twelve at once. They are known to the Costa Ricans as "gavilan tijerilla" or "tijereta." These birds were about the size of crows, above mostly black, with a white head, pure white below. Their most striking features were the contrasting blacks and whites and the long, deeply forked, wide-spreading tail. They are consummately graceful birds, and their airy evolutions as they soared, turned, floated upward or downward, or circled in one plane with never a flap of their wings, formed a beautiful sight. The common zopilotes can likewise soar wonderfully but compared to these kites they seem heavy and clumsy. In late

September no kites were to be seen anywhere; in their stead were many swifts. On March 20 we saw the kites here again but none in late April.

In June and in September there was a handsome black woodpecker (*Cæphlæus lineatus scapularis*) with white shoulder straps and a large projecting red crest on its head, tapping on the tree-trunks and apparently finding some food. It was larger than a large pigeon but smaller than a crow.

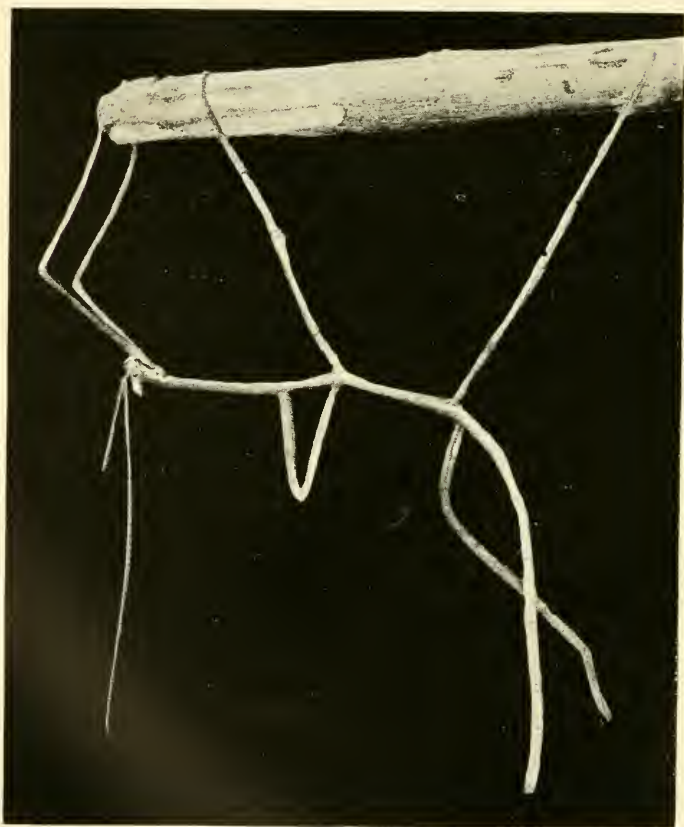
A mottled black and gray lizard (*Anolis* sp.) was resting on a log by the road to the lower Naranjo on June 28. Its body exclusive of tail was between three and four inches long. On the middle line of the throat was a thin fold of skin which could be inflated and when fully expanded reached at least an inch below the neck. This "dewlap" or gular pouch was bright orange in color and consequently quite conspicuous. The expansion lasted only for a fraction of a minute but was repeated at intervals. I tried to catch the lizard in my net for further examination but failed. For a few minutes I had in my fingers a similar but smaller lizard caught on a nearby stone; it had, however, no such "dewlap." Perhaps it was a female watching the charms which the male was displaying for her benefit.

In late April, usually hanging on damp rocks by the roadside, was a handsome snail (*Drymæus sulphureus citronellus*) about an inch long. The shell was a bright canary yellow, the foot blue-green, the "horns" dark greenish-brown.

Insects were not equally numerous throughout the year in the valley, February being the month when they were least apparent. On first going down to the Reventazón in June the forest was resonant with the loud shrill notes of the cicadas. The insects themselves were not easily seen. The note was not pitched quite as high as that of our annual cicadas in the United States but was sufficiently ear-splitting



Flowers of Jorquito, *Symphonia globulifera*.



Megalopygid caterpillar.
Wingless Walking Stick, *Bacteria* sp. $\times\frac{3}{4}$. (Both from life.)

and much more continuous. It did not give the impression of constantly increasing speed but was steady and uniform, and there were so many cicadas that the noise was deafening. In March the penetrating notes of a few cicadas seemed to indicate the waxing of insect life again.

Of all the butterflies the most conspicuous were the metallic blue species of *Morpho*. This genus is characteristic of tropical America and extends from Southern Mexico to Argentina. Some authors, like Godman and Salvin, consider it to belong to the Nymphalidæ, forming a special subfamily thereof, the Morphinæ. Others make of it and its allies a separate family, Morphidæ. Most of the species have a number of eye-spots, or ocelli, with a diameter of $\frac{3}{8}$ inch or less, on the under sides of the wings. Six species and subspecies are considered by Frühstorfer, the latest writer (1912) on the group, to occur in Costa Rica.¹ Their wing-expanse is from four to five inches. In Costa Rica *Morpho* extends from sea-level to an altitude of 3500 feet. We never saw them near Cartago, but occasionally one could be seen along the road leading upward from the station at Juan Viñas to the village. Their flight when undisturbed is an easy sailing with many a rise and fall over the tops of shrubs and bushes, but when alarmed they fly very swiftly. Many of the individuals one sees, except just after they have transformed into the winged condition, have the wings torn and tattered. On May 2, while I sat in partial shade at the little cascade west of the farther waterfall, a great blue *Morpho* which had several times sailed over the place, alighted on my knee. Its wings were rubbed and their edges ragged so that there was little temptation to

¹ Four of these species have the upper surfaces of the wings with more or less metallic blue: *M. peleides limpida*, *M. granadensis polybaptus*, *M. cypris cypris* (with a conspicuous band of yellow across the blue of both pairs) and *M. amalonthe centralis*. *M. theseus aquarius* has the wings rich brown, *M. polyphemus* white with a few black marks.

try to catch it; I sat perfectly still to induce it to linger as long as possible. Presently it flew quietly away and I did not see it return. Bits of the exquisitely blue, iridescent wings of *Morpho* are often mounted as pendants or lockets in the so-called "butterfly jewelry" and may be familiar to our readers in this form.

In places where *Morpho* was found we sometimes observed the great owl butterfly, *Caligo*. It is a member of the Brassoline subfamily of the Nymphalidæ and has the same geographical distribution as *Morpho*. It tends to fly more in the twilight or in shade. The upper surface of its wings (which spread from 4 to $5\frac{1}{4}$ inches in the five Costa Rican species) is rich dark brown with slaty blue or buff or orange. The under surface has numerous fine lines and streaks of various tints of brown and of yellow and a number of eye-spots. The eye-spot near the middle of each hind wing is the largest and is from $\frac{1}{2}$ to $\frac{5}{8}$ inch in diameter, its outermost rim being black, within which is a ring of yellow. It is to these two large eye-spots and their background of color that these insects owe their name of owl-butterflies.

Other conspicuous and characteristic butterflies both near the laguna and down the Reventazón road, were the narrow-winged Heliconiines, some members of which have been described in Chapter VI. Such were *Heliconius petiveranus*, with black wings, crossed by a broad orange red band on the fore pair, the hind ones having a narrower yellow band parallel to their front margins, and *H. charithonia*, whose black wings bear three yellow bands on the front pair, a band and two rows of small spots, on the hind ones. *Petiveranus* has a wing-spread of $2\frac{1}{2}$ inches, *charithonia* of $3\frac{1}{2}$. Four *charithonia* were sleeping on the roots of a tree, exposed by the washing away of the soil, by the roadside on April 27. Their wings were folded and hanging down, and so dormant were they that A. picked one of the group

off while the others only fluttered a short distance and returned to the same roots and same positions.

In April flocks or single individuals of a handsome butterfly, *Anæa onophis*, were abundant, particularly at wet spots along the road. The upper surface of its wings (which expanded $2\frac{1}{4}$ inches) was dark blue with pale blue spots near the outer margin. Each hind wing had a slender tail $\frac{1}{4}$ inch long. The under surface was colored brown and much resembled a withered leaf so that the insect was inconspicuous when at rest.

On June 25 our attention was attracted by small moths which settled on the rocks, both on the river bank and out in the stream, an inch or two above the water surface. There was no apparent cause for their positions, as in many instances the rocks were bare and are no doubt frequently submerged. On one rock in the stream about three feet long we counted twenty-five of these moths, facing in different directions. Their wings were bright orange, the outer margins broadly edged with black, and expanded about $1\frac{1}{4}$ inches. Mr. Champion observed the same stream-frequenting habit of this species (*Nelo chrysomela*) in the Chiriqui district of Panama.

At different times some curious or interesting caterpillars were met with along the Reventazón road. While A. was sitting on a rock at the ford of the Naranjo on June 25 she was startled by seeing walk toward her what looked like a miniature skye terrier about three inches long. It was a caterpillar (family Megalopygidæ) thickly covered with long silky hairs which on the front end of the body were brown. The hairs of the greater part of the body were whitish, beginning on the first abdominal segment and arranged in correspondence with the segments. The head and prothorax had no long hairs, so that the brown ones above mentioned were borne by the other two thoracic segments and

these hairs pointed forward as well as upward. The remaining white hairs were inclined upward, backward and toward the middle line of the body so as to give a "ridge-pole" effect along the back. As the creature walked these hairs separated into cross-rows, corresponding to the segments, and also opened down the middle line, exposing to view shorter, brown hairs lying within the white ones, by which they were concealed when the insect was at rest. In addition each abdominal segment had on each side a bunch of white hairs above and brown below; these bunches curved down to the surface on which the caterpillar walked, simulating legs. The hairs of the upper surface of the body were one-half to three-quarters inches long, of the side bunches shorter; all looked and felt soft and silky, nevertheless an incautious prodding produced a severe stinging in the finger, the pain lasting several hours. Next morning, after a long and tiresome siege, this caterpillar was persuaded to sit for its photograph.

Two days later two very curious caterpillars attracted our attention. One, with legs so short as to be invisible from the side, was pale green in color with thirty-four clusters of short blue-black spines arranged in four lengthwise rows; each cluster comprised two to twelve spines. Its body was plump and rounded at both ends so as to have the general appearance, or rather shape, of a pillow (family *Megalopygidæ*).

The other caterpillar was covered with hairs and flattened scales—red above the bases of the legs and over the head; above the red they were black for the whole length of the body as well as on the entire upper surface of the thorax; above the black a band of white scales extended along each side for the length of the abdomen, at the front end of which the white bands of the two sides united on the back. Finally the middle of the upper surface of the abdomen was

black except for the cross-band of white just mentioned. The creature looked almost as if made of variously colored plush and the colors themselves entitled it to be seriously considered as a national German caterpillar—if it had lived in Deutschland. It walked or crawled not continuously as most caterpillars do, but by jerks, with an appreciable stop after each forward jerk. There was a tuft of black scales at the hind end of the body; at the conclusion of one jerk this tuft was up, at the conclusion of the next it was down, so that the progression of this insect was not unlike that of a mechanical toy which is but partly wound up. We kept this caterpillar alive for several days, chiefly in a little wooden match box. On July 3 I had it out on the table while writing these notes and measured its rate of speed over a sheet of paper. In one minute it traveled 18 cm. (7.2 inches). It belonged to the family Eupterotidæ.

On one of the boulders on the bank of the Reventazón on March 20 was a caterpillar which had probably dropped from a tree overhead. It was not quite an inch long and its upper surface was generally gray. From each side of the body projected three somewhat twisted flat extensions, each nearly half an inch long and an eighth wide. Each one of these extensions was truly a part of the body and was covered with short hairs forming a dense pile. The middle of the upper surface was also covered with a short dense pile of darker blackish hairs. The head of the caterpillar was reddish-brown. When I first saw it I thought it was some sort of bag-worm and that the three extensions of each side were pieces of dry withered leaves which the insect had attached to its bag. Its legs were short as in the slug caterpillars (Limacodidæ or Cochliidæ) to which this species no doubt belongs.¹ This description is less accurate than I

¹ Our description of this caterpillar and its cocoon suggests the curious North American species *Phobetron pithecium*. The moth which emerged from the cocoon

would like, as it is based partly on memory; when I came to write it down on returning to our cabin I found that the caterpillar had begun the spinning of a cocoon in the box in which I had placed it. On the following morning it had completed its cocoon, using its own curious outer covering to serve as the outer covering of the cocoon.

Bag-worms do exist here, for on April 27 we found a number of small ones on a rock by the side of the Reventazón road. Their cases were about one-third inch long and closely resembled the lichens growing on the same rocks. Each consisted of an outer oval or ellipsoidal case enclosing an inner three-sided prismatic case, the latter containing the minute caterpillar, 4 millimeters in length. Both cases were of silk and both were open at each end; the inner was loosely moored to the outer by a few strands of silk passing from the three edges of the former to the inner surface of the latter. After death at least, the hind end of the inner case projected about one millimeter beyond the outer case. Attached to the outer surfaces of both cases were some fragments of plants such as seed-coats, chaff, an akene with its pappus, and also chitinous parts of insects such as the heads of small ants, prothoraces of beetles, wings and legs. Such cadaverous booty is attached to their own silken cases by some neuropteroid insects but is not often reported for lepidopterous larvæ, and it is difficult to imagine that the tiny builders of these bags could overcome ants which must have been as large as themselves. Can they obtain their trophies from the dead which they find in the course of their wanderings? We know nothing of the identity of these caterpillars, but one thinks of the insectivorous habits recorded for some of the tineids, the clothes' moth family.

was found two months later in a badly battered condition. The fragment resembles *Ph. pithecium* but is not identical; can it be *Euryda variolaris* of the *Biologia Centrali-Americana*?

Of the beetles (Coleoptera) which we found on the cañon side the largest and most striking was the Harlequin beetle (*Acrocinus longimanus*), well known in tropical America. Its larva, a thick white grub, bores into rubber trees and probably others also. It owes its name of "Harlequin" beetle to the bizarre markings, red, black and gray, of its elytra or wing-covers. Its front legs are immensely long, (14 cm. or 5.6 inches) and also the antennæ (15 cm., 6 inches) as compared to the length of the body (6.5 cm., 2.6 inches). Moreover the tibia of these legs is quite sharply bent whereby the grasping power is greatly increased. These peculiarities are alluded to in its specific name, *longimanus*. We found one lying on its back in the road on July 28 and kept it alive several weeks but were unable to induce it to eat anything. When we picked it up it produced a rasping sound resembling a file drawn over wood. On the middle line of the front part of the mesothorax is a patch of highly polished black chitin, which under the lens shows very fine cross-wise ridges or teeth. The back of the prothorax rubs over these ridges and so produces the rasping. On August 12 we photographed this beetle. During a previous attempt it bit A.'s finger but no ill consequences followed. On both occasions the beetle was exceedingly restless. On August 25 we chloroformed it and found many external parasites. Most of these were mites, several hundred in number, representing two species of *Uropoda* (*clavisetosa* and *bisetosa*) described by Mr. Banks as new. They were most abundant between the elytra and wings but were also on the upper surface of the body between the pro- and mesothorax. Two pseudoscorpions (*Chelanops nodulimanus*) were on the upper side of the abdomen below the wings, resting on a small silken web as wide as the abdomen, which presumably they had spun. A third pseudoscorpion was found on the cotton holding the chloroform and probably came from the same place.

A beetle of quite unusual form, found in the Reventazón valley on July 28 was *Tauroma casta*, of the Cassididæ (Chrysomelidæ). It was half an inch (13 mm.) long, bright metallic green in color and had very fine punctures, not visible to the naked eye, on the prothorax and large coarse black punctures on the elytra. Projecting from the anterior outer angle of each elytron was a stout process, one-third as long (4 mm.) as its entire body, curved upward. What can be the function of these elytral processes—if they have any?

A familiar beetle was the gray blister beetle *Epicauta cinerea*, which occurs over the United States east of the Mississippi, through Mexico and Central America to this valley, where we obtained it on June 23.

On February 17 a peon who met us on the Reventazón bridge presented us with a large live Buprestid beetle 6.5 cm. long, of metallic green, rose, and purple colors (*Euchroma goliath*). We photographed it two days later, the creature proving very sluggish. This species is found from Mexico to Colombia. On April 28 numerous beetles, particularly longicorns and passalids, were flying about although we saw no very large species.

One day in July a large reddish spider suddenly ran across the road, followed at a distance of six inches by a black wasp with a yellow spot on its head. The spider doubled and twisted, and hid behind stones; the wasp followed every move, rising on her wings when the spider disappeared. At length she touched the spider with her antennæ, when the spider wheeled and struck at the wasp with her front legs, then hurried off in the interval of the wasp's rising. The chase lasted several minutes, then the spider got under a stone and the wasp, at fault, hovered over the place with quivering antennæ, frequently alighting to search the ground but unsuccessfully. Here we interfered by lifting the stone



Euchroma goliath x1.4 (From life).



Harlequin Beetle, *Acrocinus longimanus*. $x\frac{1}{2}$ (From life).

and exposing the spider which happened to be turned upside down. The wasp discovered it as it struggled to turn over and after some cautious feeling about managed to plant its sting into the spider's ventral surface, almost between the bases of the legs. This disabled the spider and the wasp then stung it repeatedly over almost its entire body. Twice it left the spider and rested on a nearby stone, then returned to sting it again and again. At last the spider was limp enough and the wasp gathered it up between her legs, turning the bulky victim over and over, and then tried to fly off with it. The spider was too heavy to be easily lifted and as the wasp struggled a train of packmules came along obliging us to move; this frightened the wasp away.

On the under side of a large rock overhanging the side of the road was a hymenopterous nest covered with a gray papery substance closely resembling the rock in color. This cover was flattened, the nest occupying a concavity in the rock. One July day we stopped to examine it. Cautious lifting of one edge revealed a little stalked comb of several (6-12) cells within and some yellow wasps (*Chartergus smithii*) who came out to see what the fuss was about. They were little more than one-quarter inch long and had but a short petiole or waist; they belonged to the social wasps (Vespidæ). They were very polite, giving us no trouble when we lifted the floor of their house.

A nest of a different kind was found in April, consisting of mud built around a root exposed by the washing away of the roadside. It was pear-shaped, two and three-quarters inches long and two inches wide at most. In the mud, at unequal distances, were thirty-one cells, some empty, others capped with a cement of different color from the mud. We cut the root across above the nest and brought the latter away with us. On May 16 we found a live black and red wasp half an inch long in our stateroom on the "Prinz Joa-

chim," which we supposed to have come from this nest. After our return to Philadelphia we took a dead wasp out of one of the cells, similar in size, shape and color pattern to that of May 16 but with yellow replacing the red. Both of these wasps had a long slender waist and belong to the species *Zethus histrionicus*, of the potter wasp family. The black and yellow one, which certainly came from this nest, closely resembles in size, shape, colors and pattern the social wasp *Polybia fasciata*, which we obtained in March at Cachí. *Zethus* is a solitary wasp, that is, there is no coöperation among the adults in building their nests or caring for their young. It is a curious fact that, among the true wasps (those whose fore wings are folded lengthwise) the solitary or social habit appears to be correlated with a structural peculiarity whose relation to these habits is still unperceived. In the solitary forms the claws terminating each leg have a tooth before the tip, which does not exist in the social species. We know that certain small parts of the legs of the honey bee perform certain definite functions and it may be that more intensive future study of the habits and modes of work of wasps will show that these teeth have a definite relation to the development or non-development of social life. But for the present, these anatomical details are merely convenient indexes to the nature of the lives of these industrious little artificers. In addition to this difference in the claws which distinguishes the Vespidæ (social) from the Eumenidæ (potter wasps, solitary), our *Zethus* has relatively coarse punctures over much of the body, which are absent or but feebly developed in *Polybia fasciata*.

In March an immense paper-wasps' nest, high up in a rather isolated tree near the Reventazón bridge, harbored an active colony. It was as large as a man's body, balloon-shaped and with an opening below through which the insects were entering and leaving.

A very large and handsome ichneumon fly (*Thyreodon laticinctus*) was captured in October, flying in the forest at the bottom of the valley. Its body was more than an inch long, shining black with a bright yellow band across the abdomen, while the wings were brilliant metallic blue.

A curious katydid (*Ischnomela impennis*) quite fooled us when we found it in the woods within a long, partly folded leaf on our June visit. Its jumping legs, 66 mm. (2.6 inches) long, were stretched straight behind, its first pair, 28 mm. (1.1 inches), straight in front, giving A. as a first impression that the creature was a gigantic member of that spider group which possesses a long narrow abdomen and legs held in similar positions (*Tetragnatha*).

A month later, while striking at a dragonfly in these woods, P. accidentally caught a large green wingless walking stick, a species of *Bacteria* allied to *bicornis*. It had a pair of curved yellowish horns on its head, one just behind each antenna, which increased its grotesque appearance. Its body and legs were so soft and flabby that it was almost impossible to handle it without feeling it "give" between the fingers. We thought it full grown, but it moulted in the night, increasing in length to $5\frac{1}{3}$ inches, but was still wingless. A week later we photographed the creature, which hung like an insect sloth from a twig. The walking stick with beautiful rose pink wings (*Pseudophasma menius*), which we occasionally took at the waterfalls, was more common in this valley. Its body was dull brown, two inches (50 mm.) long in the male, two and two-thirds inches (67 mm.) in the female, and lacked the cephalic horns.

Many times, when we reached the ford of the Naranjo in the valley bottom, instead of crossing it and continuing toward the Reventazón bridge, we would turn off to the right into the forest until we reached a little brook which glided with a hardly perceptible current through very deep

shade. Here came the fairy humming-birds to bathe, flying through the water repeatedly at our very feet and after each dip perching on a branch not a yard away to shake their glittering feathers. Here, too, we often found two species of dragonflies whose habit it is to live along just such deeply shaded streams, *Heteragrion erythrogastrum*, whose male has a bright red body 45 mm. long and *Protoneura remissa* with a thread-like body 34 mm. long. In the latter the only visible parts are its red eyes and a small blue spot near its hind end.

In this part of the forest and at various points along the Reventazón road, we saw, at different times, three species of an extraordinary group of dragonflies, the Anormostigmatini, confined to tropical America. They are recognizable by the great length (two to five inches) and extreme slenderness of the abdomen, by the front and hind wings being long, narrow and of equal size and by the stigma (or colored spot on the front edge of each wing near its tip) being divided by cross-veins into several minute areas or "cells," instead of constituting but one cell as in the great majority of dragonflies. The largest of these three species was *Megaloprepus cærulatus*, described in Chapter XV. It is chiefly an inhabitant of the lower country, and an individual observed on September 29 near the upper end of this road at about 3000 feet, had reached the highest elevation in Costa Rica at which we ever saw this species. The second in order of size was *Mecistogaster ornatus*, whose body length was 3 to 4 inches (75-100 mm.) and wing expanse $3\frac{3}{5}$ to $4\frac{4}{5}$ inches (90 to 120 mm.). Each wing-tip inward for 5 to 8 mm. was greenish-yellow, bright yellow or orange. Its area of distribution is from Vera Cruz and Durango States, Mexico, to the Amazon valley. The third species was *Mecistogaster modestus* with a body 3 inches in length and a wing-spread of $3\frac{2}{5}$ to $3\frac{4}{5}$ inches. The wings were

colorless except for the small white, rosy or pale brown stigma. It has been found from the State of Vera Cruz, Mexico, to Panama.

When flying, the bodies of these insects are extremely inconspicuous. An old man, near the Rio Buena Vista in Nicoya, told Professor Tristán that Mecistogasters were not "pipilachas" or dragonflies at all but human spirits, because they have not head or body, only wings! When a person dies the spirit (soul) begins to fly for some days in the woods and nobody can disturb it.

CHAPTER XIII

JUAN VIÑAS—THE TENANTS OF BROMELIADS

Up to the time of our arrival in Costa Rica the larvæ of these large Anormostigmatine dragonflies, referred to in the closing paragraphs of the preceding chapter, were unknown. Mr. O. W. Barrett, who collected for me in Mexico in 1897 and 1898, made the suggestion¹ that possibly their larvæ lived in the large water-retaining bases of bromeliads. Remembering this we had looked for dragonfly larvæ in some bromeliads near Cartago, without success. Indeed there is as yet no reason to think that species of *Mecistogaster* or *Megaloprepus* exist there, the altitude being perhaps too high. Mr. Frederick Knab, of the U. S. National Museum at Washington, wrote us under date of August 5, 1909, "In the course of my mosquito work in the tropics I investigated the water between the leaves of the epiphyte Bromeliaceæ and found that besides mosquito larvæ there was a rich insect fauna. The winter of 1907-8 was spent at Córdoba, Mexico, and there I found that nearly every bromeliid investigated contained dragonfly larvæ. I was not prepared to rear Odonata but I finally did succeed in breeding out a couple of rather large, unfortunately crippled, Agrionids." Mr. Knab's letter determined us to make more persistent search in the bromeliads of the warmer parts of Costa Rica.

The pineapple is the most familiar example of this family of plants but many of the other members are epiphytic. Such are the Tillandsias, or Spanish mosses, which form long gray-green festoons both in tropical and sub-tropical

¹ *Entomological News*, XI, p. 601, Philadelphia, November, 1900.

America. Other epiphytic bromeliads of Costa Rica, which in general appearance are more suggestive of pineapples, are of the genera *Androlepis*, *Aechmea*, *Billbergia* and *Pitcairnia*. Collectively they range from sea-level to the craters of such volcanoes as Irazú (11,000 feet), but they are much more abundant in the moister parts of the country. Sometimes they are situated close to the ground; frequently they are attached to an unbranched trunk thirty or forty feet from the soil, or may be lodged among the branches at a still greater height. Their narrow leaves, often two feet or more long, taper gradually to near the tip; they are toothed or spined on their edges and in color a bright green or a beautiful pink or red. The leaves spring from a very short stalk so that their bases are pressed closely together. As a rule a number of stocks grow side by side on the same host tree, whose trunk or branch they may completely encircle, and as the stocks may also be attached to each other it is not easy to separate one individual plant from its fellows. The leaves diverge from their bases and either stretch up stiffly for their entire length or droop gracefully near the tips; owing to their stiffness and their serrated spiny edges they must be handled carefully to avoid scratched and bleeding hands.

On October 3, P. examined some of the more accessible of these plants on the Reventazón road. The first was quite a thick clump, not more than eight feet above the ground with many vines growing about it. I threw a rope, weighted with a stone at one end, over it and by pulling on both ends brought the whole mass to the ground much more easily than I expected, leaving the tree-trunk to which it had been attached quite clean. Some large, black, rather slender ants (*Odontomachus hastatus*) appeared very soon after the mass fell. They were 15 mm. ($\frac{5}{8}$) inch long and had long slender jaws bent near the tip; as they ran about

they carried these jaws wide open, at 180° , so that the tips were nearly a quarter inch apart and when they closed them, as they did in a mechanical sort of way with a sudden snap, there was a distinctly audible click. I do not doubt that these ants can inflict a painful bite, although I did not experience it.

I cut across each leaf near its base, beginning at the outside of the clump and working in toward the center, so that I could see whatever might be lodged between the bases of the leaves. When the mass of plants first fell, considerable water ran out from between the leaves, derived of course from the rains. In all the bromeliads examined this day there was also much mud between the leaves, especially the outer ones, as well as dead leaves which had fallen from above or perhaps been carried in by winds.

The second bromeliad examined was lying on the ground at the bottom of the Reventazón valley, still attached to its host tree with which it had fallen. The third was near the second on an upright tree, but although I got the rope over it I was unable to dislodge it, pulling with all my strength, and as I shook down a great many of the *Odontomachi* I had some doubts whether this plant would have yielded many other insects. The fourth and last was in the forest about 200 feet above the river, perched on a tree-trunk ten to twelve feet above ground. The unavoidable shaking, produced by my repeated attempts to throw the rope over it in just the right spot, brought down a few small ants (*Apterostigma*) but none of the larger *Odontomachus*, which I took to be a favorable indication. After half an hour's tugging and pulling the mass, consisting of three plants and weighing surely not less than fifty pounds, fell to the ground. I cut off the leaves as before and soon found a dragonfly larva between two leaf-bases not far from the circumference. In an hour's further searching no other such larvæ were

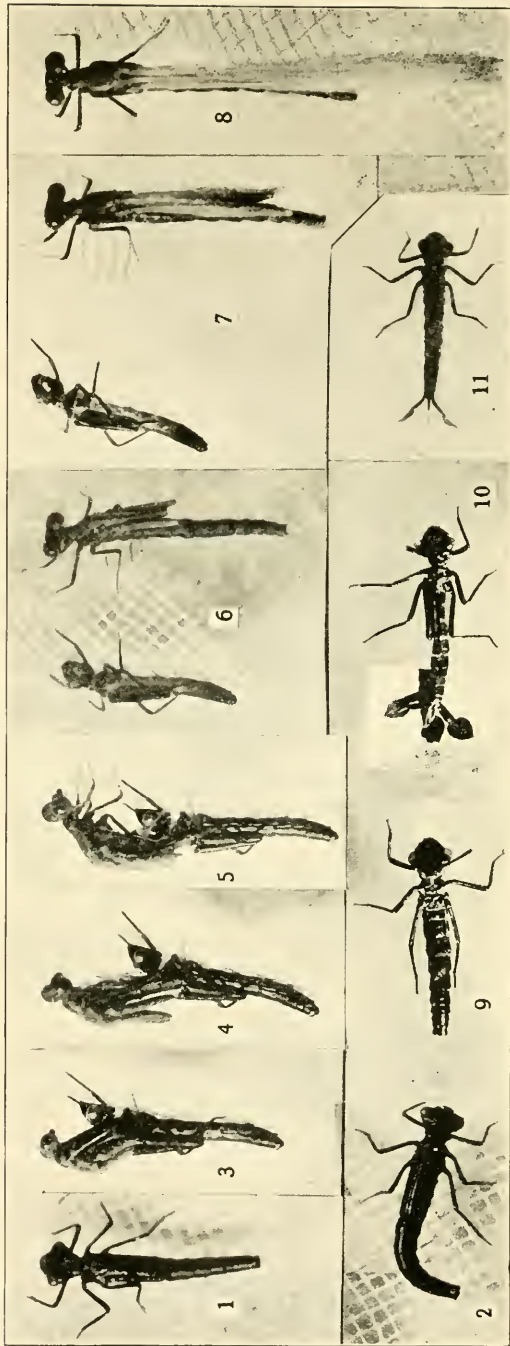


1. Beetle (*Pachyteles seriatoporus*) from bromeliad, Juan Viñas, $\times 3\frac{1}{2}$.
2. Fore leg of same showing Antenna-cleaner, $\times 14$.
3. Walking Stick (*Ceroyx bigibbus*), Peralta, from life. Nearly life size.
4. Caterpillar (*Castnia?* sp.) from bromeliad, La Emilia. $\times 2\frac{3}{4}$.

LARVA NO. 55

FROM
LARVA NO. 59
APRIL 4, 1910
9.05 A.M.

APRIL 4, 1910.
9.10 A.M. 7.25 A.M. 7.27 A.M. 7.40 A.M. 7.44 A.M. 7.51 A.M.



LARVA NO. 55
APRIL 4, 1910. 9.20 A.M.

EXUVIA OF
NO. 55

EXUVIA OF
NO. 57

NO. 57
MARCH 2, 1910

10.46 A.M.

10.46 A.M.

10.11 A.M.

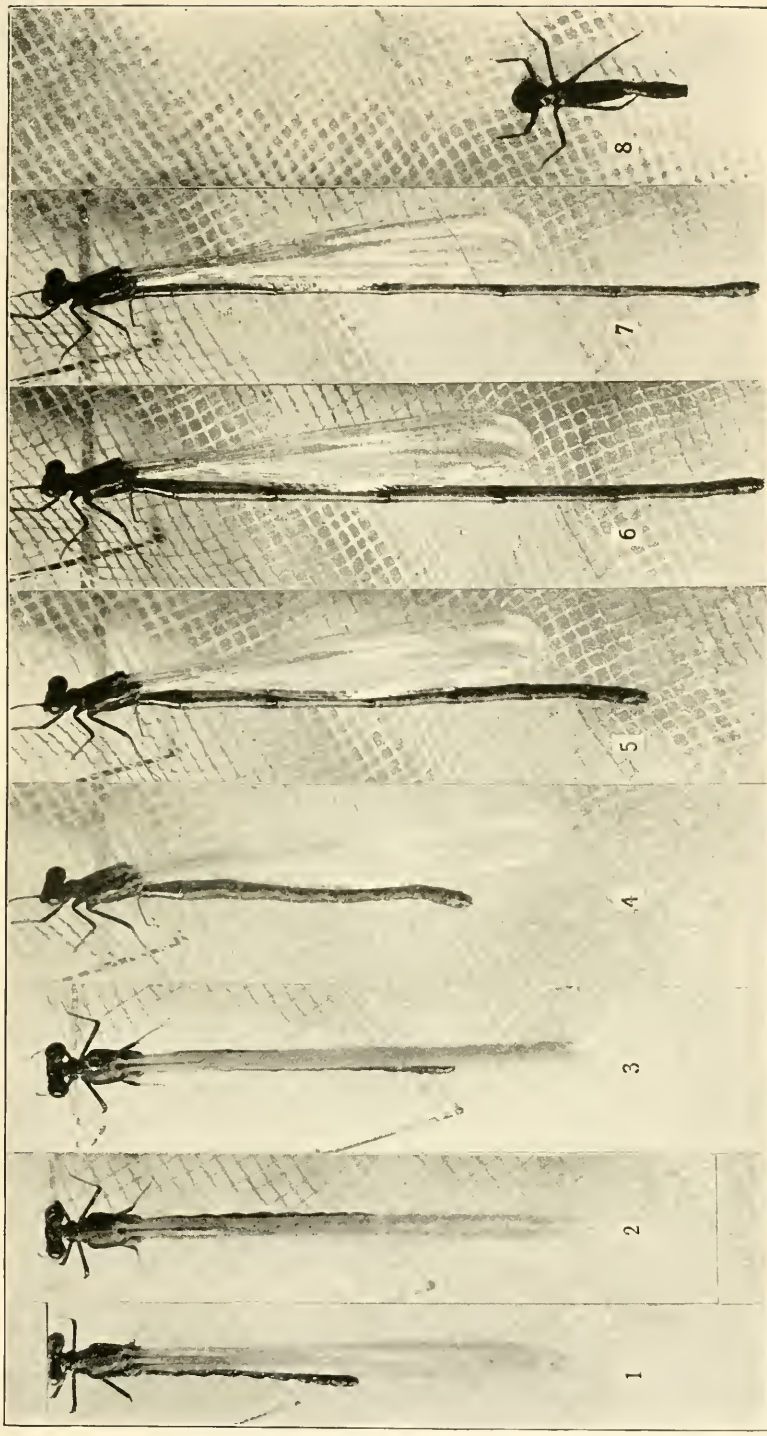
9.58 A.M.

9.48 A.M.

9.45 A.M.

9.20 A.M.

9.10 A.M.



The Transformation of *Mecistogaster modestus*, XI.2.



Bromeliads on a Branch of Poró, Cartago.

Ants. 1. Queen, 2. Two Workers of *Apterostigma calverti*, Banana River region. x6. 3. *Odontomachus hastatus*, Juan Viñas, x3.

found and there was so much still to be examined that I left the plants where they had fallen, and resumed the cutting off of the leaves the following morning. When all the larger ones had been removed I carried the three stocks, still so firmly united that I was unable to separate them and weighing some fifteen pounds, to the spring farther down the cañon side so that I could wash out the mud and make more careful search. At noon—after three hours' constant work—I finished the examination and had found two more dragonfly larvæ. These larvæ were kept in bottles with a few bits of bromeliad leaves added to make the surroundings homelike. All reached Cartago alive, but the one found October 3 died when attempting to moult on October 7; one of the others died from some unknown cause, while the third lived until December 30-31. They were fed, and seen to eat, smaller dragonfly larvæ and blood-worms.

All four bromeliads examined were inhabited by some animals. The fourth, besides containing dragonfly larvæ, was tenanted by a young scorpion two inches long which had just shed its skin, the latter also found; several species of daddy-longlegs (Phalangids), and of Pseudoscorpions; the latter are like miniature scorpions but without the long slender hind abdomen. The Pseudoscorpions have a pair of relatively long fore limbs (pedipalps) ending in claws like a crab's and as the creatures ran or walked over the surfaces of the leaves they held these pedipalps stretched wide apart as if to embrace whatever they met. There were also several species of beetles, both adults and larvæ; certain of the latter seemed especially well adapted to life between the appressed leaves of the bromeliad, for although the larvæ were one to one and one-half inches long and a quarter inch or more wide, they were relatively thin, less than one-eighth inch. These are believed to be the larvæ of *Semiotus*, one of the click-beetles (*Elatridæ*). A caterpillar, perhaps of the moth

Castnia, also lived in this plant, and in the mud between some of the leaves dwelt a fair-sized earthworm (*Andiodrilus biolleyi*), quick in its movements and with a peculiar smooth proboscis which was frequently thrust out and looked like a spine.¹

In the first and second bromeliads were also a large scorpion six inches or so in length, which continually got away from me into the deeper recesses so that I had but momentary glimpses of it; round beetle larvæ of the "June bug" style, a species of snail (two species if the owners of empty shells found also lived here), earwigs, smaller ants, isopods, collembolans and a smaller species of earthworm.

Most of December 17 was spent in the Reventazón exploring bromeliads. Some we tried to reach were perched too high, as we discovered when we attempted to throw the rope around them. But we did succeed at last in pulling down a big one, although it took all our combined weight and strength, and were rewarded by finding seven or eight dragonfly larvæ of different sizes. This bromeliad, among other animals, contained a few of the black *Odontomachus*, so that their presence does not necessarily preclude the existence of dragonfly larvæ in the same cluster of plants. We found the bromeliad examined on October 3 lying on the ground where it had fallen and when we tapped upon it, out rushed these ants. They had not been disturbed in their housekeeping by having their house turned upside down.

Other bromeliads in this valley which we examined in March contained no dragonfly larvæ but many planarians (*Rhynchodemus bromelicola*), flat worms 20 mm. ($\frac{3}{4}$ inch) or more in length, striped lengthwise with black and dull yellow.

¹ For further details see *Entomological News*, XXII, p. 405, Philadelphia, November, 1911, and the *Entomologists' Monthly Magazine* (2) XXIV, pp. 2-5, London, January, 1913.

Early on the morning of April 4 we noticed that one of our bromeliadicolous dragonfly larvæ collected on December 17 was climbing up out of its tumbler, which act, together with certain recent changes in the coloring of parts of its body, suggested that it was about to transform. The eyes, the upper surface of the thorax and the tips of the wings had become yellow and a yellow spot had appeared on the middle of the under side of each abdominal segment, the rest of the body remaining a dull brown or reddish-brown. The tumbler contained a little water and a small bromeliad plant with root and leaves entire, about 12 cm. high, gathered near Cartago and replaced from time to time as it withered or decayed, also a little stick on which the larvæ might climb, as an additional piece of furniture. This larva repeatedly tried to climb up the smooth glass side of the tumbler, applying almost the whole under surface of its wet abdomen to the glass. It would reach to a height of two or three inches and then fall to the bottom of the tumbler but immediately begin climbing on the glass again, even though it touched the stick or the bromeliad. We helped it then by tilting the tumbler so that it reached the netting covering the top and to this it clung with its legs. The netting with the larva still clinging to it was pinned up so that we could photograph the successive changes. The transformation began at 8.15 A. M. and full size was attained by 10.46. The adult dragonfly, a female *Mecistogaster modestus*, remained on the netting until 1.53 P. M., then made its first flight to the window, where it was captured and put into a large paper bag or "cage" to perfect its colors.

A second bromeliadicolous dragonfly larva transformed at Cartago on the morning of April 6, beginning about 7.20, and was similarly treated. From the two larvæ we obtained the practically complete series shown in the accompanying illustrations. This larva transformed into a male *Mecis-*

togaster modestus. Both had lost, weeks before, the three conspicuous gills at the hind end of the abdomen, while other larvæ of the same species apparently about the same age and from the same bromeliad at Juan Viñas still retained the gills. Absence of these organs seemed to make no difference in the transformation of the former two individuals, which accomplished this feat perfectly.

This and other bromeliad-dwelling larvæ had been kept in captivity, under the conditions we have described, for nearly four months. They had been fed with blood-worms, but although we did actually see them swallow some of the worms they never seemed to eat many. Compared with other dragonfly larvæ, they were very abstemious and we could not see how they obtained enough nourishment to carry them through four months and a successful transformation at the end.

In the afternoon of April 26 we walked along the railroad from Juan Viñas station to a fresh clearing planted with beans. Here the ground sloped more gradually than in many parts of the bank below the railroad, and on the edge of the clearing was a tree with some large bromeliads that seemed to be accessible. So thither we went with our rope and big knife, pail and bottles, to secure the vast horde of *Mecistogaster* larvæ that ought to be living there. Arrived at the bean patch we found a man busily weeding and asked his permission to go through, which was readily granted. We worked all afternoon on the various clumps of bromeliads and found a few larvæ of *Mecistogaster*, with an accompaniment of mosquito larvæ, spiders, cockroaches, slugs, planarians, earthworms, and the big-jawed black ants.

On April 28 we passed the remains of the bromeliad cluster which yielded the larvæ from which *M. modestus* transformed in our room at Cartago on April 4 and 6. A single male of this species was sitting on the tip of a leaf and was easily

caught. Around bromeliads of a different species two females of *M. modestus* were fluttering and alighting, and although we did not see them making any motions of oviposition one of them disappeared into the leaf-bases as if she might be on such an errand. On the outside of one of the yard-long leaves, about six inches from the apex, was a shed larvæ skin which we secured. On May 1 a female of *modestus* was transforming on the outside of a leaf on this latter cluster and P. secured both her and her exuvia. These observations show that in spite of unnatural surroundings and perhaps lower temperature our larvæ at Cartago were not retarded in their development as compared with their free relations in their native forest.

After our return to the United States Mr. Knab sent us the fragments of the two dragonflies which he bred from arboreal bromeliads. These fragments, of adults which had transformed at Córdoba, Mexico, in April, 1908, proved to be also *Mecistogaster modestus*.

The origin of the bromeliadiculous habit of the larvæ of *Mecistogaster modestus* may possibly be accounted for in the following manner. The majority of the species of *Mecistogaster* are South American and some of them occur along the Amazon, where also are the headquarters of the Bromeliaceæ. As is well known, "thousands of miles of forests" along this river are inundated each wet season, so that a person "will travel through this forest for days, scraping against tree-trunks and stooping to pass beneath the leaves of prickly palms, now level with the water though raised on stems forty feet high" (Spruce, Wallace). At such periods of high water, epiphytes, whether of the Bromeliaceæ or of other families, would often be just at the water's surface, or only slightly submerged, and would offer to dragonflies quite ordinary and usual places of oviposition. An association with certain plants might thus be formed by

Mecistogaster or its ancestors which would persist even when the water-surface was much below the level of the epiphytes. Only such plants as could retain water for long periods of time (weeks and months) would permit the development of essentially aquatic larvæ and the water must be renewed from time to time. Once the association of this insect with bromeliads or any other suitable plant was formed it might persist with the spread of the insect away from the regions of deep yearly inundation,—the Amazon or wherever we conceive its possible origin to have occurred—to the forests at Juan Viñas where the trees which harbored our larvæ were far, far above the highest flood marks of the Rio Reventazón. *M. modestus*, *M. ornatus* and *Megaloprepus coeruleatus*, as we saw them in Costa Rica, usually fly above the underbrush and when disturbed rise many feet above the ground.

Although all dragonflies have the abdomen in the winged stage much longer than in the larva, *modestus* and, very probably, all Anormostigmatini are extravagant in this regard. In one *modestus* the fully extended adult abdomen alone was 71 mm. long while the whole body in its larval condition was but 20 mm. The abdomen of the adult *modestus* is from $5\frac{1}{4}$ to $5\frac{1}{2}$ times as long as that of the abdomen of the exuvia which it has just left, while in no other Zygopterous species with which we are acquainted is the corresponding figure more than $4\frac{2}{3}$. In this latter case (*Philogenia carrillica*, whose larva is not bromeliadiculous) the adult abdomen is 42 mm. long as contrasted with a minimum of 63, for our Costa Rican *modestus*.

The excessively long abdomen of the adults of all the Anormostigmatini may be a special adaptation to the life of their offspring in water-containing plants, since the abdomen of the larva of *M. modestus* is no longer, proportionally, than in other Agrioninæ. The space between one leaf of a

bromeliad and the leaf next without decreases downward and if *Mecistogaster's* eggs are deposited in the plant tissue in or near the contained water in accordance with the habit of Zygopterous dragonflies, it would often be necessary for the female to reach far down into crevices possibly too narrow to admit of the entrance of her thorax and wings. The long abdomen with the ovipositor near its hind end would therefore be of distinct advantage and it will be a matter of great interest to ascertain, by future observations, if the lengths of abdomens seen in various members of the Anormostigmatini are correlated with peculiarities in length in the plants or other objects in which they oviposit.

The abdomens of the males of the species of *Mecistogaster* are as long as or longer than those of the females. Their length of course cannot be explained in the way suggested for the females, but is possibly due to the necessary correlation in length which must exist between the two sexes to enable them to assume the characteristic mating position.

In describing our discovery of these peculiar dragonfly larvæ we have incidentally mentioned some of the other animals which were living in the bromeliads. In addition to the plants of this family examined at Juan Viñas, La Emilia, Cachí, Cartago and the crater of Irazú also furnished interesting bromeliadicoli, although none of the dragonfly group. The favorable character of bromeliads as shelters, or as sources of food, for animals is indicated by the fact that the cluster from one height on a tree at Juan Viñas, which has been designated the "fourth bromeliad" yielded 25 species associated at one and the same time, although one of these species was an external parasite on the body of a beetle. These 25 species were distributed among the following groups: Insects: 18 species (of 15 genera, of 14 families, of 7 orders, Orthoptera, Odonata, Heteroptera, Coleoptera in the majority with 11 species, Lepidoptera, Hymen-

optera, Diptera); Arachnids: 6 species (of 6 genera, of 4 families, of 4 orders, Scorpioni, Pseudoscorpioni, Phalangida, Acarina); Annelids: 1 species.

Of the beetles which we found in bromeliads at Juan Viñas the most interesting in structure was the carabid *Pachyteles seriatoporus*, because of its possessing, on its first pair of legs, organs suggesting the antenna cleaner of the bees and ants. In the latter two this organ is formed by the tibia and first section of the tarsus of the first leg, the first tarsal joint bearing a semicircular notch lined with a row of stiff hairs, while at the tip of the tibia is a spine which holds the antenna in place as it is being drawn through the tarsal notch. In *Pachyteles seriatoporus* the semicircular notch is located at mid-length of the tibia and is bounded by a grooved and pointed process of the under surface; the grooved floor of the notch runs obliquely across the tibia and is smooth and polished on its forward end while its hind edge is guarded with a row of close-set, short hairs. On the under surface of the femur at mid-length is a strong, slightly curved, tapering, sharp spine, so placed that when the tibia is flexed upon the femur the spine of the latter would guide the antenna and hold it from slipping out as it was drawn through the tibial notch.¹ *P. seriatoporus* is three-fifths inches (15 mm.) long, uniform shining brown in color, and has antennal joints 5-10 almost square, 1-4 and 11 more elongated.

The Costa Rican naturalist, Señor C. Picado, has published in Paris (1913) a thorough and detailed study of the epiphytic bromeliads and their fauna. He groups the members

¹ Prof. L. C. Miall has recorded in his *Natural History of Aquatic Insects* (second edition, London, 1903, pp. 376-378) some observations and experiments by Mr. W. F. Baker showing that many Carabidæ possess and use a similar antenna-cleaner. No spine on the femur, such as we describe for *P. seriatoporus*, is mentioned, however.

of the latter as: 1. Those which attack the plant itself, 2. Those which feed on the vegetable debris and the fungi which develop there, and 3. Predaceous animals. He has brought together a long list of about 250 species included under these three categories.

The inter-relations of members of these different elements are interestingly shown by our "fourth bromeliad." The ants brought from it were described by Prof. W. M. Wheeler as a new species, *Apterostigma calverti*, of which we had also other specimens (although not from a bromeliad), together with fragments of their nest, from the Banana River district, in early November. We had suspected these latter to be fungus-growing. Professor Wheeler wrote of them, "As you surmise it is a fungus-growing ant of the most primitive and, at the present time, most interesting genus of Attii. No species of this genus has ever been taken in Bromeliads. All of the known species have been described from cavities in rotten wood where they build a peculiar fungus-garden using caterpillar excrement as a substratum, and enveloping the whole garden in a mycelial web, which is not known to exist in any of the other genera of Attiine ants. Your species is very dark in color, all the other forms being yellowish or brownish. The sculpturing of the thorax is more pronounced and the head of a different shape." In his technical description of this ant, whose workers are 3.5-4 mm. and females 4.5 mm. long, he states: "Fragments of one of the fungus-gardens, preserved in alcohol with the ants, seemed to present the same primitive development of the hyphal swellings ('ambrosia') growing on a substratum of insect (beetle?) excrement as described by Møeller for some of the South American species of *Apterostigma*." We have made no direct observations on the nature of the fungus-garden of *Apterostigma calverti* in the bromeliad; but in view of Professor Wheeler's statements it is apparent

that the excrement for the growth of the fungus may well be furnished by the caterpillar or by some of the beetles which were found there. This affords, then, a glimpse of the food dependence of a member of the second group on those of Señor Picado's first group.

The predaceous members, like their non-bromelia-dwelling relatives, do not hesitate at cannibalism. The alimentary canal of a larva of *Mecistogaster modestus* taken on April 26 contained a smaller larva of the same species, a mosquito larva and a copepod crustacean. Larvæ of mosquitoes of the genus *Megarhinus* have been found both within and without bromeliads and are known to feed not only on other mosquito larvæ but also on their own species.

Of all the elements composing the bromeliad fauna, the first is likely to prove most dependent on the host plant. It remains to be determined how far the members of the second and third elements are limited to bromeliads. Mr. Knab believes that the beetle larvæ of the family Cyphonidæ inhabiting bromeliads are distinct species from those which breed in tree-holes and adds, "My belief, in the meantime, gains some support from the fact that the Diptera breeding in the Bromeliads have been found to be, almost without exception, confined to this habitat."

Señor Picado has likened the totality of the epiphytic bromeliads to a great interrupted marsh extending throughout tropical America. Noticing the purity of the water retained between the leaves where one would expect foulness from the decomposition of the organic material, he made some chemical researches and experiments from which he obtained highly interesting results. The bromeliads produce a gum which has a digestive action on starches and on nitrogenous materials (albuminoids). The products of the digestion of the vegetable and animal detritus retained

between the leaves, as well as mineral salts, are absorbed by the plant. A bromeliad is thus a veritable dialyzer which constantly removes from the pools formed between its leaves all the products of decomposition.

CHAPTER XIV

TURRIALBA AND PERALTA

In our second chapter, on Costa Rican railroads, we have referred to Turrialba as the "pineapple station." Our first visit to it was on July 24, 1909, when in company with Professor Tristán P. went there from Juan Viñas. We went first to an acquaintance of Professor Tristán's, A. Alfaro, whose shop was in the lower story of one of the few two-storied buildings. Turrialba was built entirely of wood; the houses were chiefly shanties or a little better, many of these occupied by Jamaican negroes. One of the cabins was used as a jail in which two men were confined over Sunday and Monday for drunkenness—released on becoming sober and paying a fine or "multa," part of which went to the support of the school. A better-built but one-storied house was labeled "Alcaldia," the magistrate's court, while "Tesoreria Municipal" was the inscription over a little window like a ticket-seller's, in the side of Señor Alfaro's shop. Besides this last there were, I think, only two other two-storied buildings, one of which was occupied by J. Gomez and Brothers, the lower floor as a shop, the upper by sleeping rooms rented out to lodgers. To this we were directed in search of a room for ourselves but, owing to the presence in town of engineers engaged in the extension of the railroad bridge over the Rio Turrialba and of a "Junta Politica" from Cartago to advocate the candidacy of the Republicano party in the Presidential campaign, all rooms were taken and our quarters seemed destined to be the railroad station. However it was found that the engineers had

gone away for over Saturday night so that we were given their room; on Sunday, the politicians having departed, we obtained a room for ourselves—with, so far as I was concerned, the most uncomfortable, broken-down bed that I have yet occupied. Our meals, which were very good, we had at the little house of a Nicaraguan woman named Simona; the fare was Costa Rican but suited me perfectly, and Simona seemed much pleased that I ate her tortillas.

Through the little town flowed the Rio Colorado, emptying a short distance below into the Rio Turrialba lying to the east. The latter was a very rocky stream with heaps of rounded boulders along its bed. The railroad crossed it on a stout iron bridge, dated as having been built by an English company in 1889. Its ends rested on heavy concrete piers but the floods of the preceding December and January tilted the eastern end pier so much out of perpendicular that the bridge was now being lengthened and a new concrete pier sunk in the soil some distance east of the tilted one.

Each morning at Turrialba was clear and usually it was possible to see the summit of the Volcano of Turrialba distinctly; later in the day it was apt to be cloud-covered. It is a more imposing mountain than Irazú, whether seen from the northern side as at Guápiles or Guácimo, or from the south as here at Turrialba. Its more imposing appearance is due not only to its greater apparent height, for Turrialba, Guápiles and Guácimo are much lower than Cartago from which we commonly saw Irazú, but also to the more conical shape of its upper portion. Looking at Irazú from Cartago one cannot see the cinders above the tree line, but Volcano Turrialba, seen from Turrialba town, shows the upper limit of the forest clearly and above that, at the western end of the summit, reaches upward a cone whose sides are deeply fissured and ridged, so as to form veritable cañons. Pro-

fessor Tristán, who had been to the top, told me that the ascent must be made by one of these cañons, whose steepness adds much to the difficulty of the climb, and that some sulphurous vapors are still given off by the volcano. Two eruptions of Turrialba volcano are known. One lasted from August 17, 1864, to the middle of March, 1865; during part of this time there fell a rain of very fine ashes and dust in the valleys of Cartago and San José, carried thence by the prevailing winds. The second and at times more violent eruption began February 1, 1866, and was accompanied by earthquakes which, on May 8, were felt at San José; the column of ashes reached to Puntarenas, a distance of seventy miles in a straight line.

On July 24 we crossed the Rio Turrialba on the railroad bridge and walked for a mile or so through a potrero dotted with trees, a coffee-plantation, and a second similar potrero, all bordering the eastern bank of the river; we searched particularly under logs, beneath the bark of decaying trees and in the sheathing bases of the leaves of bromeliads growing upon trees for earwigs, spiders and earthworms. During the course of our stay at Turrialba we found a number of these last in bromeliads seven feet or more above the ground; Professor Tristán supposes that the egg-cases have been brought by birds in the earth on their claws and accidentally dropped so as to enable the worm to develop occasionally in these plants.

To me the most interesting find of the afternoon was one of the animals known as *Peripatus*, a form intermediate in many respects between the earthworm group on the one hand and the centipede group on the other. *Peripatus* and its immediate allies to the number of fifty species, known collectively as the Onychophora, are found only in the warm regions of the earth—South Africa, Malacca, Sumatra, Australia, New Zealand, South and Central America, Mex-

ico and the West Indies. Thirty American species have been listed by a recent writer (Bouvier, 1905). In zoölogical literature *Peripatus* is famous as a "connecting link." We found two specimens this day, the larger one being about three inches long, of a reddish-brown color with yellowish dots and marks; it had a cylindrical body and twenty-nine pairs of legs. Both were found in one of the potreros above mentioned and, as is usual, under decaying logs. The altitude was about 2400 feet. I put both specimens in a bottle with some decaying wood and moss in the hope of keeping them alive, as Professor Tristán had kept one under such conditions for nearly a year, and eventually took them to our quarters in Cartago. On August 5 we made a couple of photographs of the larger one but with little success as the creatures became too restless in the amount of light requisite. In September the smaller one was sent to Philadelphia by a returning traveler, but did not reach its destination alive. At that time we found two little ones in the bottle, but as these animals live in rotten wood away from the light we supposed we had gathered in more than we knew along with the food. On November 12, 1909, we saw that the large one was dead and mouldy and supposed all was over with the *Peripatus* family. However, we pulled out the soft wood and to our astonishment found *four* lively little ones, while everything in the bottle seemed sweet and wholesome except immediately around the dead one. These animals are viviparous and the large one was evidently the mother of the small ones that appeared from time to time. The infants were returned to the bottle and we hoped that they would continue to thrive. Within the next three weeks, however, two small ones were removed from the bottle, dead. We believed that two more small ones still remained, but on December 5 not a trace could be found and we suppose they must have died and disintegrated. A

search for additional specimens of *Peripatus* in the same potrero at Turrialba on October 2 was unsuccessful.

In one of these potreros was a jicara (*Crescentia cujete*) whose branches were intertwined with those of a manzana rosa (*Jambosa vulgaris* or *Eugenia jambosa*). The leaves of the former were rounded at the tip, those of the manzana acutely pointed. The single fruits of the jicara, which were still bright green, were as much as six or eight inches long, oval or egg-shaped; they contained many small seeds and the hard rind makes them useful "gourds" when the seeds are cleaned away, although the actual relationship is with the Bignoniaceæ, the family of the trumpet vine and the catalpa. The fruits of the manzana rosa resemble the guayabo, both belonging to the Myrtaceæ, but are commonly eaten raw instead of being made into dulces. The flesh has a pleasant flavor, suggesting a rather dry sweet apple—hence the name of "manzana" or apple.

In the pastures were many clumps of trees of two or more species, one of which had produced numerous aerial roots which, running off sidewise from the trunk at right angles, clung to and encircled the trunks of the others, binding them all firmly together. Smaller trees or vines tightly wrapped their branches around the trunks of larger ones and the whole formed an inextricable mass. A common binding plant was the vine *Monstera*, often cultivated in greenhouses at home and remarkable for the large natural holes in its big deep green leaves. Trees loaded heavily with parasitic plants or epiphytes like *Monstera*, bromeliads, huge masses of long hanging ferns, great festoons of vine-like aroids with heart-shaped leaves, made this potrero exceedingly interesting. Here also, at the highest altitude at which we saw them (about 2400 feet) were a number of cacao trees, with clusters of small flowers and pods directly upon the bark of the trunk; the flowers were cream color, the pods

green or, when mature, rich brown, and six to eight inches long.

On October 2, A. and P. revisited Turrialba and these potreros, when we had a good view of one of the grotesque basilisk lizards. This particular basilisk was on the ground, but on our approach ran ten or twelve feet up a tree and remained on the far side even when we walked around the tree. Its body was bright grass green, except that the tail was cross-barred with black. The lizard remained quiet as long as we stood still, but a cautious move preparatory to photographing it caused it to dart instantly to the opposite side of a branch over which it peeped at us warily.

On July 27 Professor Tristán and P. walked northeastward along the railroad track, crossing the Rio Turrialba and the Rio Aquiares by the railroad bridges, until we came to a third bridge over the Rio Azul. All three rivers lie in gorges more than fifty feet below the general level of the country and in places the sides of these gorges are steep, in others more gradual. The Rio Azul is much less rocky than the Rio Turrialba, the vegetation reached to the water's edge and the scene was much prettier. We turned to the right into a charral and across it into the woods which immediately border the stream, but there was not a great variety of animals of the groups in which we were interested. Among other things we looked for fresh-water planarians but found only three, representing possibly two species, one with little earlike lobes on the head.

On the morning of July 25 we walked in a general easterly direction from Turrialba along a road which led to the Rio Reventazón and across it to San Francisco de Tuis, but did not go as far as the river. We passed a field of yuca; most of the way the road ran through pasture land but finally entered forest, into which we turned aside for a short distance. We saw three snakes this morning, more than we

had previously seen in Costa Rica. One was bright green, about four feet long; it was lying dead in the road. The second, apparently of the same species, glided into the grass; the third was smaller, mottled brown in color. All three were harmless. By the roadsides were many melastomaceous trees, *lengua de vaca*, which also occurred commonly at Cartago, and on some of the higher trees were nests of the oropéndolas.

One man whom we met along the road told Professor Tristán he knew what we were doing—we were collecting butterflies (we collected none this day) to print them upon muslin and thus give the latter its decorative pattern! Sixty years earlier the Brazilians gave the same explanation to Wallace of his actions on the Amazon.

North and west of the town the country ascended in gentle swells and low rounded hills, intersected by little streams entering the Rio Colorado. Along these streams were bright green pastures extending high up on the hills, giving the surroundings a soft and billowy appearance, softer, smoother and greener than we saw elsewhere in Costa Rica. The hillsides were formerly forest-covered and here and there single trees had been left standing so that the effect was very park-like. Here in July afternoons before the usual rain, flocks of twenty to thirty green parrakeets (probably *Conurus finschi*) flew screaming over our heads, resting first on one large tree, then on another, their green color rendering them invisible among the foliage. Their most characteristic feature when in flight is the bluntness, even squareness, of the head in front, owing to the shortness of the bill. Professor Tristán told me that this parrakeet does not learn to talk in captivity. A parrot found on the Pacific side talks readily and for this reason is often kept as a pet—there was one next door to Simona's and Mrs. Ridgway at Juan Viñas had one. This Pacific, talking, species (*Ama-*

zona auropalliata), known as the "loro," is light green with a yellow spot at the back of the head and a pair of black spots above the base of the bill. The primary wing feathers are chiefly black but are largely concealed by the green plumage when the wings are folded; there is some red on the edge and bend of the wing.

Just west of Turrialba the railroad passed through one of these beautiful, green, soft-looking hillside pastures and then bordered a thick forest. Along a brook where it left the forest but still shaded by some trees, were a larger number of a species of *Heteragrion* dragonfly than I had previously met, although I had found it below Juan Viñas. It had a brilliant patch of gold on the front of the head between the eyes and a one-and-one-half inch long, slender, blood-red abdomen; the colors of the rest of the body were more somber, the wings transparent, and in the shadow it was the golden patch and the line of red that were chiefly visible. These colors are possessed only by the male, the female being a sober brown. The species of *Heteragrion*, as far as I know, are only met with in well-shaded places, never in bright light, and by reason of this habit are often somewhat difficult to see, especially the females.

Leaving the stream we entered the forest and attempted to pass through it up the hillside into a pasture above, but there was no path and the ascent was so steep and the vegetation so dense that after going a little way we gave up our plan. Besides the deciduous (exogenous) trees there were many palms and tree-ferns all bound together with vines and lianas. There were numerous epiphytic ferns which also had a vine-like habit and hung in festoons from the branches of trees. Many trees, lianas and even some ferns had their stems and branches armed with sharp and cruel thorns so that in catching hold of the vegetation it was necessary to look carefully to see what was safe to grasp.

A not uncommon low plant on this hillside was a palm-like grass with leaves divided into two lobes each ending in an elliptical point and known (*teste* Professor Tristán) as "cola de gallo" (cock's tail). Two of these cock's tails, of about three feet in height, had curious nests upon them, attached in each case to a leaf. Both nests were inhabited by small black ants, but the nest-substance resembled that of which termites' nests are formed and the plan was termite-like, although there were no covered passages leading to them as termite nests have. One leaf was so decayed that, soon after I plucked it, it fell apart. It is difficult to understand why nests should be built on so temporary a foundation as a leaf must afford.

Only a few yards from the site of these nests I caught one of the most ethereal of butterflies (*Callitara menander*). Its wings, spreading two inches, were chiefly transparent and brownish, but each of the hind pair had a blue-black "eye-spot" on the outer margin and a patch of delicate rose along the hind edge. It is of the Satyrine subfamily of the Nymphalidæ distinguished by one or more of the veins of the fore wings being swollen at the base.

On Saturday, August 7, 1909, P. went to Peralta. On my arrival I presented to Mr. B. M. Hess, the station-master, a letter of introduction from Mr. John M. Keith. Mr. Hess (a native of Lancaster, Pennsylvania) took me to his own room in the second floor of the station and placed a cot at my disposal. I had brought a mosquito net with me, under which I slept each night, as I had been warned that Peralta was malarious. In fact, Mr. Hess said that he was suffering from it; he had a net but was not using it, although when I left he was promising himself to do so. Red ants were abundant in our bedroom. I know I picked many from my cot; perhaps they kept other insects away. Mr. Hess inquired if two other kinds of insects had eaten me up;

he said they were bad in the next room. I did not see either of these, but I preferred not to look for them and I do not know the actual authors of the numerous bites on my person!

Mr. Hess kept a "commissary," as general shops were called in this country. He had a Jamaican mulatto woman as cook. She had a brown monkey, a squirrel, two dogs and a cat in the kitchen or the little room next to it,—not the most sanitary arrangement perhaps. For company at meals, besides a young Costa Rican assistant and myself, Mr. Hess usually had—except at our six o'clock "coffee"—two or more of the railroad engineers or conductors whose trains might happen to be in Peralta at the time, for Peralta was a station where much shifting of cars, coaling of locomotive tenders and, on Sundays, transfer of passengers took place. One other item of the establishment was the Victor phonograph kept in the bedroom. This nightly rendered American songs and recitations in my honor while I attended to the day's catch, and Mr. Hess fell asleep on his bed.

A second visit to Peralta was made on March 23, 1910, when I put up as before at the railroad station, Mr. Hess having sent me word that he thought conditions good for collecting.

Near noon on August 9 I was standing on the station platform when a very curious bug alighting upon it attracted my attention. Its body and folded wings together were about an inch long, its colors yellow, orange and red, as well as I can remember, but its most striking feature was its hind or third pair of legs. Each one of these was one and one-third inches long and very slender except that the tibia had a thin leaf-like expansion half an inch long and one-third of an inch wide, with cross-bands of orange, brownish-red and blackish-brown. I was holding the insect in my hand examining it when most of it flew off, leaving but one of these remarkable legs in my fingers. I was unable to capture

it again and so have nothing but this single member in my possession now, but this *disjecta* would seem to place the insect in the genus *Anisoscelis* of the family Coreidæ.

Later that same day it rained and while sitting on the porch of the second story, I watched the dragonfly *Orthemis ferruginea* fly to and fro over the pool alongside the tracks in spite of the (moderate) rain, although dragonflies are usually fair weather insects. Four or five green parrakeets (*Conurus finschi*?) flew screaming to a tree on the opposite side of the river, their green color showing well as they flew. By 3.45 P. M. the rain had ceased and I walked north along the track. Not far from the station, a curious bird whose character I could not make out, flew across the track and into the wild cane, of which there was much between the railroad and the river both above and below Peralta station. The cane was now ten to fifteen feet high. I kept looking into it as I approached the place where the bird had entered, hardly expecting to see it again. But when I reached the place, there on a slanting cane, sat my first toucan, big beak and all. I stopped to look at it, it sat and looked at me, giving me the chance to make mental note of its colors before it flew off. It was chiefly black, with a yellow breast bounded with black below, and with an isolated black streak in the middle of the yellow, the rump red both above and below. It was *Pteroglossus torquatus*, one of the smaller toucans of Costa Rica, this species being about eighteen inches long. Similar to it, and occurring chiefly, if not solely, on the Pacific slope according to Carriker, is *Pt. frantzii*, which has a wide crimson band, sometimes mixed with black, across the middle of the yellow belly. Another genus commonly found in Costa Rica has a yellow throat and black breast; this is *Rhamphastos*. *R. tocard*, the "quioro" of Costa Ricans, is twenty-two to twenty-four inches long and has the tip of the maxilla bright yellow. *R. brevicari-*

natus, the "curre grande," with this tip "deep purplish blood-red," is sixteen to twenty-four inches in length.

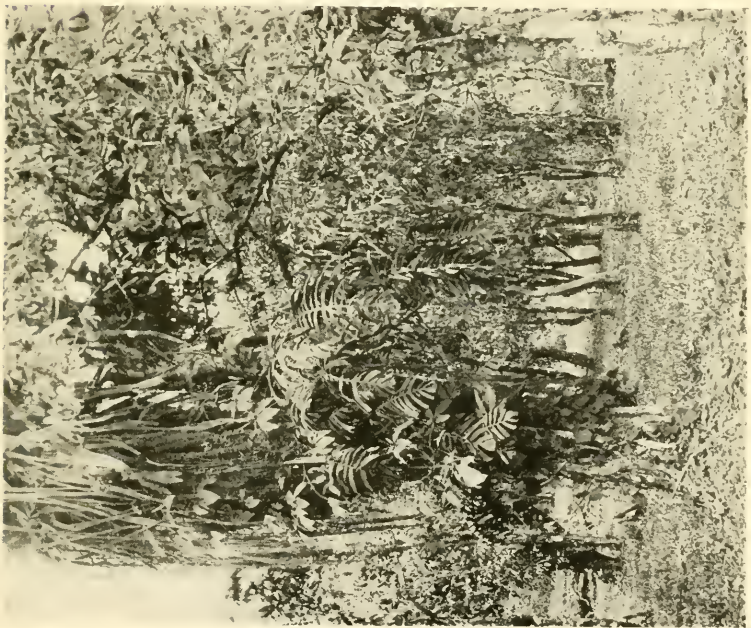
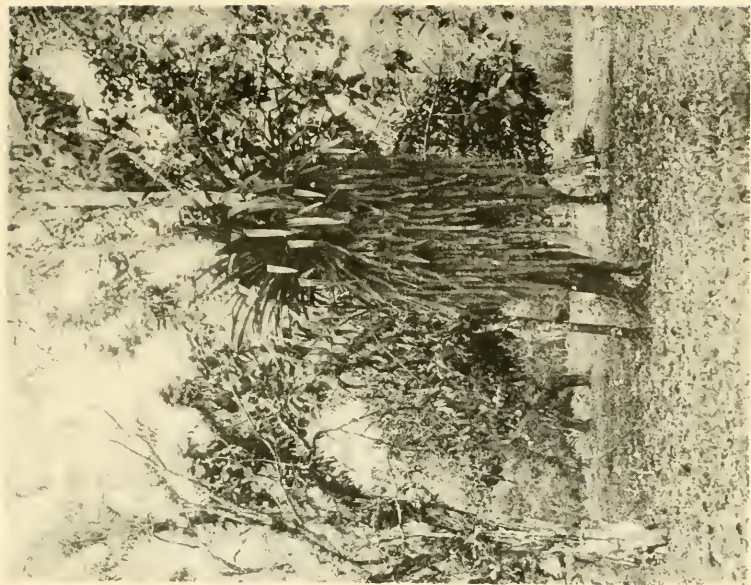
Not only the toucan thus justified my going out for this antepandial walk, but also at the first little river north of Peralta station I took the only specimen of *Heterina miniata* found anywhere in this locality, and probably the highest elevation (1075 feet) from which this species has yet been reported, as it seems to be chiefly a lowlander. Like almost all members of the genus *Heterina*, the male has a beautiful carmine spot at the base of each of its four narrow, transparent wings. This carmine is accompanied by almost no brown along its front edge, in contrast to the condition existing in the ubiquitous *Heterina cruentata*. Moreover, *miniata* male has a carmine spot on the tip of each hind wing (where *cruentata* male is edged with brown) and only one pair of clasping organs at the hind end of the body (the lower pair existing in *cruentata* being represented merely by stumps). *Heterina* is an exclusively American dragonfly and is richer in species in the tropics than in the temperate zones, although one member reaches Canada.

There were about half a dozen small cabins near Peralta station occupied by Jamaican negroes, and some railroad buildings, but no other human habitations. Behind the latter extended a Y-shaped track to enable locomotives to reverse their heading. At the end of the stem of the Y was a slow-moving stream called simply "laguna." Mr. Hess having told me of this as a likely place for me, I went there on August 8 about noon. Two women were washing clothes at the laguna, so I went into the low woods just beyond, which consisted of small trees, arums, ferns, heliconias and numerous vines or creepers. I had hardly entered when I caught a medium-sized dragonfly, of an apparently new genus allied to *Cora*. Nearby I found a pair of *Palæmnema* dragonflies, likewise new, with extremely slender bodies (two inches long in the

male). The egg-laying habits of *Palæmnema* are unknown and I stood in the mud for forty minutes keeping my eyes fixed on the pair, in the hope that I would obtain some information on this point. During this period they shifted their position to five different leaves or twigs but gave no sign of depositing eggs, so, fearing that I might lose them, I caught them in my net. Experience had taught me that the dragonflies which inhabit dark woods are very difficult to keep in view, owing to the transparency of their wings and the prevailing somber tint of their bodies. Often there is, however, a small limited area of a lighter color and, if one can keep his eye on that, he can follow the insect as it flits from plant to plant, but even so the greatest attention is necessary and I have often lost desirable insects. In this *Palæmnema* the most conspicuous light area, but not the only one, was formed by two small parts of the head—the labrum (or upper lip) and the nasus—which were pale blue. A species which I lost in this same piece of woods this day, a *Philogenia*, had only one or two segments of the hind end of the abdomen pale colored, like the whitish “bloom” sometimes seen on a plum; all the rest of the body was dark and the insect kept to the shadows so closely that it was very difficult to see.

Some writers, like Mr. E. B. Williamson, have suggested that these more conspicuous pale areas on dark bodies of dragonflies (not necessarily those confined to dark woods) serve as recognition-marks to the other sex.

I naturally looked for additional specimens of the new genus and of the *Palæmnema*, but unsuccessfully, until the increasing cloudiness warned me to seek shelter before the beginning of the usual heavy afternoon rain. Search for them was in vain on the following morning also, when I attempted a grassy road which led up from the laguna into the woods, and which I finally gave up because of the deep



Trees laden with Epiphytes in a Potrero at Turrialba.



Wild Ginger—*Costus malortianus*.

1. Vijagua, *Calathea insignis*, with yellow bracts. 2. *Heliconia marica* and 3. *H. imbricata*, both with dark red bracts.

soft mud beneath the grass. However, I did obtain some species of dragonflies that I had never, or but rarely, taken myself in Costa Rica. Feeding on a patch of morning-glory (*Ipomœa*), known in Costa Rica as "churrystate"—the same name is applied also to a mallow, *Anoda hastata*,—near the laguna were some uniformly dark metallic violet-blue Chrysomelid beetles (*Haltica amethystina*). Each one was one-third of an inch long and had many fine punctures over its dorsal surface but not arranged in lines.

In the afternoon of August 10 I went again to the end of the Y-track and into the woods beyond the laguna, where I had taken the new species two days before. I did not see them again but there were other interesting things. Both here and along the Rio Chiriquí trail where I had been that morning were a number of those transparent, pale-brown-winged butterflies with an eye-spot and rose color on the hind pair (*Callitæra menander*), one of which I had taken in the woods at Turrialba on July 26 (see page 252). I tried to capture some of them but did not find it easy, for unlike most butterflies, they did not rise when alarmed but flew horizontally close to the ground, through or beneath the underbrush, and the dead or living stems and branches prevented me from getting the net over the insects quickly enough to catch them. I saw them only in dark shady places with plenty of undergrowth.

Lying on the glossy green leaf of an aroid about a foot above the ground, in a fairly shady but hardly dark place, were a dead leaf and apparently a twig three inches long and one-fifth of an inch thick. Both looked as if they might have fallen by chance upon the living leaf. But on second glance I noticed that from the apparent twig there extended two pairs of slender outgrowths, the members of each pair placed so exactly opposite each other as to suggest at once that they were insect's legs—and so they were. The appar-

ent twig was a wingless walking stick (*Ceroys bigibbus*) whose color and roughness of body-surface were perfect imitations of the color and surface of a broken twig. The antennæ and the first pair of legs were held close together and straight forward in prolongation of the body and did not betray their possessor as did the oppositeness of the remaining legs, which projected at marked angles. The most interesting feature of the observation to me was that the insect was resting not on a woody stem or branch, where the protection derived would have been greater, but upon the contrasting background of the green leaf. It is not uncommon for veritable twigs to fall upon such leaves, but the occurrence of this insect upon the leaf certainly indicated an absence of the power of selecting an advantageous resting place where its "protective coloration" would protect. The walking stick was taken to Cartago and photographed while still alive.

Coming out of the woods, I stopped at the laguna to dredge for dragonfly larvæ, but without success. My brown tin collecting case was lying in the sun on the ground and some patches of black paint, which had been put on five months previously and were thoroughly dried, attracted a number of large brown-winged horse-flies (*Pangonia pyrausta*) with probosces nearly as long (one-half inch) as their bodies, which were five-eighths inches long. I paid little attention to them at first, but when one of the insects flew again to the box after it was placed in the shade thirty feet or more from its former position, I caught the fly for future identification. The paint had not softened, so I do not see what the attraction for the insect was.

On March 23, 1910, I visited the laguna again, crossed it and went into the thicket nearby to the spot where in August I had taken *Palæmnema*, the new genus, etc. A small clearing had been made here since then and a miscellaneous lot

of vegetables and plaintains planted. This, with the drier weather prevailing, had so changed the character of the spot that I could hardly recognize it.

After retracing my way nearly to the laguna I followed a road which in August I gave up on account of the deep mud. Here I found a dragonfly which I had never seen alive before and which no one had previously taken in Costa Rica—*Gynacantha tibiata*. It is two and three-quarters inches long and quite striking when flying about because it was bright green at the head including the large contiguous eyes and bright orange at the tail. This road brought me to a swift brook and I spent some time following it up and down until the skies grew clouded and rain began about four o'clock. The rain continued at intervals through the night. During the preceding twelve or fourteen days it had not rained at all, according to the record of Mr. Hess's rain gauge in front of the station. Two days later I went up the bed of this brook again and examined its banks. Many of the stones which formed the latter were breaking up into clay and one could see all the stages of the disintegration—some were split up into irregular masses so that a kick easily separated the whole, each fragment, however, retaining its shape; others were evidently dissolving rapidly under the action of rain.

The vicinity of Peralta was rich in wild cane and in heliconias (wild plantains), Zingiberaceæ and Marantaceæ, the shoots of these plants frequently reaching a height of fifteen feet. Since in the latter orders the apparent stem is really composed of tightly wrapped leaf-sheaths, this height means that a single leaf and its stalk together may be fifteen feet long. The species blooming in March were different from those blossoming in August. The flower clusters of the Heliconias were large and enclosed in bright red bracts, the conspicuously colored portions of the inflorescences.

These bracts are so shaped that they can hold an ounce or so of water. When I examined several inflorescences on March 25, 1910, I found in each bract two or more mosquito larvæ or pupæ and in some other quite different dipterous larvæ also. Some of these mosquito larvæ were eventually carried to Philadelphia alive in a vial and, although nothing was given them for food but merely the supply of water maintained, they transformed to the adult stage on May 31, 1910. Some of these larvæ and a pupa were identified by Mr. Knab as *Wyeomyia pantoia*. They therefore belong to the same genus as the mosquito (*W. smithii*) whose larvæ breed in the water contained in the pitchers of the pitcher plant (*Sarracenia*) of the United States. The larvæ of *W. smithii* are known to be able to withstand fasting for long periods. Larvæ of other species of *Wyeomyia* live in the water between the leaves of bromeliads or in bamboo joints in tropical America. The adult *W. smithii* is believed not to suck blood, but of *W. grayii* of St. Lucia and other West Indian islands, Theobald reports that it "bites with great readiness and pertinacity." Busck, who studied mosquitoes in Panama, says, "The species of the genus *Wyeomyia* . . . are among the few day-biting mosquitoes and are decidedly noxious where they abound . . . are very persistent biters during the day-time." Heliconias, bromeliads and bamboo, therefore, offer a breeding place to mosquitoes which annoy man.

Behind Peralta station (that is, west) the forest began within a few hundred feet of the railroad. An ascending road led into it, which I followed for some distance on August 7, and then turned aside on the first path to the right. Immediately I was in the midst of a thick forest of very tall exogenous trees and many palms, from both of which hung clumps of ferns and lianas binding the trunks and branches together. The soil was damp and, in places, deep mud.

Although the sun was shining, the foliage was dense enough to prevent strong light from reaching the ground and in consequence the dark woods had a rather mysterious aspect. An onion-like odor made me suspect peccaries. I stole along the path as quietly as possible, hoping that one of the big *Staurophlebia* dragonflies, such as I had seen at Guápiles and at Guácimo, would come along the path to meet me and my net, but neither of these hopes was gratified.

Instead, somewhere far above, was the sound of breaking branches and a little later a short bark something like a dog's. Still I crept on cautiously, looking constantly upward into the tree-tops; in another minute I saw, in an opening amongst the leaves which permitted of a clear view of his whole person—my first wild monkey! It was the common white-faced or capuchin monkey (*Cebus capucinus*), such a one as lived chained to a pole in the patio of Weldon's Hotel at Cartago. This free fellow looked down at me from his bough for a few minutes while I looked up at him and then, although I made no movement to alarm him, he turned and disappeared among the leaves. Near him were two or three others which I could not see as well. Ten or fifteen minutes later, and at a short distance away, I had another and still clearer view of one of these monkeys as he ran along an almost bare branch of a great tree and stopped midway to watch me.

Between the two views of the monkeys I saw a *Megaloprepus* dragonfly, the largest of all living species, mentioned in more detail in the chapter on Santa Clara. It alighted first on one and then on another twig, seven to ten feet above a little stream whose waters were arched over and partly covered by vegetation. The interest of this observation lies in the fact that in the *Biologia Centrali-Americana* under this species is quoted the remark of an experienced collector who spent four years in Central America, that he

had always found this species in deep woods and far from water; here the woods were deep, but—.

The next morning I went to these woods again but although I spent two hours in the immediate neighborhood, I saw neither monkeys nor *Megaloprepus*, nor indeed much of any kind of animals and no dragonfly larvæ in the streams. So I returned to the road, which continued to ascend through the forest; here and there in it were pools of rain-water, occasionally supplemented from little running streams which preceded the human-made road or have taken advantage of it. I had caught a dragonfly at one of these pools and was putting it away when, looking ahead, I saw an armadillo (*Dasypus novemcinctus fenestratus*) crossing the road some twenty feet away and disappear into the shrubbery. My next visit thither was on March 24, 1910, a cloudy day with fitful gleams of sunshine and I could find few dragonflies, no monkeys and no armadillos.

Mr. H. H. Smith, when collecting in Brazil, observed that certain dragonflies were only or chiefly to be found just after sunset along river banks. With this in mind, I went after dinner on the first day at Peralta (August 7, 1909) to the Rio Reventazón about one hundred and fifty feet away. Mr. Hess called a Jamaican negro to guide me through some garden patches and cane-brakes, after which we crawled around and over numerous boulders and so came out on a flat, treeless and rocky beach. The Reventazón is moderately rough here between rapids above and below. My guide showed me the height to which the river reached in the great floods of the preceding December and January. Between the river and the station the land rises a little and in the same floods—as Mr. Hess told me at another time—the Reventazón broke through its banks farther upstream and came down the railroad tracks to a depth of four feet near the station. Owing to landslides above and below which

carried tracks, telegraph poles and wires and everything into the river, they were seven days with no communication with the outside world, while day and night the air was filled with the continuous roar of the rocks and boulders swept downstream by the tremendous force of the river and constantly striking and loosening others as they were hurled along. A conductor supplied another picture of the Manager of the United Fruit Company obliged to stand on a chair in the chair car on his train because the car was flooded.

But I saw no dragonflies by the Reventazón in the fast falling darkness.

Following a suggestion of Mr. Hess, on August 9 I went along the track southward, as far as "mile post 55" from Limón, stopping on the way at a small stream crossed by a short railroad bridge where I took a couple of additional species of dragonflies for Peralta. A short distance beyond post 55 was a siding turning off to the east; just north of it was a corrugated iron cabin and a pretty grass-covered path also leading east to the Reventazón. This soon brought me to the river which at this point had no projecting rocks although above and below there were foaming rapids and boulders. A wire cable was stretched across the river here from platforms of logs lodged in tree-trunks about eight feet above the ground on either bank. On the cable, at each bank, was a tiny car consisting of a couple of grooved wheels from which hung two short pieces of rope each suspending a wooden crosspiece. There was no pulling rope across the river and apparently the only way of crossing was to sit upon one crosspiece, put the legs upon the other and then laboriously pull the car along by hand-over-hand work on the wire cable—probably cutting one's hands to pieces in the attempt. Mr. Hess had said that I could cross the river by this car if I wished—but I did not wish! At the opposite end of the cable a man was apparently about to

cross by the car at that end, but if so he gave up the idea and disappeared into the forest.

A black cormorant was sitting on the rocks of the rapids downstream but did not linger, although I did not actually see him fly away. The river banks were lined with fairly large trees whose branches, on the river side, overhung the water for many feet; they were heavily loaded with epiphytes—ferns, Spanish moss and other bromeliads. Looking down on the rocks at the very water's edge, I saw a basilisk lizard (*Basiliscus*) perhaps a foot and a half long, with a long conical projection on the top of its head and a fold of skin along the back. As I stepped a little nearer to get a better view, it disappeared in a twinkling behind a rock and perhaps into the water. While returning to the railroad by the grassy path a second and similar basilisk gave me a better opportunity to examine it. The lizard was bright grass-green in color, somewhat over a foot in length; its head was produced upward in a conical fashion that gave it a most grotesque appearance and there was a dorsal crest to its body seemingly not fully elevated but plaited. When I came very near it ran off into the underbrush.

Some "bobos," fishes of delicious taste which I had previously eaten at Guápiles, were for sale at the Peralta Commissary on August 10, a negro having caught them in the Reventazón with a net. The negroes present pointed out, as characteristic of the bobo, a horny tubercle on the front end of the middle line of the upper jaw. A few days later Professor Alfaro gave me the technical name of the bobo as *Joturus pichardi*; it is a member of the mullet family (*Mugilidæ*).

Mr. Hess suggested that I go north along the tracks to the Chiriquí(?) River, whence, by a trail leading upstream, I could reach another piece of forest. He had once followed this trail on horseback as far as two "crater lakes" of which

little was known, he said; one, much the larger, was eighty manzanas in area, the other about thirteen manzanas. (A manzana is a Spanish square measure equalling 10,000 square yards.) The crater lakes were too far away, by his account, to be reached on the cloudy morning of August 10, but otherwise I adopted his suggestion.

The Chiriquí(?) River was crossed by the railroad at about milepost $53\frac{1}{4}$, if there were one present but I failed to find it. The long-tailed, black and green, day-flying moth *Uranidia fulgens*, mentioned on page 110 as so much resembling a *Papilio* butterfly, was very abundant this morning and a little north of post $53\frac{1}{2}$, I stopped, at 7.50 A. M., to make a definite count. There was evidently a migration in progress, for the moths were flying northwest to southeast steadily without returning or diverging. Most of them were high in the air above the tops of the forest trees remaining near the tracks, but enough were flying lower to be plainly identified. I counted 176 passing just above me in two minutes and then stopped because the glare from the sky was too hard on the eyes. There was no wind; the sky was mostly clouded over, the sunshine feeble. The migrating column was of no great width.

The banks of the Rio Chiriquí were heaped with rounded boulders. A negro who was gathering old ties and logs told me that the trail I was seeking was on the north side of the river, and crossing the railroad bridge I found its starting point at the very abutment. But before turning into it I walked along the tracks a little farther to look at the Reventazón, which was filled with great rocks that made it a boiling rapids opposite the mouth of the Chiriquí. The trail entered the woods a short distance from the railroad. The principal characteristic of this piece of forest was the great number of lianas which hung from the trees. They were of all sizes from those little thicker than light twine to

huge cables as thick as a man's body and composed of several smaller lianas, each as thick as one's wrist, wound round each other.

The trail broadened to ten feet or more in width, was much cut up by horses' hoofs and in many places extremely soft and muddy. It crossed several small streams which were not affluents of the Chiriquí but flowed in the opposite direction. Finally I reached a clearing with much grass and a few trees, beyond which was a grove of large trees with no undergrowth or grass, the ground being rough and muddy. Crossing this clearing I caught a *Megaloprepus* dragonfly, much to my surprise—the locality was indeed far from water but certainly not "deep woods." The buttress-roots of some of the trees in this grove enlarged the diameters of their trunks at the ground to twenty or thirty feet. The altitude of the little hill on which this grove was situated was 1400 feet by my aneroid. From here I returned to Peralta as I had come.

In the morning of March 25, 1910, I went to the Rio Chiriquí again, but instead of going into the woods bordering it on the north, as I did before, I went along the river bank itself, which is formed of boulders of various sizes. The river had several channels and in the southernmost of these, where the current was less swift, were not a few small dragonflies with brilliant coppery heads and thoraces and bright sky-blue abdomens (*Argia* near *cupraurea*). When I had gone upstream several hundred yards from the railroad two deer crossed the river about fifty feet away from me. I saw them before they discovered me but one soon turned and spied me; they quickened their pace but did not run and soon disappeared into the shrubbery, which on both banks intervened between water and forest. These deer stood not more than four feet high and had no horns. According to Elliott, there are four species of deer which prob-

ably occur in Costa Rica, *Odontocælus truei*, *costaricensis* and *nemoralis*, and *Mazama sartori*. Miller spells the first of these generic names *Odocoileus* and gives *tema* as the specific name of the *Mazama*. *Odocoileus*, which includes the Virginia deer of the United States, has branched or unbranched antlers (but on the male only) and usually a long tail and a metatarsal gland. *O. truei* has (in its summer coat) the upper parts light chestnut or tawny, the tail tawny above, the height at the shoulders 27 to 29 inches. *O. costaricensis* is larger than *O. truei*, is mixed black and buff above, has the tail cinnamon above and a total length of 56 inches. The upper parts of *O. nemoralis* are yellowish-brown and gray, the tail dusky above, the height at the shoulder 27½ inches (Lydekker).

Mazama has simple unbranched horns which are directed backward, a short tail, the hair on the forehead forming a tuft, but no metatarsal gland. *M. tema* (or *sartori*) has the upper parts of the body and of the tail brownish-red, the height at the shoulder 20½ inches. It is one of those deer known as brockets.

Between four and five that afternoon I saw a few toucans by the Chiriquí, both perching and flying. When flying, a toucan is elongated and bent down in front and so at the opposite extreme from a parrakeet in flight, the latter appearing very short and "sawed off" in front.

The green-and-golden-eyed, blood-sucking flies, *Chrysops tanycerus*, were here in numbers to-day. This genus of the horse-fly family is widely distributed over the earth and persecutes man and other mammals wherever it occurs.

This day being Good Friday, not a train or an engine moved in either direction on the railroad and a construction train which arrived at Peralta on Thursday evening waited until Saturday before going on. Such was the custom of the country rather than the wishes of the railroad management.

CHAPTER XV

SANTA CLARA

The level country on the north side of the bases of the Cordillera Central is known as the "Llanuras de Santa Clara" or, by abbreviation, merely as "Santa Clara." Our first acquaintance with this region was made on Tuesday, June 1, 1909, when P. took a letter of introduction from Mr. E. J. Hitchcock, Manager of the United Fruit Company for Costa Rica, to Mr. E. W. Reed, Superintendent of the Santa Clara Division, located at Guápiles. As far as La Junta the route was the main line from San José to Limón; at La Junta the tracks diverge to the so-called "Old Line."

About two o'clock I was deposited on a tiny platform between two tracks at La Junta and the train went on to Limón. There was no one about but negroes who worked on the adjoining banana farms. A row of their cabins faced the track. My questions brought the answer that the train for Guápiles would stop at that platform about three o'clock—the schedule time for leaving La Junta was 2.40 P. M.—and that there was no station here. The temporary bridge in use in June was a little upstream from the site of the old one, which caused some change in the track arrangements. It soon began to rain, so I went to one of the cabins, where a young negro woman was washing clothes, and asked permission to sit on her little porch under shelter. This was readily granted and a chair was also brought out for me. A number of men were lounging on the porch of the next cottage and remained there all the rest of the afternoon, one of them strumming on a guitar; the most frequently

repeated air had a refrain of which the intelligible words were "Sally Maun day." I saw many other Jamaican negroes during this week for they do nearly all the work in the hot banana fields. They speak English, nominally, but it was often difficult to understand them and apparently for them to understand us.

Opposite the cabin where I sat was a tall tree whose trunk rose straight from the ground without a branch for about fifty feet; then its branches spread rather widely with not very thick foliage and with long depending wisps of *Tillandsia*. Attached to many of the branches were the hanging nests of the lowland oropéndolas. Each nest looked to be one and a half to two feet long, thickening somewhat from top to bottom and with an opening on the side. I counted fifty-four such nests on this one tree. The birds made frequent visits to the nests; their flight was strong and their call a long and somewhat calliope-like whistle.

By and by the rain stopped and I walked a little in the neighborhood of the junction though I dared not go far since the train was already overdue. A banana plantation came down to the tracks on the southern side and a little pool lay near it. As I approached, two green lizards, each a foot long, left the water's edge and darted into the bananas. Following them, I saw on a tree (forming part of the fence around the bananas) at about two feet from the ground, one of those tree nests of termites or so-called "white ants," well-known in the lower parts of tropical America. This nest was about the size of a man's head, brownish and made as usual of the wood which has been chewed by the termites and so worked into building material. Breaking a small hole into it, the termites could be seen running about actively within. The sound of a locomotive broke off my observations and I returned to the platform. It proved a false alarm and by five o'clock (the scheduled time for arrival at Guá-

piles) when no train had yet appeared, I began to wonder whether it had been omitted for the day. However it came a little later and left La Junta for Guápiles at 5.25 P. M. It was a mixed train with more freight cars than passenger, and the only one of the day in that direction. I learned later that it was usual to go on past La Junta to Siquirres, where the Guápiles train started, and wait there, but no one had told me this. Further, Tuesdays, Thursdays and Saturdays were heavier freight days than the others and in consequence the train was always later on those days.

Between La Junta and Guápiles Mr. Reed found me on the train and I had the pleasure of his company the rest of the way. He told me that in the twenty miles between the two places there was the possibility of sixty-three stops on the railroad. This was because there were practically no roads for teams in this part of the country and consequently everyone depended on the railroad for the carriage of all goods. We did not make the sixty-three stops but there were enough of them and enough freight to be unloaded to make it after nine o'clock when we reached Guápiles and Mr. Reed took me to "Salvador," as the Superintendent's house was named. Here I met Mrs. Reed and here I unexpectedly found Mr. Schaus and Mr. Barnes who had arrived the day before to collect Lepidoptera.

Salvador was approached from the railroad by a straight walk bordered on each side, for part of its length, by a row of majestic royal palms; some gaps which had been unaccountably left had been filled in with younger specimens. The house itself, about three years old, was of frame, as was the case also with all the farmhouses of the region. It was two-storied, square, with a wide veranda running completely around all four sides on both stories, a central hall for the entire length of both, and in the rear a detached but connected building containing a kitchen and pantry below and

a well-equipped bathroom and other small rooms above. In the main house the interior of all the rooms—walls and ceilings—was finished in dark stained wood. All the sleeping rooms were on the second floor and at night all windows were left open—a welcome change from conditions enforced by sleeping on the street level at Cartago.

From the upper veranda at the front of the house there was, in the clearness of each early morning, a magnificent view of the Cordillera Central lying just south. From left to right one saw Turrialba, Irazú, Barba and Poás. The view of them from Guápiles is more imposing than from Cartago and San José because Guápiles is but 1000 feet above the sea while Cartago is 4750 feet and San José 3800 feet in elevation, so that the mountains gain immensely in height when seen from here. Turrialba, which is more or less hidden by Irazú when looked at from Cartago or San José, is especially fine. The northern slopes of all these mountains were well wooded to the summits, which was in great contrast to the appearance of Irazú from Cartago—the forests being largely replaced by cattle pastures.

Mr. Schaus and Mr. Barnes offered to show me some of the best collecting grounds which they had found on their previous visits to Guápiles, an offer which of course I was very glad to accept. On the morning of the second we crossed to the south of the railroad, went along a row of wooden houses one of which bore a large sign "Blue Nose Villa" for no visible cause, passed a sawmill, crossed two potreros diagonally and so arrived at a bit of forest into which a trail wide enough for a rider entered and soon forked right and left. The second of the above-mentioned fields still contained a number of trees and shrubs, remains of the forest that once covered all this country solidly, as indeed it still did in large part. One of the tall trees, with all the characteristics of the tree I noticed at La Junta, had like-

wise a population of hanging "yellow tails'" nests and the call of the birds could be heard for a considerable distance. The number of nests was much smaller than on the tree at La Junta.

Not long after entering the forest, I had my first view of a living example of the largest species of dragonfly now known to exist—*Megaloprepus cærulatus*—found in the lower parts of tropical America from Mexico to Bolivia. Its very slender body attains, in the largest individuals, a length of five inches and it has a wing-spread of more than seven inches. It owes its specific name, *cærulatus*, to the fact that on its large otherwise clear wings is a broad, dark, purple-blue band which makes the insect conspicuous when flying through the forest. Some writers (who have not seen this insect in life) have suggested that the dark bands on the wings, by resembling flickering shadows cast by leaves, etc., are thereby protective, but I could not see that the supposed resemblance exists. This day I saw two or three individuals flying from dense vegetation into the trail. When flying all four wings were spread far apart from each other, the body was horizontal. The flight was sufficiently slow to allow the movement of each wing to be seen; but in spite of this slowness the insect can dodge. Mr. Barnes compared the motions of the wings to those of a windmill, but I should say that the effect produced by the moving wings was more like that of a jumping-jack with movable arms and legs pulled by one string, rather slowly but at regular intervals. When caught and held by the wings, the legs were folded against the thorax and remained immobile, even when they were touched or rubbed—the insect seemed to "play 'possum." When held by the mid-abdomen, movements in legs and wings soon appeared. When I struck at individuals in the forest with my net and missed them they usually rose in the air, at the same time making into

the vegetation. A male was kept alive in an envelope and in the evening was let loose in my bedroom. The walls and ceiling were of dark-stained wood, while there was yellow straw matting on the floor; the height of the ceiling was between eight and nine feet, and from the center hung an incandescent electric light which I placed at about mid-height. Above the bulb was a flaring fluted shade, the effect of which was to render the space above darker than that below. With the illumination afforded by this one light, the *Megaloprepus* was repeatedly released and repeatedly flew up to the ceiling. Once indeed it got under the fluted shade and bumped up against the latter several times until I gently moved the insect out from under the shade, when it flew upward to the ceiling again. Nothing whatever is known of the nature or habits of the larva of this species of dragonfly.

Another interesting dragonfly first found this day, of smaller size than the above and with a beautiful red abdomen, was *Orthemis cultriformis*, originally described from Paraguay and which had not hitherto been known north of Panamá.

Many beautiful butterflies were in this wood, some not greatly unlike those at home, others of characteristically tropical groups.

On June 4 I visited this bit of forest again; there was a young bull in the trail but he gave no trouble. I went up first the left and then the right fork of the trail already mentioned as far as a point on each where it had become so choked with bushes that further progress was difficult. An early prize this morning was a great green, strong-bodied dragonfly, *Staurophlebia reticulata obscura*, originally described from Surinam and hitherto recorded only from Honduras, Nicaragua and Chiriquí in Central America. We had seen this species here on our first visit but had failed to capture one. Another prize was a species of *Uracis* hitherto

entirely unknown to Mexico and Central America. The point on the right fork of the trail at which I stopped, and where I ate my lunch and in all spent a couple of hours, was a small stream which I suppose, from Pittier's map, to be an affluent of the Rio Toro Amarillo, or simply Amarillo. There was an exquisite little dragonfly here with bright red eyes, brilliant coppery thorax and blue and black abdomen (*Argia*, near *cupraurea*). The much duller female of this species was laying eggs in the floating, more or less submerged vegetation, some of the insects themselves being submerged during the operation, as is not uncommon in the whole group to which they belong.

The stream-bed, as usual in all this country, was filled with stones and boulders so that it was possible to go some distance downstream from the trail by walking on these, although the banks were impenetrable owing to the vegetation. I was so engaged when a great metallic-blue *Morpho*, perhaps the handsomest butterfly of all Central America, came by and fluttered around me so close that I could not use my net at once. I was astonished at its boldness for, notwithstanding the strikes which I made toward it with my net in the endeavor to capture it, it came back twice to where I stood on the rocks, each time after an interval of five minutes or so, circling around me in real mockery of my impotence.

This piece of forest differed from that described below, through which the Florida road passed, in the much smaller number of palms to be found in it, although the difference in elevation is not more than one to two hundred feet. It may have been partially cleared once, but as many of the tall exogenous trees were untouched and surrounded by thick growth, it seems unlikely that these would have been left and the palms cut out if they ever had been here, since comparatively few species of these palms are of use to man.

On the afternoon of June 2, Mr. Barnes, taking his gun to try for a wild turkey, led me north from Salvador past the original and much plainer farmhouse and the machine shop to a pasture where the calves were kept. Crossing this we reached and crossed the Rio Guápiles by a rough bridge. From this point the river was bordered by a narrow strip of woods and undergrowth separated by grassy pastures from banana fields lying farther east. Mr. Barnes left me here to examine the possibilities, but neither of us did much for it soon became very dark and fearing a general downpour we hastened back to the house.

Saturday, June 5, was devoted to this strip of woods along the Rio Guápiles, as on the previous hurried visit I had noticed some *Palæmnema*, a genus of dragonflies peculiar to Mexico, Central America and northern South America, of which I had never seen many specimens. I was not disappointed for this day too they were abundant in the low plants a foot or two high growing in the fairly dark shadows of the trees. They had the peculiarity of remaining closely in one place and not flying swiftly or vigorously, so that in most cases I could, with a little caution, pick them up with thumb and forefinger more readily than secure them with a net. They also had the peculiarity of keeping the body motionless in the same position and location in the air while the wings vibrated rapidly, thus suggesting a habit of the hover-flies or Syrphidæ. Without much exertion and without extermination, I gathered fifty-four specimens of two species of the genus (*paulina* and *nathalia*) whereas for the *Biologia Centrali-Americana* the various museums had been able to furnish only seventeen specimens of five species and of these seven were imperfect while my catch of to-day was perfect. Another matter of interest is that these two species, which completely intermingled and did not, so far as I could see, possess different habits, were not the two most

closely related species of the genus but (if I may so express it) species at least once removed in relationship. The observation has some bearing on recent discussions of the origin of species. Those writers who believe that geographic, or topographic, isolation plays a great part in differentiating species point out that it is not the most closely allied species that occur together; on the contrary, the most closely allied are always separated from each other by some kind of barrier which prevents their intermingling or interbreeding and consequent loss of distinctness.

The larvæ of *Palæmnema* were entirely unknown at this time (although we subsequently obtained them at Juan Viñas) and the abundance of the winged insects, a few of which had evidently only recently transformed, gave me hopes of finding the early stages. But although I looked long in the waters of the nearby river, under stones, in the floating and submerged vegetation, and in the sheathing bases of bromeliads and other plants, I was totally unable to find the objects of my search.

There was a number of brilliantly-colored day-flying moths belonging to the family Syntomidæ, in this strip of woods. One which I secured, *Cosmosoma teuthras*, had the thorax bright red, the abdomen black with rows of metallic blue spots, the wings clear almost lacking scales except around the edges, where they were reddish along the front and hind edges and dark brown along the outer edge. When the insect flew about, the red and blue markings were very conspicuous. Another species of the same family was of such interest to Mr. Schaus that I gave him the specimen. It likewise had transparent wings and its general appearance was wasp-like, due in large part to the way in which its abdomen was marked. Although this region of the body was broad at its front end as is usual in moths, the central part of the abdomen was white, the sides black so that look-

ing down upon the insect when at rest the black sides were unnoticed while the white central portion was highly conspicuous. This naturally gave the appearance of the slender-waisted abdomen of a wasp, an illusion which was increased by the narrow transparent wings.

I ate my lunch on a great rock in the midst of a smaller arm of the Rio Guápiles which flows past a little island. From this rock I could look into a quiet pool seemingly about four or five feet deep in which were fishes six to seven inches long. They reminded me of that fine fresh-water fish, the bobo, which was twice served for dinner at Salvador while I was there. One of the two, seven pounds in weight, was said by Mrs. Reed to be the largest she had met with in her housekeeping. Mr. Reed said that fishes in these rivers will not bite at hooks but are obtained by exploding a charge of dynamite in the river which stuns, and kills many fishes which are then picked up by men who wade out to gather them. It is a most wasteful method and should be prohibited, or at least restricted, by the Government, but nothing had yet been done. No one at table suggested a comparison of bobo with one of our fishes, but all agreed that it is superfine and there were no small bones to detract from the enjoyment of eating it. This fish has also been mentioned on page 264.

On the third of June, arrangements having been made the day before, Mr. Schaus, Mr. Barnes and I went to the railroad where a hand car was waiting, with a negro and a Costa Rican to work it. This took us westward along the tracks to San Jacinto, a farmhouse, near which a negro was waiting to guide us to the present starting point of the "Florida Road," a trail leading into untouched forest. This was a favorite collecting ground of the two butterfly hunters but since their last visit here, two years ago, much of the forest had been cut down and the entrance to the trail consequently

changed. The negro led us in a stiff walk for an hour, down a pasture by a little river, through a banana field, then some standing timber partly cleared, out into open sun again by a very winding path where the clearing had proceeded farther until finally the welcome shade of the forest itself was reached. The trail led westward here but was said to be part of a route to Nicaragua—in any event it traverses many a league of forest. We followed it for perhaps a mile and then returned as we had come. Its width varied and was often not greater than that of one's body although the trail was often traveled on horse or mule-back. On each side of the trail the vegetation was so thick and dense that one could not make way for more than a few feet without the use of a machete such as all the natives and negroes carry. In this forest were mingled exogenous, deciduous trees of many kinds and a variety of palms. The former were rather tall on the whole but there were many exceptions. All the trees lacked branches until they were many feet above the ground, but this lower space was occupied by the epiphytes and parasitic plants, bromeliads, ferns, orchids, lianas and other vines which shot upward from the trunks or hung from the far-away branches and twisted and twined in both profusion and confusion. On the ground itself were shrubs and smaller plants reaching up to mingle with those descending. There was much difference in the tree-trunks as to bareness or as to being covered with lichens. The large exogenous trees rose out of the soil with numerous ridge-like buttresses, while many of the palms had aerial roots. Most of the birds were far away overhead in the foliage of the trees proper, but sometimes an opening above, admitting sunshine, gave a glimpse of them or there was a swarm of butterflies around a full-flowered tree.

There were so many new things to look at, both those of which I had read and those totally unknown, and so many

insects to be stalked, that I was soon the third to go along the trail, Mr. Barnes being in the lead and Mr. Schaus between us. Once, a couple of peccaries rushed across the trail just in front of the latter; I was too far behind to see them but the scent was still very marked when I reached the spot where they crossed—it was like that of strong onions. Mr. Barnes saw some red monkeys feeding quietly in a tree-top, learning of their presence first by the debris they dropped. He told me of them when we met later and I went on to look for them but was unsuccessful.

I did not go again to the Florida Road during my stay at Guápiles, but Messrs. Schaus and Barnes repeated their visit and brought me a few dragonflies, while in return I gave Mr. Schaus any of the Lepidoptera I picked up that were of interest to him. One of the dragonflies caught by Mr. Barnes on the Florida trail was of especial interest, as it belonged to the Cordulines, a subfamily of dragonflies never before found in Central America or in Mexico except once near Monterey in northern Mexico. It has in consequence been supposed that the absence of this group was one of the faunal characteristics of this region, but Mr. Barnes' capture proved this idea to be erroneous. His specimen has been described as *Neocordulia longipollex*; its congeners are known at present only from Ecuador and Brazil. The unexpected taking of this Corduline in the Florida Road indicates how much collecting and study are still necessary for a thorough knowledge of the neotropical region, and how rash it is to generalize from collections made during one visit only or at one season only.

Mr. Schaus had collected Lepidoptera in various parts of tropical America for over twenty years, of which three were spent in Costa Rica. As a result of his long experience he preferred to collect in the forest, during the daytime at least, since it was his opinion that specimens to be

found in open country such as banana fields, pastures, grassy fields, etc., were of species having a wide distribution over all or a large part of tropical America, while those living in the forests were more often peculiar to a limited region. Beside collecting with a net in the usual way in daytime, he did much around electric lights at night. At Salvador Mr. Reed had an arc lamp arranged for him under the veranda of a whitewashed building and here he spent several hours each night. One evening two enormous beetles, a male and a female of the same species (probably *Megasoma elephas*, but the specimens are not accessible) came to the light and were caught. Each must have measured five to six inches long, two to three inches wide and correspondingly thick so that they were quite bulky and heavy. The male is somewhat larger and has a slender projection forked at its tip, on its head; this projection alone is nearly an inch long.

Somewhat to his surprise, I think, Mr. Schaus did not find the night collecting at the electric light as prolific as at Juan Viñas (at 3500 feet) and was disposed to think it due to the rather unusual dryness of Guápiles at this particular time. In fact his collecting experiences inclined him to the opinion that in Costa Rica there was no seasonal distribution of insects on the Atlantic slope, but that the presence or absence of adult insects depends in any locality on the wetness or dryness; this is a condition which may be quite different in the same place in the same month of two consecutive years.

On the night of June 3 we saw clearly a total eclipse of the nearly full moon; it began about 6 P. M. on the lower right hand edge of the moon and gradually extended to the upper edge so that for a time the entire disk was covered.

The Florida Road was visited a second time on November 18, 1909, when A. and P. started thither on horseback from La Emilia. For two miles we rode westward on the

railroad, sometimes between the tracks, sometimes along a crooked narrow trail one side of the rails. At San Jacinto we turned into a field containing a sawmill and as there was an extremely heavy cloud hanging over the field and the forest, we waited on the porch of this house until this particular shower should have passed, which it soon did. Then we rode on around great numbers of logs, through deep slippery mud full of stones and stumps, and after fording a small milky stream traveled along its bank until we neared a large banana plantation. Our way led through this, but seeing a well-traveled road running directly into the woods we turned aside to the left and followed it. From its general direction we thought it must finally join the Florida Road, and probably it did at one time, but after we had ridden about a quarter of a mile—over a rough, “rooty,” muddy, slippery, loggy path, including a gate to be opened—we came to a great heap of brush which effectually blocked the road. This part of the forest was pretty enough with its huge trees, many epiphytes, and numerous palms, and we saw a *Megaloprepus*, but we wanted to visit the real Florida Road, so there was nothing to do but ride back to the fork and go through the bananas. And here was just where our troubles began, for there were many paths through the bananas with branches in every direction and all looked alike. We had been offered a guide, but as P. had been there before he thought he could surely follow the same path. He was not prepared for the way the trails grow up and change their locations and as luck would have it we followed every trail but the right one! Fortunately the day was cloudy with some showers so that it was not so hot as usual in the bananas and we took a few insects, although there was nothing remarkable. About 11.30 we started back to the forest we had first entered, having convinced ourselves that we could not find the main Florida Road, and retraced our way as far

as the gate in the woods, where we left the horses. Here we ate our lunch, stopping to catch a *Megaloprepus* that obligingly alighted near us. Then we rambled about, following little paths where we saw tapir tracks, enjoying the many new plants but seeing very few dragonflies. One striking plant was *Uragoga tomentosa*, a Rubiaceous species peculiar to Costa Rica. This was a bush with opposite, reddish leaves, the heads of small white tubular flowers subtended by large fleshy bracts of a flaming red. In fruit it was still more conspicuous, for the bracts persisted and the berries were three-quarters of an inch long and bright purple in color. Another was an epiphytic vine (*Columnea* sp.), which sent out stiff short branches from each side of its main stem, the latter closely following the host trunk. The leaves of this plant were three to four inches long; from above they looked bright green with a small white patch not more than one-quarter inch across, from below they showed symmetrically-placed blotches of clear crimson. The tubular flowers were borne on slender peduncles two to three inches long, depending from the stiff little branches. The flower itself was a beautiful red, with a five-parted calyx of delicate, tender green set with soft whitish prickles, and in the forest of dark greens the tree bearing this vine was an exquisite sight.

All this time the clouds were growing more threatening and by one o'clock rain began; as it increased steadily and rapidly we hurried to the horses and started back. The road was even worse than it had been on the way out and P. was soon wet through; my poncho protected me quite well from the water descending as rain—but not from the water ascending as splashes, for in addition to the general wetness of the road we forded four rivers, two of which were deep enough to come over my boot tops unless I held my feet up out of the stirrups. Our horses were excellent, however, sure-

footed as goats, and we had no trouble in getting over or through these bad places. La Emilia, the starting and returning point of this second expedition to the Florida Road, was a cattle farm one mile east of Guápiles belonging to the United Fruit Company, where we were the guests of Mr. R. E. Woodbridge, the manager. We had left Cartago on November 15, on the "passenger" train for La Junta, where we waited for the Old Line train. The fine new bridge over the Reventazón at La Junta was completed but there was still no station there and we spent the time (nearly an hour) sitting on a bench on the little porch of a negro commissary, "restaurante y cantina" that stood on one side of the track near the switch. The heat was not at all noticeable as the day was cloudy and it was fairly comfortable there. We watched the Reventazón tearing along, a big swift stream, much nearer to the shop and cabins than would be agreeable to us if we had to live there, and the cocoanut palms and breadfruit trees made the place somewhat picturesque, otherwise it was simply a collection of negro huts, railway tracks, bananas and plantains.

We left La Junta about three o'clock, having planned the trip so that we should not go up the Old Line on a freight day. We therefore did not stop at every possible station and the delays were not long, but the train was exceedingly slow and jerky and it was six o'clock when we reached La Emilia.

The "stations" along this line were simply sheds built over the path leading up from the track to the company's farmhouse of that particular district, and clustered around the "station" were the cabins of the negroes who worked on the place. There were no roads except the railroad and the footpath along it and no villages except these clusters of cabins. This region was all forest until the Fruit Company cleared it for bananas or pasture land and it had been

unoccupied land for many years, probably centuries. That it was once occupied, however, perhaps thickly settled, is shown by the great number of Indian graves which contain quaint gold ornaments of forgotten workmanship and pottery of shapes and glazing far beyond the skill of the present native potter. The pottery was not firebaked and when first taken from the graves was as soft as mud, but if carefully removed and exposed to the sun it became as hard as rock although brittle. The gold ornaments were usually in the form of animals or birds, often quite accurately worked, and were found only in certain kinds of graves, supposed from the better workmanship and finer quality of pottery and the golden ornaments to be those of chiefs or important men.

The house at La Emilia was a two-story wooden building with a long ell and balconies nearly all around on both floors. In front of the house, between it and the tracks, was a formal garden with beds in geometrical patterns and the path edged with beautiful pink and white "mariposas" or periwinkles. The garden was rather new as yet but gave promise of being very pretty. Halfway down the walk was a pair of large "gavilans" (*Pentaclethra filamentosa*), leguminous trees with much divided leaves, but having the leaflets so closely arranged that they look quite solid and undivided. They were stiff and glossy and did not present at all the fern-like appearance of the guanacaste, for example, which has its leaves divided to the same degree. The pods were large, twelve to fifteen inches long, and borne stiffly at the outer surfaces of the crown of the tree.

Mrs. Woodbridge was extremely fond of flowers. All around the balconies were numerous potted plants and hanging baskets of orchids, ferns, caladiums and begonias. Many of the orchids were now blooming beautifully and all the plants were luxurious and thriving. One of the doorways

(all the rooms had doors and windows on the balconies) was draped in green, for an asparagus (*sprengeri* or near that species) growing in a small tub, had been trained up one side of the doorway, across the top and down the other side. On one side of the porch there was a wire network over which was trained a vine foreign to Costa Rica and highly esteemed here—white and yellow honeysuckle. On another side was a screen of *Clerodendron* with red and white flowers. The orchid tubers were favorite places for the nests of a little black bee (*Trigona cupira*) which has the habit of going always into the hair or beard to sting, never attacking the bare face or hands. Fortunately its sting is not severe, but it was necessary to look out for these bees when going about among the baskets on the balcony.

After coffee on the sixteenth we walked back (south) of the house into a potrero bordering a good-sized stream, the Rio Santa Clara, Mr. Woodbridge riding with us a little way to start us in the right direction. The potrero was pretty, though not so beautiful as the one we visited at Turrialba, and had many grand forest trees standing in it, left purposely for shade. Some of these trees bore an incredible weight of epiphytes, others having a smoother bark or the habit of peeling off the bark (like our northern sycamores) were perfectly clean. We spent parts of several days in this potrero, at times down among the rocks of the river, at times in the pasture itself where there were some small streams and pools but without finding anything very valuable. There were few dragonflies flying and those seen were not particularly rare. We noticed a large fallen tree, with glossy compound leaves, which bore curious fruits—small woody pods split in two, of which one side fell away leaving the other attached to the stem. The contents, one seed in a mass of pure white pulp, fell out and hung by some threads to the lower end of the pod and as the pod it-

self was colored a bright red inside and the fruits hung in large clusters, it was very conspicuous. The white pulp was sweet, with a curious flavor suggesting both turpentine and peppermint, and the leaf-cutting ants were busily cutting it up and carrying it away to their nests. Nearby was a fair-sized tree, which Sr. Tonduz later identified, from some pods we gathered, as a "Lorito" (*Pithecolobium* sp.). The fruit was a twisted legume four to five inches long with thick, fleshy, bright scarlet walls and containing a few fully uncovered shiny black seeds each half an inch long. The red and black of the fruit made a marked contrast with the shining green leaves. On the edge of the potrero and also in the banana fields we found a large purplish lubber grasshopper (*Tæniopoda centurio*) with bright red under-wings.

We often hunted for dragonfly larvæ between the bases of bromeliad leaves. There was a great variety of creatures living there and we found earthworms (*Dichogaster hilaris**, *Andiodrilus biolleyi*), pill-bugs (Isopods) daddy-longlegs (Phalangids—*Cynorta biguttata** and *longispina*), pseudo-scorpions (*Chelanops uniformis**), millipedes (*Aphelidesmus calverti*), earwigs (*Sparatta calverti*), roaches (*Anaplecta mexicana*), several species of beetle larvæ, as well as an adult beetle (*Phænonotum* sp.), caterpillars, larvæ of three species of mosquitoes and of one other dipterous insect. Those whose names are marked with an asterisk we found also in bromeliads at Juan Viñas at an altitude at least 1500 feet higher.

But the most astonishing creatures, and the most exciting, were two snakes, coiled up into a very small space, each in his own leaf. The bromeliad containing them was a single stock growing on a small tree at a height of about five feet from the ground. The first snake we dislodged with a stick, disabled it and carrying it as far as the house measured its length as twenty-five inches. The Costa Rican gar-

dener called it a "tamagá" and told us it was very deadly, as poisonous as the coral snake. If this were so, it seemed to us at the time, that this snake must chew and not strike. The head and fore part of the body were brought back to the United States and identified as *Leptodira albofusca*, widely distributed throughout tropical America. It has a pair of enlarged grooved teeth behind the other maxillary teeth, and the groove, on the front of each tooth, "conducts the secretion of the enlarged upper labial glands." *Leptodira* is a member of the subfamily Dipsadomorphinæ, one of the divisions of the Opisthoglypha Colubridæ. Of the Opisthoglypha, Dr. Gadow says (in the *Cambridge Natural History*): "Apparently all these snakes are more or less poisonous, paralyzing their prey before or during the act of deglutition. So far as man is concerned they are rather harmless, since the poison is not very strong, not available in large quantities, and above all because the small poison-teeth stand so far back that the snake cannot easily inflict wounds with them. The Opisthoglypha are of considerable morphological interest, since they connect the Colubridæ with the Viperidæ, the characteristic poisonous apparatus of which seems to have been derived from that of the Opisthoglypha by the reduction or shortening of the anterior portion of the maxillaries and the harmless teeth, so that the posterior or poison-fangs come to the front."

The second of our bromeliad snakes escaped unhurt. Both were very sluggish with eyes filmed over and, we suspected, were about to moult.

On November 18 we investigated some bromeliads on two trees that had just been cut down and were lying on the ground, practically untouched, in the potrero west of the stable of La Emilia. A peon cut off eight or ten of these epiphytes for us with his machete, when I examined them,

but although they still contained water and various insects, including the beetles *Alegoria sallæi* and *Metamasius ochreofasciatus*, there were no dragonfly larvæ. In all I must have spent two hours on a dozen plants which had been fifteen to twenty feet above the ground. The next day we pulled down a fair-sized bromeliad, perched ten feet up on a tree, by means of a convenient, nearby liana; still no Odonate larvæ. Thus although fifteen bromeliads at least were examined during our stay at La Emilia, all containing insects, some or all of which were associated in the same plant with dragonfly larvæ at Juan Viñas, not a single one of the last named was found. However, none of these bromeliads were in actual forest, but were on trees forming a mere fringe along the Rio Santa Clara, or were in open potreros, and the situations may account for the absence of these particular insects.

We had very few adult dragonflies to show for our stay at La Emilia, owing to the little sunshine and much cloudiness and rain. Our object was, indeed, to observe these insects under wet season conditions, but usually the mornings are bright even in this period, whereas we encountered a "temporal" or steady rain of several days' duration. The slightness of our results was doubtless due to the absence of sunshine.

When P. left Guápiles on June 6, he took the train for Guácimo, about eight miles to the east on the way back to La Junta, Mr. Reed having telephoned the night before to Mr. Stähle, the Mandador or manager, that I would come. Mr. Stähle (originally from Stuttgart) met me near the station and took me to the house, much less pretentious and comfortable than Salvador and tenanted by men only with the single exception of a Costa Rican(?) woman cook. I was given a room at the east end of the second floor having two windows and three doors, and stayed here two days.

As usual the farmhouse had verandas on both floors running completely around the house. From the veranda on which my room opened, one looked down almost directly on the Guácimo River, the constant roar of its waters usually making me think it was raining. Following the river upstream (south) the eye passed over the forest to the imposing crest of Turrialba; the other three volcanoes could not be as well seen here as from Salvador.

Mr. Stähle and Mr. Blair (Assistant Manager, a Harvard graduate of 1908) were about to go into the bananas on horseback and offered to show me a trail into the forest. They offered me a horse also but I declined it, knowing that in all probability I would frequently want to go where a horse could not or where it would be in the way.

At all the banana farms there run off from the main railroad tracks into the plantations, spurs which form right angles to the main tracks and are parallel to each other. To-day we followed the main track a short distance west from Guácimo farmhouse and then north along Spur 1. Workmen (negroes chiefly) were busy—Sunday seemed to be no different from other days here—cutting bunches of bananas, loading them on mules, bringing the loaded animals to certain points on the spur where the fruit was piled up on banana leaves laid on the ground and finally covered with the same when the pile was complete. The bananas are cut while still green at stages known as “three-quarters” or “three-quarters full” and much depends on the judgment of the cutter in selecting fruit just at these stages. If cut at a younger stage the fruit will not ripen when it reaches the United States or Europe, if cut a little riper it will spoil before it reaches its destination. Here and there along the spur were bunches with some yellow and consequently ripe bananas. These were rejected and left to rot. I ate some of these ripe bananas and could not find that they differed

much in taste from those to which I was accustomed at home. Spur 1 was, I believe, about three miles long, and the cutting done to-day was chiefly in the farther half and yielded some 2000 bunches or "stems" as they were called here. Stems bearing nine or more "hands" or tiers were reckoned as "firsts," those with a smaller number as "seconds." In some places "thirds" were also distinguished as stems with six or fewer hands. Each hand is composed of twelve or more "fingers" that is, individual bananas. It was no uncommon thing for a stem to comprise 150 bananas so that 2000 stems would mean 300,000 bananas for this week's cutting. In about a week later, depending somewhat on moisture and heat, the same ground can be cut over again—that is, other shoots of banana plant will have come into the cutting stage and this process is continued throughout the entire year for seven or eight years or even longer in some spots where the surface soil is deeper.

This constant productivity of the bananas is brought about by the care taken to plant continually new young shoots to replace those which have borne, for each shoot yields but one stem, after which it is cut down and, so far as my observation went, allowed to decay on the ground. According to Mr. Blair (who supplied much of the preceding information) the productive soil at Guácimo farm is only two to three feet deep and is underlaid by red clay and loose rounded stones. When this surface soil is exhausted the bananas no longer thrive. In such cases it was the policy of the United Fruit Company to let the land lie fallow since it was cheaper to clear off forest and make new plantings. The abandoned banana fields soon become filled up with a dense growth including saplings. Mr. Blair's experience was not long enough for him to say certainly whether the forest eventually reclaimed its own, although he inclined to think that the reclamation did come albeit slowly.

The tracks of Spur 1 were supported on iron ties ballasted with small rounded stones and for much of the way through the bananas ran on a low embankment, intersected frequently by "culverts" or short wooden trestles crossing streams of swift-flowing water. Horsemen traveled along the embankment until they came to a culvert, where a side path led down from the tracks to the stream and ford and up to the tracks again. Progress on horseback was only at a walk and not much faster than that of the pedestrian who could follow the tracks uninterruptedly across the culverts.

As I walked along Spur 1 every now and then the brilliant green-and-black-barred day-flying moth (*Uranidia fulgens*), rose from the ground as I approached and fluttered on ahead or into the bananas. A great heavy lumbering grasshopper (*Taniopoda centurio*) of Indian red, mottled with darker colors and with short bright red wings edged with black, sometimes crawled off into the grass; its weight seemed too great for it to execute more than very short flights. At one culvert, where the water was easy to reach and rippled over small stones, were some dragonflies whose flight up and down short reaches of the stream was so swift that I could not recognize them. I stationed myself to watch and to catch them. When several were together they flew so fast that recognition and capture alike were impossible even at a foot's distance. When one was alone, however, it flew more slowly. I found that by holding the net a few inches above the water, waiting until the insect was underneath and then suddenly submerging it, the current carried the dragonfly into the net. I thus secured in all six specimens of the insect (*Brechmorhoga præcox*) but it took about half an hour in the full heat of the sun.

There was localization in distribution too in the banana field dragonflies. Near the end of the spur, four or five yards from the tracks, was a narrow ditch containing a little

slowly-flowing water. The six or eight species found here were all different from those on the larger swift-flowing streams.

The road which had been cut into the forest for a distance of 2300 meters in direct continuation of Spur 1 had not been entirely cleared but here and there was filled with grass and shrubs, at other places was open with rain-water puddles on its clay surface. The forest immediately bordering this road had few palms but these increased in number to the eastward.

Crossing a pasture with cattle, horses and mules, directly opposite the Guácimo farmhouse, brought me into another part of the bananas. Following a very narrow gauge tram track and then a log-hauling trail, I reached a piece of forest where palms were largely in the ascendant although exogenous trees were not lacking. The trail was in places completely overarched and was then dark and muddy. In one of these dark spots, amidst a tangle of lianas where the net was not usable, I caught in my fingers a great dragonfly (*Gynacantha membranalis*) never before known north of Chiriquí. It was three and one-quarter inches long, with a wing-spread of four and a half inches; it had brilliant metallic green eyes and a reddish-brown patch on the bases of the hind wings.

At another lighter place there was on the ground what at first looked like a long, slender, wriggling, whitish worm, but a second, nearer glance showed at once that it was a procession of termites ("white ants" or "wood ants," which of course are not ants at all). The procession issued from a hole at the surface of the ground on one side of the trail, the objective point being a tunnel running up a small tree to a nest on the opposite side. The trail was about two feet wide but there was water and wet mud in the middle so that to cross on dry land the route lay down one side of the trail

to a dry spot, then across and up the opposite side to the lower end of a tunnel almost directly opposite to the hole from which the insects issued. This meant a journey of three or four yards to accomplish two feet of air-line. The termites walked singly, or by twos or threes, in a continuous line, those behind practically touching those in front. Every little deviation from a straight line made by the insects in front was exactly followed by those behind, these deviations being often not explicable by wetness or roughness of the soil. The procession consisted of two kinds of individuals, the larger workers and the smaller, dark-headed "nasutes," so called because their heads are prolonged forward into a rather sharp process suggesting a snout. The nasutes were fewer than the workers. The tunnel to which the column proceeded was one of the usual kind—a flattened arched way running up the tree-trunk to the nest and made of wood which had been chewed by the termites.

After watching the procession for a few minutes, I took a little clump of wet mud and put it on the insects' path. Those approaching this obstacle were instantly confused on reaching it, for although winged termites have eyes these workers and nasutes are eyeless; they have antennæ, however. Some turned back and went for several feet along the way they had come, followed by an increasing number, even after a way around the obstacle had been found. I think that those which turned back were exclusively workers. In the meantime some workers and the nasutes were exploring to each side of the lump of wet mud, which was not more than an inch in length, some going to one side, some to the other. The mud thus produced a break in the procession, and some nasutes that had already passed the place where I put the mud came back as if to learn what was wrong. Finally it was found that it was possible to pass around one end of the mud and, this done, to find the original trail

and in a short time the procession was again continuous, every insect in the line making a slight detour around the wet mud.

Then taking a little stick I drew it across the line of march so as to form a tiny trench about an inch long, an eighth of an inch wide and an eighth to a quarter inch deep. Again were the termites troubled when they reached its edge, and some time elapsed before a detour was made around it and the march resumed. A few also made their way down into and up out of the trench in the same line as they had originally marched. In both interruptions it seemed to be the nasutes which led in finding the way, although a worker was usually not far behind.

I broke a little of the arched tunnel running up the tree-trunk; within were ascending termites. When I came back to this spot, in less than half an hour, the procession was over, only a few straggling individuals being visible.

The last five days of walking over wet, rough, uneven ground had so chafed my heels that they were now very sore. But I could not bear the thought of losing another opportunity of visiting the forest as the weather was good and I needed to return to Cartago on the morrow. So on the seventh, declining another offer of a horse for the same reason as before, and taking lunch with me, I set out for the forest road at the end of Spur 1 which I had already visited. Walking being slow and painful, it took me the greater part of two hours to cover the three miles, including, however, a half hour's stop in a broiling hot sun at the ditch near the spur's end.

A train of a few freight cars had been run up the spur this morning and was stopping at the piles of bananas, which were loaded into the cars by negroes. Banana cutting was also proceeding on the nearer half of Spur 1 and 1600 stems were expected for the day. From the farms the bananas

were carried by rail to Limón where they were transferred to steamers of the United Fruit Company or Hamburg-American Line, fitted up with cooling appliances which keep the fruit at about 60° Fahrenheit during the voyage.

Several species of dragonflies which I had not previously taken at Guácimo or Guápiles rewarded me on this walk and made me feel justified in the day's program. Another interesting insect was a long-horned beetle (*Ptychodes lecontei*) 27 mm. long, whose black and yellow striped body and legs spread out in various directions caused me to think it at first glance, a spider, like the large black and yellow *Argiope* we have at home.

I left the forest about 1.30 P. M. for the long hot walk back, although this day I had brought an umbrella as protection from the sun, which blazed fiercely down on the track. A number of bright and interesting butterflies enlivened the way, however. There were swarms consisting of twenty to forty individuals of three species, with bright orange (*Callidryas argante*), yellow (*Callidryas trite*), or white (*Pieris ilaire*) wings, all of nearly the same size, the wing-spread being two and three-eighths inches. These settled near together between the tracks. As I approached they rose gradually and for a few steps I would be in the very center of the flying insects, realizing exactly Andrew Lang's simile of "living blossoms of flying flowers." Then they flew off in advance, in what from behind looked like irregular confusion, but which I think was really a single file whose members made a series of undulations but nevertheless strictly "followed their leader." Then by and by the line reassembled in a close mass on the ground until my approach again dispersed them. The spots at which they settled did not seem to be determined by presence of moisture as is often the case.

Where some rotting bananas lay on the ground there was

frequently to be seen a moderate-sized butterfly (*Victorina stelenes*) whose wings, spreading three inches, were pale green marked with brown; the brown marks were so arranged as to cause the paler color to form two rows of spots on the front wings, a band and a row of spots on the hind wings, the inner row or band wider than the outer row in both cases. I came to think of it as preëminently a banana butterfly, but its swiftness and wariness prevented my taking it, at least in my physical condition at that time. Subsequently, however, I caught it at Turrúcares and Alajuela where there were few bananas.

Once when resting near a pile of bananas to see if the butterfly would return, I heard a loud clicking noise that I at once supposed to proceed from a grasshopper or katydid and on looking around to find the musician was astonished to see two butterflies in the spot whence the sound came. Once again at another place I heard the same sound from a pair of the same kind. They belonged to the genus *Ageronia* and the wings were spotted pale blue and white on the upper side. I saw many individuals during the two days I was at Guácimo but never heard the sound except when two were together, so it may be a sex call. So few Lepidoptera make sounds that the case is noteworthy. One observer's idea, quoted in the *Cambridge Natural History*, was that the sound attracts a certain bird; I did not know of this when I heard the butterflies, but I saw no bird pursuing the insects.

Several times in the banana fields I saw handsome black and reddish-brown butterflies of powerful and swift flight, which were, I think, *Aganisthos orion*. I had come to consider it as very wary so that I was astonished this afternoon to have one, on two distinct occasions, fly round and round me close to my person and at length, on the second occasion, alight on my leg as I was standing up. The only explanation

I could think of was that the insect was attracted by the perspiration, as has been noticed in some other species.

My insect net these two days was often much hampered by brushing against seeds (which we think of as autumnal) which then adhered to it and tangled it up. These were beggars' ticks very like our own *Desmodium*, small burrs a quarter of an inch long and seeds resembling "Spanish daggers" but narrower and having three prongs at the end instead of two.

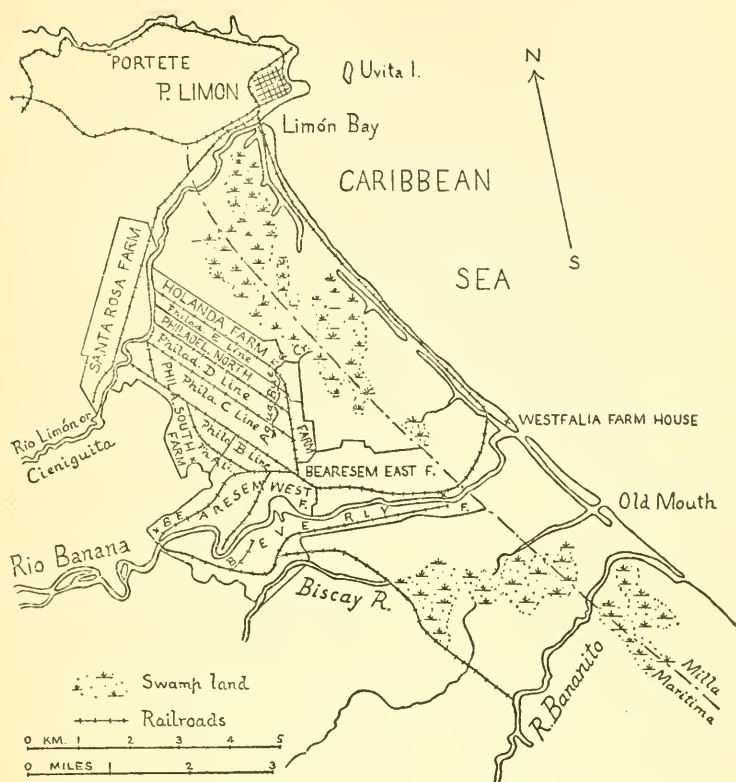
By way of summary of the Guápiles-Guácimo trip, I found on returning to Cartago that in the six days of June I caught or definitely identified specimens of forty-four species of dragonflies, not one of which had I met around Cartago; that of the forty-four, three had not been recorded from Central America or Mexico and may possibly be entirely new, one of the three representing a subfamily never before met with in these countries; fourteen had not been previously recorded for Costa Rica, and thirteen, although known from the Pacific Slope of this country had not previously been recorded from the Atlantic side, so that thirty of the forty-four were additions to knowledge of geographical distribution.

CHAPTER XVI

THE BANANA RIVER COUNTRY

About six miles south of Limón, the Banana River empties into the Caribbean Sea. The United Fruit Company has a number of banana farms in its watershed and a railroad runs to the river, ascends its left bank, crosses and goes on five miles beyond to the Rio Bananito, which also discharges into the Caribbean.

On the morning of November 4, 1909, P. left Limón by the Banana River train, which ran south along the beach above high tide, among cocoanut palms and here and there patches of swamp palms. At Westfalia Commissary Station, about six miles from Limón, we left the beach and soon after passed a plantation of cacao, with trees only ten to fifteen feet high; they were planted in rows and bore fruit on their trunks which was now green tinted with pink or rose. For the rest of the way we were among bananas. At Bearesem East Farm the track was very close to the Banana River. Sometimes going ahead, sometimes backing, we came to, stopped at and went on from Beverly Farm, and Beverly Commissary, which were on the level, and Bearesem West Farm to Philadelphia South Farm. The farmhouses on these last two farms were each set on a hill some hundred feet above the tracks. At Philadelphia South I alighted, having a letter from Mr. Hitchcock to Mr. C. J. Veitch, Superintendent of the Banana River Division. Mr. Schaus had suggested Bearesem West Farm as being probably the best for my purposes and Mr. Hitchcock had named this place in the letter of introduction. Mr. Veitch received



The Banana River country. (From a map of the United Fruit Co.)

me cordially and said he would send me to Bearesem West if I wished but thought I would find more comfortable quarters with him at Philadelphia South. So I accepted his offer for a day or two at least and having been given a pleasant airy room changed to my collecting outfit and went into the bananas at the foot of the hill, collecting along a little brook until breakfast. The elevation was perhaps fifty feet; a refreshing breeze was blowing, but the sun shone brightly and when not shaded by the bananas it was decidedly hot.

The location of the Superintendent's house on the hill made it much more pleasant as regards temperature, as it usually received more wind. The two-storied house, with verandas on all sides, was connected with an office over which were two bedrooms and one of these I occupied. The house presented a very attractive appearance, due to the hanging baskets of ferns and other plants with which Mr. and Mrs. Veitch had adorned it. In front were a few eucalyptus, cocoanut and orange trees. A garden had been started and on one side were breadfruit trees. A fallen leaf from one of these last was twenty-nine and a half inches long. It was deeply divided into five pointed lobes on each side of the midrib and glossy green.

Mr. and Mrs. Veitch were English and had lived in South Africa before coming to Costa Rica. Before he became Superintendent here, they were at Chirripo Farm when the floods of December, 1908, came down the Chirripo River at midnight carrying away seven houses just above theirs and the iron railroad bridge and flowing a foot deep across the office in their first floor. Expecting their house to go next, Mrs. Veitch, her daughter and two negro women servants were put into a dugout at 2 A. M. in pitchy darkness amid the roaring of the flood and the boat was then dragged by a rope, while Mr. Veitch waded behind guiding it, to the foreman's house which was a little higher up. The next day, the floods having subsided a little, they returned to their own house, but other freshets came and before the floods were over they left their house seven times on account of threatening danger. The house here at Philadelphia South was situated on a hill of reddish gravelly clay (apparently without pebbles), and seemed entirely free from the possibility of danger from floods.

Back of the house were many pineapple plants for the family's use, the stable yards for the horses, mules and cows,

a pasture, and then the forest, barely a quarter-mile from the house. There was a trail into it whose beginning was marked by a cluster of fine trees called, I believe, "pavon." At some distance east along this trail was a clearing with a few scattered bananas and pineapple plants. Among the dry withered banana leaves lying on the ground I had a glimpse of a great brown cockroach, seemingly more than three inches long, but although I searched for him, turning over the leaves, he managed to escape. I did secure, however, a magnificent metallic green wasp, *Ampulex neotropica*, an inch long, its wings clouded with brown. Under a lens the surface of the entire body is finely pitted, while on head and thorax are larger pits among the small ones and many short whitish or grayish hairs. The head is prolonged forwards into a triangle and the antennæ situated on the prolongation in front of the level of the large eyes. The large black mandibles are attached to the head, one below each eye, and curved outward and forward in such a way as to leave an open space between each mandible and the remainder of the head, instead of the jaw when closed lying in contact with the head, as is the usual condition in insects. This arrangement of the mandibles suggests the zygomatic arch of the skull of higher mammals, while it must give *Ampulex* a very wide gape. The maxillæ and labium are attached to the head at a level in front of the attachment of the mandibles. As the Ampulicidæ are said to feed on cockroaches the finding of this individual immediately after seeing the large roach may not have been a mere coincidence.

Then I passed through more forest and finally into a creek, walking down whose stony bed brought me into the bananas of the farm again. Just before reaching the bananas the creek ran through many *Heliconias*, some of which were the largest I saw, each leaf and leafstalk being about

twenty feet long while the pendent red flower cluster was fully ten feet long. The Heliconias have no trunk, all the leaves springing from the surface of the ground. Elsewhere pasture instead of bananas bordered the same piece of forest, and in a higher part of the pasture a bank of the red clay was exposed. Many large dragonflies were flying about here, and looking more closely I found that they frequently alighted on the grass stems at the edge of this clay bank, assuming a vertical position and often closing the wings. Even so I caught them with difficulty and found them to be *Pantala hymenæa*, mentioned in Chapter V.

On November 4 Mr. Veitch gave me a "trolley" to take me to the end of a line of railroad track known as "Philadelphia B Line." A "trolley" is a two-seated hand car manned by two men on the front seat, the passenger sitting on the rear seat. In such luxury I reached the Cieniguita River, which on arriving near Limón becomes the Limón River. I crossed it on a narrow footbridge at a place where, with the dry conditions that had prevailed here for weeks past, the river was not more than ten to fifteen feet wide. The opposite (left) bank in Santa Rosa Farm was planted in bananas. The banks of the river were in many places almost perpendicular and ten to fifteen feet high, but here and there it was possible to get down to the water's surface. All the banks were fairly well covered with bushes or high grass and there were many logs and fallen branches. Once while stalking some insects I heard a loud splash, as if some large body had fallen into the water, a few rods farther upstream. Looking in that direction I saw a large iguana crawl out on a slanting log and rest a few seconds at full length upon it so that I had a distinct profile view showing its large neckfold and its serrated dorsal edge. The reptile was fully five feet long. Just then something else attracted my attention for an instant and when I looked again the iguana was gone.

A pair of the handsome dragonfly *Heterina titia* were engaged in laying eggs, the male holding the prothorax of the female by his caudal appendages and the two flying along together. They alighted on a bare sloping branch which projected some eight inches above the water's surface. On the downstream side of this they backed toward the water, the female becoming completely submerged, but the male on reaching the water let go his hold of the female and remained in the air, making short flights from time to time but returning to the top of the stick. The female meanwhile backed farther and farther down and was much of the time out of sight, owing to the muddiness of the water. Occasionally I could get a glint of light reflected from the white envelope of air around her body and wings. She was inserting her eggs into the stick and remained completely submerged from 2.35 to 2.47 P. M., then climbed to the water's surface—to be met by my net and transferred to my collecting box.

The male of *Heterina titia* has much or all of the hind wings dark brown, the front wings bright red at the base, the red bordered externally with dark brown but leaving the outer half of the wing clear except at the extreme tip. The females have the wings yellowish or, when older, dark brown, but without any red at any time. The body of this species is one and seven-eighths inches long and the spread of wings two and one-quarter inches. *Heterina titia* and a companion species on the Cienguita this day, *Neoneura amelia*, had not been recorded as occurring in Costa Rica. *Neoneura amelia* is a much smaller insect, less than one and one-quarter inches in body-length, with clear wings which spread one and two-fifths inches; the body of the male is black and orange-red, of the female black and greenish-yellow; both sexes are very slender.

As usual in the hotter parts of Costa Rica there were

many termite nests and tunnels among and on the trees. Many of the inhabited nests were but three feet or so above the ground. I broke a piece of a tunnel and of a nest; in both cases the damage was at once inspected by nasutes, ten or twelve appearing in the latter case, but repair did not begin in either case as long as I cared to spend in watching.

Under a very tall tree by the river bank were numerous hard fruits three to four inches long, two to three wide and one to one and one-half thick, flattened or concave on one side, convex on the other, with low ridges radiating from a point near the blunter end and with minute pits between the ridges. The following day Mr. Sullivan told me he thought the tree producing them was called "cacheibo." The fruits were subsequently identified by Professor Pittier as *Prioria copaifera*, the Costa Rican "camibar." He adds that from it is extracted the resin known in commerce under the name of copaiba balsam, which has various applications in medicine and in pharmacy.

By trolley again on the morning of the fifth I went to the "Philadelphia E Line" of track, lying in Holanda Farm (the Spanish name for Holland, referring to the low swampy character of much of the land within it). Here by arrangement of Mr. Veitch, Mr. Sullivan, the mandador, met me to show me the path into the forest lying a short distance north of the "E Line." Mr. Sullivan was formerly employed in the Botanical Gardens in Jamaica and had some acquaintance with plants in consequence. We went through the bananas and then into the forest along Agua Buena Creek, as it is marked on the Fruit Company's maps of these farms; but the water although moderately clear did not look to be particularly good as there were many shreds of apparently organic matter in it. Its bottom is a bluish clay. The place looked promising for dragonflies but the sky was dull—had the sun shone brightly I think I should have secured some

specimens. In the hope that the light would improve we waited an hour at one place, but in vain. While there, humming-birds came to look at us and to bathe. Three different species were represented at one time or another. One, the largest, had a markedly forked tail and a long curved beak. A second, the smallest, was almost entirely a pale reddish-brown. The handsomest was deep metallic blue with a patch of paler greenish-blue at the throat; this was the "Costa Rican Wood Nymph" (*Thalurania colombica venusta*). As many travelers have noted, they were quite fearless, approaching to within a few feet of us. The blue one bathed repeatedly before us, retiring to a low branch after each dip to shake its feathers.

There were many tracks leading down to this creek which Mr. Sullivan pointed out to me as those of the "mountain cow" or tapir. A large log which had fallen across the creek about eight feet above the water was a resting place for bats of moderate size, half a dozen being disturbed by the waving of my net as I tried to flush some insects that might be lurking in the neighboring vegetation.

As the morning of November 7 was bright, sunny and hot I decided to try Agua Buena Creek again. The trolley was not available and a horse not very useful so I set out on foot across the banana fields. Parts of Philadelphia North and Holanda Farms through which I passed had been abandoned owing to the poor quality of the fruit. These parts were in consequence much overgrown and progress over them was rather tiresome.

Every morning during my week in this region I frequently met small flocks of moderate-sized dragonflies along the railroad tracks, these flocks separated from each other by intervals of a hundred yards or even less. The insects usually flew at such a height above the ground as to be beyond the reach of my net, say fifteen to twenty feet. But this morn-

ing I fell in with a flock of about twenty-five individuals flying lower than usual and by standing still in the hot sun and waiting until one was very close to me I succeeded in capturing enough specimens to show that the flock was comprised of four species—the very widespread *Pantala flavescens* and *P. hymenæa* and the less widely found *Tramea cophysa* and *Macrothemis hemichlora*. These differently-colored and -marked species flew around and among each other, sometimes seeming to drift in one direction, sometimes in another, chiefly employed in catching small insects in the air. They rarely alighted and apparently sustained themselves with little muscular effort except when the wind blew. In Chapter V we have already given brief descriptions of the species of *Pantala*. The genus *Tramea* is closely allied and likewise has the hind wings very broad at the base. Those interested in identifying them may recognize *Pantala* by the third and fourth segments of the abdomen (counting always from its anterior end) having each three cross-ridges which almost entirely surround the body, while the same segments in *Tramea* have only two cross-ridges each. Moreover, in *Pantala* in the apical third of the wings, are two parallel and closely adjacent veins (M_2 and R_s) which are strongly waved with two convexities directed forward; these same two veins in *Tramea* are almost straight and only as they approach the hind margin of the wing are they curved toward it. *Tramea cophysa* has a brown band, about an eighth of an inch wide, on the base of each hind wing reaching from the fifth vein (counting that on the front margin as the first vein) to the hind margin; this insect is of very nearly the same size as the two *Pantalas*. The peculiarity of *Macrothemis* is that the tooth, which is present on the under side of each of the two claws with which each leg of a dragonfly is tipped, is here so large as to equal or exceed in length and thickness the point of the claw itself. The claw conse-

quently appears divided into two nearly equal branches. *Macrothemis hemichlora* has a wing-spread of two and one-quarter to two and one-half inches, the wings being usually tinged more or less with yellowish; the females often, but not always, have the apical two-fifths of the front wings browner than the remainder of the wings.

Going eastwardly along E Line I came to Agua Buena Creek where it was unshaded except for bananas, and under the little railroad bridge I saw a curious sight. A log a few inches in diameter lay partly in, partly out, of water but spanning the creek from bank to bank. From the soil at one bank ran a small covered tunnel, made of little fragments of wood, on to the upper, dry surface of the log. Farther on this tunnel was entirely open and still farther there was no tunnel at all. The uncovered portion and on to the bank where no tunnel existed was arched over with a mass of worker ants forming living roof and walls for the tunnel. Their antennæ were waving to and fro, giving the mass a most dizzy appearance. With the workers were also some soldiers. Within these living walls could be seen two files of smaller workers running with great speed in opposite directions, one file empty—"handed" (empty-jawed would be more accurate), the other file bearing pupæ and larvæ. I broke a portion of the tunnel where its roof and walls were formed entirely of wood fragments. Almost immediately a number of the larger workers appeared and stationed themselves along the edges of the broken portion, with their jaws wide open and their abdomens bent outward so as to present both weapons—jaws and stings—to a possible foe and so protect the files of workers which were running so swiftly through the tunnel. The appearance of these guards along the broken edges, with jaws and stings turned outward, was quite laughable, but a blade of grass touching them was savagely attacked. On both sides of the creek

the ants entered the soil and without much time and digging it was impossible to ascertain whether a raid by one ant community on another was in progress or not. These proved to be *Eciton prædator*, a well-known "army" or "foraging" ant.

As I left the track and went on through the bananas towards the woodland, a number of Syntomid moths (*Dinia eagrus*) with clear wings and dark brown body fringed with bright red each side of the abdomen, were flying through the underbrush in a manner suggestive of wasps.

A number of nuts and seeds were floating in the woodland stretch of Agua Buena Creek. In these the dragonfly *Neo-neura amelia* was laying eggs, the male and female flying together, the former holding the latter's prothorax by the appendages at the tip of his abdomen. On alighting on the nut, the rather dull-colored female bent her abdomen to insert the eggs into the nut's substance and owing to her colors did not at once attract the observer, but the male, standing rigidly upright with no support other than that given by his grasp of the female, was conspicuous from his red head, thorax and first few abdominal segments. At one time six to eight pairs of this species were ovipositing side by side.

A chrysopid or hemerobiid larva came from somewhere on to my net. He bore a silken case attached to which were remains of various insects whose juices he had sucked to his own bodily advantage. The case serves as a protective covering, presumably, but one might imagine that the attached insect remains might be a disadvantage to the chrysopid, for, as the latter moved about, an insectivorous enemy might mistake the movements of the case as due to the attached insects and, snapping at them, kill the chrysopid within.

There were more insects visible this day than on my pre-

vious visit, at least as long as the sun shone, and had the day remained bright later than 1 P. M. I should have found still others.

Lizards and members of the salamander and frog groups were extremely abundant almost everywhere in the Banana River Region at this time. I made no attempt to gather any lizards—which were very speedy for one thing!—and I neglected the salamanders, but some of the frogs attracted my attention, as they must everyone's who sees them, on account of their bright colors. The most abundant (*Dendrobates typographus*) was bright, flaming red with some irregular black marks on the under surface, and three-quarters to an inch in length. Less abundant but not rare was a pale greenish-blue frog (*D. tinctorius*) with black stripes and spots over the whole body including the legs; the body was one and three-quarters to two inches long. Few animals exceed this frog in color variations. Dr. Gadow (*Cambridge Natural History*, vol. viii, pp. 272-273 and fig. 53) gives examples of their very great range and mentions that the animal's specific name is due to the secretion from its skin being used to dye the green Amazon-parrots, the subsequently appearing young feathers being yellow instead of green. The secretion is also said to be used as an arrow poison by Colombian Indians. Individuals of *D. tinctorius* may very closely resemble in color those of another Costa Rican frog, *Atelopus varius*. Externally the former may be distinguished by the tips of the fingers and toes having bifid pads, the toes not webbed and the head in dorsal or ventral view less pointed at the muzzle. *A. varius* has the same tips undivided and the toes webbed, but also shows many color variations. Gunther has given some colored figures of these in the *Biologia Centrali-Americana* and says: "The ground-colour is black, the ornamental colours pink, yellow and green. The latter are distributed in various pat-

terns, in the form of spots, or longitudinal bands, irregularly and more rarely symmetrically. The upper or lower parts may be black, almost uniform, or pink with scarcely a trace of black. In some of the most aberrant colour-variations the ground-colour is grayish, and the yellow bands are edged with black; in others the colours assume a reticulated pattern; and, finally, specimens occur of a brownish-olive, mottled and dotted with darker, the abdomen in these being yellow with some irregular black linear figures." A third species, of about the size of the red one, was black with a narrow yellow stripe along each edge of the back; it may have been *Hylodes rhodopis*. All three species occurred both in forest and in banana land. After handling them I could not detect any disagreeable odor on my fingers. I killed a couple of the red frogs and one of the blue and black kind in the cyanide bottle and put them into separate bottles of alcohol, but the red ones lost their red after two days; the blue and black species retained the colors much better.

On November 8 the trolley took me to Bearesem East Farmhouse, on the left bank of the Banana River. Mr. Veitch gave me the etymology of the scriptural-sounding name "Bearesem" as follows: before the farms were laid out there existed hereabouts a Banana River Saw Mill, usually referred to as B. R. S. M. When the time came to name two of these farms some one devised their present names by spelling out these initials Be-ar-es-em, now pronounced "Béreseem." In advance of my arrival at Bearesem East Farmhouse, Mr. Veitch had arranged by telephone for my use of a rowboat belonging to Mr. Brandon, mandador of the farm. He in his turn procured two negroes to do the rowing and also asked permission to accompany me for part of the way.

The Banana River from Bearesem East Farmhouse to its

mouth is two to three hundred feet wide, with banks fifteen to twenty feet high; these were covered in many places with wild cane, elsewhere bordered by banana-plantations and on the right bank near the mouth by forest to a slight extent. The current was not swift here for the fall was but slight, and within the banks mentioned and at a lower level were frequent stony or sandy beaches, enclosing so-called lagunas or almost landlocked arms of the river.

We went downstream slowly, as near as possible to the vegetation of a bank so that I might see and gather any dragonflies to be found there. Once a ripple was pointed out as a place where the negroes had seen an "alligator" sink. We landed on several of the little beaches and these, or rather their lagunas, furnished better collecting-grounds than the river itself. As we neared the mouth of the river a tall tree on the right bank came into view; it was leafless but at its crown were many of the hanging nests of the oropendolas. I counted seventy and had then to stop counting owing to the changing position of the boat, but I think I had counted only half. Herons, white, gray or black, were disturbed by our approach and flew down ahead of us or turned and, passing over us, went upstream to be again aroused on our return. These herons were not numerous, however. Sandpipers, looking like those at home, ran along beach-edges or skimmed the water's surface.

The river emptied into the Caribbean by a rather narrow passage. I landed on the sandy strip which separated the sea from the river before the latter narrowed. The surf was fine and heavy. Many black vultures were standing on the sand, waiting for river or sea to bring carrion. Four pelicans were swimming inside the breakers, looking like great swans, or flying over the water for short distances. A flock of fifty or more dragonflies (*Pantala flavescens*, *Tramea cophysa*, *Miathyria marcella*) was drifting over the sand

strip near the river, fairly low but rising in the air when I tried to catch them in my net. (*Miathyria* is another relative of *Tramea* and has two cross-ridges on the third abdominal segment but only one cross-ridge on the fourth segment; *Miathyria marcella* is one and one-half inches long and its wing-spread two and one-half inches; the hind wings have a brown band at the base which usually does not reach to the hind margin. Like *Tramea cophysa* it is a widespread species in the American tropics.)

Close to the mouth of the river an arm—the Westfalia Laguna—branched to the left (north). Up this I now directed the boat, Mr. Brandon having been obliged to leave us long before; the banks were lined with water-hyacinths (*Eichhornia*) which soon became so numerous that the water's surface was completely covered. We forced our way through them as far as the railroad bridge, beyond which we could not go as a staging for repairs had been constructed beneath the bridge. We went back to the river, stopping a few moments at the landing-stage of Westfalia Farmhouse which latter lies on the beach between the sea and the laguna a few hundred feet north of the mouth of the river.

Just above the opening of the Westfalia Laguna into the river, and on the same bank, was another, opening at both ends into the river so as to form a side channel. We went through this also. At some spots in it were millions of small, almost totally transparent fish. At times, a whole swarm of these fish leaped simultaneously out of the water into the air, giving the appearance of a wave. There were many transparent prawns, about an inch in length, here also. Among the water-hyacinths of the Westfalia Laguna, and to a less extent along this second laguna, we took a number of *Enallagma cultellatum*, a yellow, black and blue dragonfly of small size, new to Costa Rica. Between this second laguna

and Bearesem East Farmhouse, on our return, we picked from the stems of plants along the water's edge, fifteen or twenty shed skins of a Gomphine dragonfly (*Gomphoides*) of a species which I never saw in the winged condition anywhere in the Banana River region. An almost parallel experience we had along Crum Creek, in Pennsylvania, in July and August, 1908, with another Gomphine and similar observations have been made in other parts of the world.

On November 9 Mr. Veitch gave me a horse and telephoned to Señor Vivo, mandador of Bearesem West Farm, to meet me at Beverly Commissary. The only road was the railroad and the horses here were accustomed to walk the ties or, where there was a smooth path at the side of the roadbed, to travel on that. In either case the pace can rarely be faster than a walk, so at a walk I rode to Beverly Commissary where Bearesem West Main Line and Philadelphia A Line met. Beside Beverly Commissary stood a schoolhouse, chiefly, perhaps wholly, for the negro children, and another edifice bearing the sign "Philadelphia Church." These buildings had red tile roofs which formed a strong contrast to the surrounding green of the bananas as seen from the verandas of the Superintendent's house at Philadelphia South.

At Beverly Commissary Señor Vivo was waiting for me on horseback. He had agreed to take me to a creek crossed by "Spur 3," to certain points on the upper Banana River, and to a potrero in (I think) Section 38 of Bearesem West Farm. So we rode first through the bananas from Bearesem West Main Line to Spur 3 and along the latter track to a creek formerly crossed by a bridge which was carried away in the great floods of the preceding December. The creek was broken up into pools here and there and dragonflies were fairly abundant but so alert and wary that I could not catch one.

Then we returned to Bearesem West Main Line and rode along it past the farmhouse to the left bank of the Banana River, up that bank, under the railroad bridge, through an independent banana farm belonging to one Schutt and so to a reservoir collecting water for Limón. Under the bridge and along the river bank our way was on a narrow and muddy path over or alongside the two large iron pipes carrying the water from the reservoir to Limón. At the reservoir Señor Vivo said it was impossible to ride further as the path going upstream was still narrower than before; after giving me directions for proceeding on foot he returned to his house for breakfast, while I, leaving my horse in charge of a man at the reservoir, walked up the river bank intending to rejoin Señor Vivo at his house later so that we could go to the potrero together.

From the reservoir, which was quite near the winding Banana River, two pipes ran up the bank to a small creek supplying water to a higher reservoir. The path followed those pipes. The forest came down to the upper reservoir and I turned into it as there was little to be found at the reservoir or the creek. However, when I first arrived at the upper reservoir, there were on the cement walls a great many of what I supposed to be flies, but on catching and examining a number they proved to be small crickets, a species of *Rhipipteryx* allied to *pulicaria*. The body, in the dried specimens, is not quite 4 millimeters long, of a dull pale brown or a dull olive above, with blackish marks on the head (other than the eyes) and on the prothorax. The under surface and the legs are largely blue-black, especially the relatively huge femora of the third pair. As in other species of *Rhipipteryx*, described on page 202, the wings when at rest project a short distance beyond the tip of the abdomen.

In the forest I found a number of dragonflies which I

had not seen since my visit to Guápiles and Guácimo in June. Some of these took a long time to capture, such as species of *Gynacantha* found only in the dark forest of the warmer parts of the country so far as my experience goes. I noticed an individual in a certain round, slightly depressed area containing no growing plants but with leaves and sticks on the still damp ground—all of which made me suspect that in wet weather this was a little pool. It was surrounded by a circle of small palms two to four feet high and the whole place was deeply shaded by tall trees. When I first found this spot and saw the insect, the dragonfly disappeared and I went elsewhere, after mentally noting the place for a visit on my return. A few hours later I came again and saw two species of *Gynacantha* there. They were large dragonflies of strong flight but one of their peculiarities was that they usually alighted close to the ground and almost invariably selected the undersides of the midribs of the arched palm leaves. In such positions it was often impossible to use a net and then I tried to slip up to them, so slowly and quietly that they would not be disturbed, and catch them in my fingers. I succeeded with *Gynacantha trifida* but not with the larger *G. gracilis*, although once as the latter flew off it rubbed against my dangerous fingertips. It was *gracilis* I especially wanted and it was essential not to frighten it, for I knew that if that happened it would fly far away and I would never see it again. So I followed it as it flew from one side to the other of the circle of little palms as I disturbed but did not alarm it. At times when my fingers approached very near, its wings began to flutter slightly; if I drew off, the fluttering ceased, if I came nearer the fluttering became flight and I must stalk the prey again. It took fully an hour of these tactics before I finally got into such a position that I felt justified in making a sweep of the net that would mean capture or complete loss—but capture

it was. During this hour of stalking one *gracilis*, however, I caught two *trifida* in the same spot.

Gynacantha gracilis is similar to *G. membranalis* mentioned in the preceding chapter but a little larger (three and one-half inches long, wing-spread four and three-quarters inches). The reddish-brown spot at the base of the hind wings is much smaller, being adjacent to the front margin only instead of extending halfway across the wing, as it does in *membranalis*. Its eyes, in life, were blue above ranging through green and yellow to reddish-brown below, instead of the metallic green of its congener. Previously, *gracilis* had not been reported north of Surinam. *Gynacantha trifida* is a smaller species (two and three-eighths inches long, wing-spread three and one-quarter inches) with uncolored wings, its eyes brilliant green, darker above.

The *Gynacanthas* have the absolutely largest eyes of all dragonflies, possibly of all insects. They fly in such dark places as these virgin forests or, if in the open, at dusk and they have occasionally been known to fly to artificial lights at night. At Poyntelle, Pennsylvania, in June, 1904, I found two species of *Cordulegaster* along the same brook; one species with smaller eyes (*C. diastatops*) was found only where the brook flowed through open pasture; the other (*C. maculatus*) with larger eyes, occurred only in the forest courses of the brook where there was much less light. All these observations suggest an inverse correlation of size of eyes and quantity of light in which they are used, at least in the case of swift-flying species. But there are other species occurring in equally dark places in these Banana River forests with eyes no larger than those of their light-dwelling brethren. Such are *Protoneura remissa* and *Philogenia carrillica*, which I caught this day in the forest with the *Gynacanthas*. These two species, however, seem to travel only short distances—a few

yards—and to float through the air instead of moving rapidly.

The *Protoneura* and the *Philogenia* are much smaller insects, being one and one-half and two and one-quarter inches long respectively, of slighter build and with narrower, feebler wings. Their right and left eyes are separated from each other on the upper surface of the head by a distance equal to, or greater than, the width of either eye. The right and left eyes of the *Gynacanthas* meet, for a relatively long distance on the top of the head, so that they cover a larger part of the surface of the head than is the case in the two smaller species. The heights (in millimeters) of the eyes of these four dragonflies are: *Protoneura remissa* 1.11, *Philogenia carrillica* 2.88, *Gynacantha trifida* 5.76, *G. gracilis* 7.44. It is well known that the surfaces of the eyes of insects are made up of a number of facets, or lenses, usually hexagonal in shape, fitting against each other. The diameters of these facets are usually greater on the upper surface of a dragonfly's eye than on the lower surface of the same eye, and the size is different in different species, *Protoneura* having the lenses smaller than in any of the other three. The distinctness of vision of an insect's eye is proportional to the number of these surface lenses whose inner nerve fibers are stimulated by light. Other things being equal, therefore, the greater the number of facets the better the eye for distinctness. The smaller the diameter of the lenses, of course, the greater is the number in a given area. In spite of the smaller diameter of *Protoneura*'s lenses, a rough calculation shows that its eyes contain only one-half, or less than one-half, of the number of facets of the eyes of *Gynacantha trifida*, and between three-sevenths to one-third as many facets as the eyes of *G. gracilis*. On the other hand, the intensity of the light stimulation which the inner nerve fibers (corresponding to each facet) receive increases with

the diameter of the facet; the larger facets of *Gynacantha gracilis* must give it an advantage in this respect over its three associates. While these eyes are not portions of spheres but of much more complicated shapes, we may, for ease of comparison, say that the eyes of *Protoneura* and of *Philogenia* correspond to much larger segments of a sphere than is the case in *Gynacantha* where the eyes are much flatter on the upper surface especially. Taking the greater absolute size of the last into account, it results that the radius of curvature of the eye surface of *Gynacantha* is greater, and this in turn means that the divergence of the axes passing through the centers of the facets is less than in the two smaller insects. The greater this divergence the less distinct the vision. These considerations tend to show that the eyes of the *Gynacanthas* are more efficient organs than those of *Protoneura* and of *Philogenia*. But since other dragonflies (*Anax*, *Æshna*) with eyes almost as large, both absolutely and relatively, as those of *Gynacantha*, are found in well-lighted places, and as *Protoneura* and *Philogenia* live chiefly in the shade, we cannot suppose that the large eyes of *Gynacantha* are a result of shadow-haunting habits. Rather must we look on their large eyes as giving them an advantage over insects with less efficient visual organs when they took to living in darkness.

These reflections on the eyes of shade-dwelling dragonflies suggest a question as to the condition of the eyes of the shade-dwelling butterflies which have been mentioned in various preceding chapters. A comparison of dried specimens furnishes the following results. *Callitæra menander* of Turrialba and Peralta, observed only in dark woods, has eyes not as large as those of *Callidryas argante* and *Pieris ilaire*, creatures of about the same total size, basking in the brightest sunshine of Guácimo. The eyes of the Ithomiine butterflies, which we took in the shade in va-

rious places, are not absolutely or relatively large. The largest eyes of all our Costa Rican Lepidoptera are those of some Sphinges and of the great Noctuid *Thysania agrippina*, but even they are not nearly as large as those of *Gynacantha gracilis*, in spite of the heavier bodies and greater wing-spread of these moths.

Searching for these various forest species kept me until three o'clock, when I retraced my steps to the lower reservoir, mounted and rode back to Bearesem West Farmhouse and there told Señor Vivo that I thought it too late to go to the potrero; then I returned along the tracks to Mr. Veitch's. There were many hawks of several species in this region at the time of my visit and to-day, as on other days, they often sat upon the tops of the telephone wire poles which were usually rails set up in the ground. I never saw these hawks pay any attention to the flocks of dragonflies which were so common along the tracks, although these insects have often been found in hawks' stomachs in Europe and in the United States.

In the evening Oscar, Mr. Veitch's colored house boy, killed a "zorro" that was troubling the chickens and as I did not know what a zorro was, it was brought for me to look at. It proved to be an opossum and at Mr. Veitch's suggestion Oscar cleaned the skull for me. It agrees with the description of that of Richmond's opossum (*Didelphis richmondi*) originally described from Greytown, Nicaragua, and from San José, Costa Rica. On another evening (November 7) a scorpion (*Centrurus bicolor*) three inches long, appeared in the office and was killed.

On November 10 two "boys" took me on a trolley past Bearesem West and Beverly Farms to the Bananito River. The last part of the track lay in Bananito Farm, belonging not to the Fruit Company but to Mr. Minor Keith. The trolley boys had orders to wait for me at the Bananito until

I was ready to return. On arriving there I walked upstream along the same (left) bank, first through bananas and cacao trees and then along the stony beaches which lay a few inches to five feet above the water. The general character of the river was much like that of the Banana River but the water was shallower and clearer, this day at least.

On the beaches were many caiman tracks, some footprints being five to six inches across. The only caiman I saw was about four feet in length; it was lying in mud at the water's edge, only its head exposed to the air. It slid into the water as I approached but only went a short distance, for a few minutes later I was on a higher bank and saw it distinctly in the shallow water. I threw a stick at it, whereupon it turned around very violently, raising a great cloud of mud, and disappeared. Subsequently I saw one of about the same size in the shallow water at the opposite side of the river, but it may not have been the same one.

There were many fish of all sizes in the Bananito, as there had been in the Banana River when I was there, also many shrimps (*Palæmon jamaicensis*). The small fishes from the Bananito proved to be *Gambusia (Priapichthys) annectens*.

Here and there along the river was growing an acacia identified by Professor Pittier as *Acacia campeachiana*¹ (= *cochleacantha*) five feet or so in height. It resembled the bull's horn thorn described in Chapters XVII and XVIII, but had a less woody stem or trunk and paired thorns not curved nor inclined toward each but nearly at right angles to the stem bearing them. There were no little fruit-like bodies at the tips of the young leaflets, but along the mid-rib of each leaf was a row of urn-shaped glands, one at the base of each of the twenty-seven or more pairs of pinnæ. Even in the dried

¹This is the *campeachiana* of Miller, of the eighteenth century *Gardener's Dictionary*, not the *campecheana* of Schenck, 1914.

specimens these urns are one-thirty-second of an inch high. In not a single plant of this species did I find any ants, but it looked so much like the bull's horn thorn as to suggest that it might be the starting point for the development of the latter.

In Bananito Farm as in other banana plantations, there were rubber trees scattered here and there, left from the original forest when the ground was cleared. The trunk of every such tree was scarred with cuts made through the bark to secure the rubber. In some of these little scars bits of the rubber could be seen, of a black color and quite elastic. Mr. Veitch told me that the rubber trees in his division had just recently been bled, that the sap is taken once a year, to the extent of about fifteen hundred pounds. It is white when it runs out of the tree, for which reason it is called "milk of rubber," but blackens on exposure to the air. In cutting through the bark to bleed the tree it is important not to girdle the tree completely, as such treatment kills it. The proper cuts, according to Mr. Veitch, are two half-circles inclined obliquely downward toward each other, but one cut about four inches below the other. If cut in this way, a tree recovers from the wounds during the year between cuts.

Near the end of the track was an immense tree (not a rubber tree, however) whose buttress-like roots ran as wooden ridges twenty feet from the trunk and reached a height of four feet, decreasing to a few inches as the distance from the trunk increased. Thence I went down the left bank of the Bananito until the bananas gave way to a dense growth of wild cane. Retracing my steps I crossed to the right bank by a fallen tree which served as footbridge, crossed a recently-burned patch of cane where the sun beat fiercely, to some thinned-out forest, but finding nothing returned to my trolley and so back to Philadelphia South.

Although the plants and animals of Cartago and the Banana River district are mostly different, correlated with the differences in altitude and in temperature, there are many species which are found in both places, such as the escobilla (*Sida rhombifolia*) among plants, *Anartia fatima*, the most common of Costa Rican butterflies, *Pantala flavescens* among dragonflies, and among birds the tijo-tijo or garrapatero and the black-headed (zopilote) and red-headed (zonchiche) vultures. The water-hyacinth, so abundant in the Westfalia laguna, grew in a ditch in Cartago.

CHAPTER XVII

ALAJUELA AND THE VOLCANO POÁS

West of San José, the country descends rapidly toward the Pacific coast, where the fringe of low level land is far less extensive than on the Atlantic side. Much coffee is grown on the upper Pacific slope and the railroad runs through highly cultivated and enclosed plantations. Few good collecting grounds were to be found in such a region, nevertheless the river valleys were often deep and richly wooded and sheltered an interesting flora and fauna. We spent one day in February in the midst of the dry season, in Heredia, the first important town on the railroad west of San José and six miles from the capital. We went by train in half an hour, and after walking about the plaza and looking into the large and imposing church, started north along a good though hot and bare road toward the village of Barba, two kilometers away. This gave us beautiful views of Poás, Barba and to the east a smaller hill which a passing traveler told us was El Gallito. We walked almost to the village of Barba—classic ground at that time, as “Don Cleto,” otherwise El Señor Presidente Don Cleto González-Viquez lived there—but not quite into the village itself. We paused where the road crossed a little stream, Quebrada Seca, by a wide bridge which was supported on a single narrow arch of masonry, making a sort of ravine. The brook was quite shady and we went down to it first because the shade was so inviting, but the high straight walls of the arch proved a fruitful source of exuviae of transformed dragonflies, so we stayed there. We were fortunate enough to find two spe-

cies (*Heterina capitalis* and *Archilestes grandis*) in the act of transforming which we had not known before in the larval stage, and it is much easier if one can find the dragonfly sitting on its shed skin than to raise the insect from the larva. We spent several hours around this little stream, gathering exuviæ and a few living larvæ. The larvæ of *Archilestes grandis* were in a quiet pool where we could see them moving about. They were very minnow-like in behavior, floating in mid-water, making a short dart in one direction or another as a stick was brought near and, when raised from the water in the net, leaping sidewise into the air as a minnow does in a similar situation. Their semi-transparent bodies increased the minnow-like appearance.

The railroad from Limón had its terminus at Alajuela, twelve miles west of San José. Our friends Mr. and Mrs. J. B. Clark lived at a large beneficio, "El Brazil," of which Mr. Clark was manager, a mile east of Alajuela, and to their kindness and hospitality we owe many opportunities of exploring the neighborhood. We visited the beneficio in September, December, January, February and March, that is, both in winter and in summer.

Alajuela is a neat and attractive town of 6000 inhabitants, prettily situated among the hills, of which fine views are obtained from the plazas. There is the usual Parque Central and bandstand and facing the Parque is the chief church, in this case a very large white structure with thick adobe walls and a conspicuous red dome of corrugated iron. In addition there were several large open grassy plazas on the outskirts of the town, on which Mrs. Clark and A. used to exercise their horses at a gallop when the roads were so deep in mud that rapid riding on them was out of the question. The town contained quite a large hospital, several public schools, and a very interesting school of weaving, "Escuela de Tejidos." The art of weaving, if it ever existed

in Costa Rica to any extent, had completely died out, so that when it was proposed to revive it there were no looms. These were imported from Salvador, where weaving is a most important art, and teachers were brought from Salvador and Guatemala. The school was designed to teach useful arts to the young people of Costa Rica. They had ten or eleven large hand looms on which they wove a great variety of cotton cloths, white ducks and highly colored denims as well as white and red-and-white cotton towelling. The yarns and threads were imported from England and we were shown several dozens of patterns, stripes, checks, plaids and plain, in a number of weaves. They were all such as were worn here by the poorer or plainer people and found a ready sale. In addition to the weaving of cloth, the school taught cane-seating, basketry, hat-weaving, stocking-weaving and leather-work (particularly the weaving or braiding of bridles and whips). The school was becoming deservedly popular and promised to be very valuable, as there were few native arts here compared with those of other Central American countries or with Mexico.

The beneficio (a place where coffee is bought, cleaned, dried and prepared for market) of "El Brazil" was on the Ciruelas River, which is there joined by the Brazil River. The house was a pleasant two-story frame building, with both lower and upper porches or "corridors" as they are called in Costa Rica, the upper floor commanding wide views towards the volcanoes of Poás and Barba to the north, the range of Candelaria to the south and a great sweep of rich rolling country between. In front of the house in a tiny garden stood lemon and orange trees and an eucalyptus, the latter brought from California by a former resident. There are many places in Costa Rica where the eucalyptus was introduced, when it was supposed to be efficacious against malaria. The tree thrives and flourishes although

the theory has become obsolete. At the back of the house were several higuerones or wild fig-trees of considerable size. The dwelling was separated by a paved road from the offices, in front of which stood a very fine guanacaste tree (*Enterolobium cyclocarpum*) and some smaller trees. Our first visit to El Brazil was in September, when we spent a fortnight. This was in the winter or rainy season and all these trees were in full leaf. The roads in every direction were unbelievably deep in mud, the roadside banks were draped with ferns, mosses and selaginellas and studded with the exquisite blue flowers, two inches across, of the little gesneriaceous plant *Achimenes longiflora*. The poró and madera negra (*Gliricida maculata*) trees in the coffee plantations—coffee being a crop that must always have some shade—were also in full leaf and the coffee trees were laden with bright green berries. The pastures and fields in every direction were beautifully green, the rivers were rushing torrents and the straight-sided ditches that ran through every pasture to water the stock were full of water.

Beyond the offices at El Brazil stood the beneficio, a huge structure of corrugated iron, housing not only the coffee machinery but also the sawmill and the dynamos for the electric lights. Behind the house and the beneficio were the great cement platforms or patios on which the coffee was spread to dry. In all, there were several acres of these patios. They were divided into smaller platforms by cement troughs designed to wash the coffee thoroughly and to carry water and coffee to any desired portion of the patio. The machinery of the beneficio was run by power from the river. The water was conducted by a cement-lined channel or intake and operated a turbine at the bottom of a twenty-foot well.

During our first visit, in September, there was of course no coffee handled, but the sawmill was quite busy. The

logs were cut in the forest, almost universally to a standard length of four varas (11 feet), squared a little and sharply pointed at one end and each log was dragged to the mill, often for great distances, by a pair of oxen. After several days of excessive rain, the mud became so deep that it was impossible to drag the logs at all, so that it was necessary to wait until the mud dried a little. This was the time-honored method but disastrous to the roads over—or through—which the logs were dragged. Since our return from Costa Rica such hauling has been prohibited and all logs must be carried in carts.

The number of species and varieties of timber trees in Costa Rica is very great. Mr. Clark had a list of one hundred woods which had been brought to El Brazil or the sawmill at "La Eva" in Sarchí de Grecia. All of these were distinguished by native names and possessed qualities rendering them better suited to one or another purpose. Many Costa Rican timbers besides the well-known mahogany (*Swietenia*) have most beautiful grains and are capable of the finest finish. Conspicuous among these are the "cedros" (*Cedrela* sp.) of which "cedro amargo" (*C. glaziovii*) furnishes cigar-box wood and much of the "mahogany" of modern cabinet-makers. Other important lumbers are the numerous "quizarrás," all belonging to the Lauraceæ; the "guayacán" or "corteza amarilla" (*Tecoma chrysantha*), one of the numerous woods called *Lignum vitæ* and much used for cart wheels; the "laurél" (*Cordia gerascanthus*) and the many valuable leguminous trees such as the guanacaste, the guapinól (*Hymenæa courbaril*), the gavián, the candelillos or vainillas (*Cassia* spp.) and the guachipelin (*Diphysa robinoides*). The last is valuable for posts, foundations, or other underground work, because when buried it remains sound almost indefinitely and is not subject to the attacks of insects.

In front of the offices and beneficio was a large paved courtyard, where the logs were piled in sawing time and later the ox-carts full of coffee waited their turn to discharge their loads of red cherry-like berries. Many beneficios have a finca or farm belonging to them, on which is raised at least a part of the coffee beneficiated, although all buy coffee from other growers in addition. El Brazil, however, had no finca and the entire quantity of coffee (nearly 5000 fanegas, equalling 575 000 pounds or 4000 sacks) was purchased. The number of small landowners and coffee growers in Costa Rica is very great and everyone who had any coffee to sell must be dealt with and bargained with separately—at El Brazil there were over six hundred growers to deal with. The competition between the different beneficios ran very high and to get the most coffee without paying for it a price that prevented any profit made the purchasing of this coffee fruit an art in itself.

Dr. Karl Sapper, after dwelling in Guatemala for some years and traveling throughout Central America, pointed out in 1902 the great advantage which Costa Rica possesses in the predominance of small landowners, in contrast with the conditions prevailing in the larger countries in that part of the world. Where many own small pieces of ground, a much greater and more general interest in the prosperous development of commerce and of peaceful progress exists than where there are only a few great landowners and the great mass of the population, having nothing to lose, are more indifferent and more easily drawn in the wake of political adventurers.

When we went to El Brazil in December the dry season had begun. The coffee was ripe on many farms and the picking, which is done by hand, mostly by women and girls, was in full swing. The coffee trees looked very pretty, with their glossy dark green leaves and showy bright red



Volcano Barba and Coffee Patios of "El Brazil," Alajuela.
Covering Piles of Coffee for the Night, "El Brazil."



Guayabo—*Psidium guava*. Entire Tree and Fruit pinned to Trunk.

berries. Owing to eccentricities in the rainfall at the time of flowering the coffee was not ripening evenly and several pickings were necessary on many farms. The ox-carts laden with coffee were rolling steadily into El Brazil all day (except during the hot noon hours) and part of the night. The berries were measured from the ox-cart into a big double-hectoliter measure, which held about three hundred pounds of fruit and made a load for two men, and were then turned into a receiving vat full of water. There were two large cement-lined vats in the courtyard, with such an arrangement of water inflow and outflow that they could be filled or emptied at will, the outflowing water carrying the coffee with it. As quickly as possible after arrival the berries were passed from this first vat to be "pulped" by machinery and then carried by water to other cement vats for fermenting from 24 to 60 hours, according to the temperature. Fermenting was conducted for the purpose of removing the mucilaginous substance surrounding the grains, and was continued until they no longer felt slippery when rubbed. After fermenting they were conveyed by means of a centrifugal pump and piping to the troughs surrounding the patios, where they were thoroughly washed. The water ran by gravity (10 per cent fall) through these ditches and there were numerous ingenious arrangements of gates and movable dams so that the coffee was repeatedly washed and the trash and such hulls as had slipped in were carried off. The smaller, inferior grains were also separated from the larger and heavier ones. Then the coffee was spread out on the patios to dry. During the day it was spread out in a comparatively thin layer which was constantly turned over and moved about by bare-footed men armed with a peculiar wooden hoe. Towards evening, or if a shower threatened, it was raked into piles or long ridges and carefully covered with tarpaulin as a protection against rain or dew. When the coffee was one day

short of dry it was finished in a steam drier, sent through hullers, cleaned by machines, and finally sorted by a most ingenious hollow cylinder with holes of varying sizes so that from one machine dropped out three grades or sizes of grains flat on one side, broken grains and Caracol or peaberry, which last is a grain round on both sides and considered the choicest. After all that, the coffee was hand-picked by women and girls, who removed any grains that were defective or twisted in shape, even if the size was right, for all such things make the coffee inferior.

The differences on which this sorting was based were very slight—much slighter than those made use of by botanists and zoölogists to distinguish different species of plants and animals—but the resulting “grades” fetched very different prices in the receiving ports, London, San Francisco, New York, or Hamburg. When we commented on these fine distinctions, Mr. Clark told us of two instances known to him of experts who were able to distinguish different sorts of coffee and of tea by taste, this sense furnishing the final test in such matters. When at a coffee broker’s in London he selected samples of sixteen lots of coffee, all grown in Costa Rica but in different parts of the country. A cup of coffee was prepared from each one of the sixteen samples and each cup given a number whose meaning was known to Mr. Clark alone. The broker then tasted each cup and said “this is Tres Rios coffee,” “this is Cochenour’s from Juan Viñas” and so on, and fourteen out of his sixteen identifications were correct. A tea expert in San Francisco, on a wager, identified two hundred and fifty different kinds of tea by tasting the beverage. This is surely carrying the development of the sense of taste to a high degree of discrimination.

When the sorting was completed and the coffee bagged—each sack shipped from Costa Rica is required by law

to be marked "Café de Costa Rica"—the shipping began. When we were at El Brazil, and during all the preceding years of the existence of the beneficio, its coffee was carried by ox-carts over the Carretera Nacional from the courtyard of the beneficio all the way to the wharf at Puntarenas. It took four to six days to make the journey. The carts traveled all night and rested through the day, saving both drivers and oxen from the midday heat. In the fall of 1910 the gap in the government railroad from San José to Puntarenas was completed, and since then the coffee has been shipped by rail. It now reaches Puntarenas in five hours with only one mile of carting to the railroad station.

The country about Alajuela was so highly cultivated that the stream ravines with their fringes of trees offered almost the only collecting places of interest, and even these were never productive of many dragonflies. They were very pretty, however, and quite different in their vegetation from the little valleys about Cartago. Along the Ciruelas River were many uruca trees (*Trichilia havanensis*), mingled with guayabos (*Psidium guayava*). The latter here grew twenty to twenty-five feet high, and in their growth and habit of branching closely resembled an old neglected apple tree. The bark of course was utterly different, for the guayabo has the habit of shedding its outer layers in large pieces which curl up, usually lengthwise of the stem, into tight rolls before they drop off. As a result of this habit the tree is kept free of epiphytic plants. The fruit was not ripe in September, but we tasted it later. It is very good raw, but rarely reaches perfection because so many small animals are fond of it and consequently it was usually gathered and cooked in some way before maturity. The ciruela or jocote (*Spondias purpurea*) was very common about Alajuela, both along the river banks and in the "living fences" where it replaced the poró to some extent. It is rather a pretty tree and the

purple plum-like fruit is excellent when made into various "dulces." There were fewer epiphytic bromeliads on the trees here than at Cartago, but the latter were often overgrown with "caña brava," a climbing cane with whorls of short branches and long internodes, or with "matapalo." The latter resembles our mistletoe in appearance and chokes and kills its host unless removed by man.

Often in the fences were tree yuccas or "itabos" (*Y. elephantipes*), ten or more feet high, or the fence or hedge might be formed of narrow-leaved terrestrial bromeliads known as "piñuelas," with spines along the margins of the yard-long leaves, curved toward the leaf tip. Such a hedge, formidable in itself, was sometimes supplemented by posts and barbed wire. Mr. Clark told us that before barbed wire came so extensively into use for fencing, fields were often separated from each other by deep ditches and we saw some of these, widened no doubt by rains and running water, which were three to six feet deep and as wide at the top—a much more laborious and expensive method of marking boundaries.

South of the house, on the left bank of the Ciruelas River, was a particularly beautiful pasture, "Flores' potrero," which sloped steeply down to the rushing, foaming, rocky river. It contained many fine trees, among them the guayabo we have figured and several magnificent isolated specimens of the vainilla or candelillo. This is a large tree, fifty to sixty feet high, with a spray recalling our New England elms but with a flatter head, and in September it was covered with pyramidal clusters of brilliant yellow flowers borne on the tips of the branches. One of these great trees covered with its yellow blooms was a dazzling spectacle. The river seen from this potrero was very picturesque with little rapids, overhanging trees and projecting stones. The latter were often occupied by lizards and we sometimes

amused ourselves by throwing stones toward them until they were induced to move into shelter, skimming over the surface of the water and using both legs and tail as locomotive organs. Many lizards can travel a surprising distance in this way. They move so quickly that it is difficult to see just how they do it, but they do not appear to be at all submerged.

Still farther south, after crossing several potreros, on the banks of a little stream, were numerous bull's horn thorns growing mingled with urucas and jocotes. Although they did not seem to be growing actively we found some young shoots with the yellow so-called food-bodies on the tips of the tender green leaflets and the three conical glands in a row on the petiole still exuding their sweet secretion. This bull's horn thorn was *Acacia costaricensis* and derives its popular name from the strong, sharp, paired thorns, which quite closely resemble the horns and forehead of a bull. In many species these thorns are commonly hollowed out and tenanted by small stinging and biting ants (*Pseudomyrma* sp.) which feed upon the nectar and "food-bodies" and have been supposed to be of great protective value to the plant. The ants on the thorns in this potrero were both numerous and aggressive. The largest bush had also a big wasps' nest hanging from its branches. We wanted to photograph a small spray of this plant, and our efforts to do so, although finally successful, were attended with various amusing difficulties. The plant is extremely sensitive to shaking and no matter how gently the spray was removed and laid on the background—the camera on its tilting top being focused and ready—the leaflets would close a little. The ants occupying the thorns also objected to the shaking, and it proved a hard task to handle the spray "gently" when a stream of savagely-biting little furies poured down the stem ready to attack the intruder with jaws and stings!

And at the most critical moment of one attempt we had to drive away the steers living in the potrero, for their overmastering curiosity almost caused them to upset the camera.

This little ravine contained many groups of a huge unidentified aroid, called by the Costa Ricans "hoja de pato" (goose leaf). It is not peculiar to Alajuela, being found in many places over the Atlantic slope as well as the Pacific. The triangular leaves reach a breadth of nearly two feet and a length of two to three feet, while the leafstalk may be nearly four feet long. One that we measured was over six feet long in a straight line from base of stalk to tip of leaf, but in its natural position the leaf and stalk are at right angles. The rhizome, creeping over the ground or submerged in the mud, is six to eight inches in diameter.

On September eighth we found in lanes between jocote hedges, a number of clicking butterflies mentioned on page 296. There were two species, *Ageronia ferentina* with the hind wings whitish below and *Peridromia fornax* with the same surface brownish-yellow. They seemed to prefer to alight on bare or nearly bare tree-trunks with the wings outspread instead of folded together as in most butterflies. The flight also is characteristic—a number of quick flaps of the wings, then they are held still while the insect sails for a short distance, after which the rapid flapping is resumed. We caught a few specimens and took them alive to our screened room, where we released them in the hope of learning how the clicking was produced; but during the three days the insects were under observation we did not hear them click. Hampson¹ thinks that in *Ageronia arethusa* the sound is produced by a pair of hooks attached to the base of the fore wing playing against a pair of hooks on the side of the thorax. I have been unable to find these hooks

¹ *Proc. Zool. Soc.*, London, 1892, p. 191, fig. 3.

in *Peridromia fornax*, however, even with Hampson's figure before me.

Going upstream, the Ciruelas River led chiefly through a series of small, narrow, grassy potreros, each running to the river bank and each one representing a different ownership. About three-quarters of a mile upstream was a log bridge (frequently swept away by the trees and other débris brought down by the floods of the rainy season) which led into a large potrero where the land rose into a considerable hill. This formed the divide between the Ciruelas and Brazil Rivers, the latter being much the smaller. At a point roughly opposite the log bridge, the Brazil flowed through a little ravine so thickly set with trees that it was exceedingly dark. A few species of shade-loving dragonflies were found here. Those which fly about in the bright sunshine of open fields, pastures or ponds, or in brightly lighted open places in the woods, are rarely found in the dark parts of the woods, and vice versa. Along the same stream, flowing now through dark woods, then open fields, then dark woods again, even the same genus will be represented by one species in the brightly-lighted, and by another in the dark, parts of the stream's course. For example, near Alajuela in the genus *Heterina*, the bright-light species was *cruentata*, the dark woods species *capitalis*. As Costa Rica, like many other parts of Central America, was more densely forested formerly than now, it is reasonable to suppose that the cutting down of the trees has brought about a marked increase in the abundance of *cruentata* and a corresponding decrease in *capitalis*. Somewhat different results were obtained near Cartago, where the elevation is fifteen hundred feet greater. Here the sun-loving *cruentata* was common along all the streams flowing down from Irazú, wherever these were open and sunny, but in well-shaded places no *Heterina* could be found. On the other hand, when I was at the Rio

Siquiara at Turrúcares in December I found *cruentata* and *capitalis* mingled in bright sunshine and moderate shade, taking them both on the very same leaf. A dragonfly with uncolored wings and a very slender bright red body (*Heteragrion erythrogastrum*) was fairly common in the dark woods of the Brazil and we had hopes of finding its larva here but in this we were disappointed in spite of prolonged and careful search.

Between the Brazil and the Ciruelas was a tiny stream emptying into the former and occupying a little "barranca" all of its own, which was narrow, fairly deep and densely vegetated. The plants here were the melastomaceous trees called Mariás (*Miconia dolichopoda*), crotons, the yellow-flowered Maranta called "vijagua" (*Calathea insignis*) and great quantities of caña brava. It seemed a likely place for dragonflies but they were scarce and few in species. Here and there in the bed of this stream, and at various places on the ground elsewhere in this neighborhood, were black shining patches, due to the presence of grains of metallic iron which are attracted by a magnet.

We usually went to the charming bit of dark wood on the Brazil by following up the Brazil itself from the place where this tiny stream entered it. Where the two streams met was a little swamp, on whose margin was a large wasps' nest attached to the trunk of a tree by one of its long surfaces and in September covering an area perhaps two feet by nine or ten inches. Marks on the trunk showed that the nest had formerly extended at least nine inches farther up for its entire width. The entrance to the nest was by a nearly circular opening about an inch in diameter, situated near the top of the nest. The wasps (*Synæca azurea*) were steel blue in color, with black wings. A., who saw the nest first, came quite close before noticing it and remained quietly looking at it; many more wasps issued through the opening but re-



Flowering spray of Vainilla—*Cassia spectabilis*.



1. Leaf of Guanacaste—*Enterolobium cyclocarpum*.
2. Leaf and fruit of Jocote or Ciruela—*Spondias purpurea*.
3. Leaf of Guachupelin—*Diphysa robinoides*.



Manzana rosa—*Jambosa vulgaris* (*Eugenia jambosa*).
Stone Church at Santa Barbara and Volcano Barba.

mained on the outside of the "paper" covering. A few occasionally dropped on the top of A.'s open umbrella but did not attempt to sting. One wasp was seen flying about with something white hanging from its tail. On catching it, we found that the white thing was ten millimeters of its alimentary canal (i. e., intestine and hind end of its stomach), its poison sac and sting. The abdomen showed no special laceration; presumably these viscera had been pulled out as a consequence of the insect's having stung something, and the sting being rather firmly embedded held long enough to pull out the organs when the wasp tried to fly off.

Farther on, A. found a leaf on which was resting a young spider (*Tinus*) with cross-barred legs, each leg extended in a different direction. The cross-barring gave the effect of radii of a web beaded with moisture and made the spider appear smaller than it really was and as if resting upon a web. On a piñuela was another species of spider (either *Acrosoma 12-spinosa* or *Argiope argentata*) having the abdomen widest at its spiny hind end. It weaves a web with fine radii and concentric threads and four heavy zigzag bands, and then takes up its position in the center of the web, placing its eight legs in pairs so that two are in the same line as each of the four zigzag bands, which are nearly at right angles to each other. The web is stretched between two leaves of the piñuela, the spines of the plant affording the spider an efficient protection against the hand or net of the collector.

Mr. Clark was manager not only of the beneficio but of a finca called "El Cerro" some eight miles away near Sabanilla, and much higher among the hills. On September 7, P. accompanied Mr. Clark on one of his periodical visits of inspection. As we turned a corner of the road, Mr. Clark pointed out the house of the president of the board of road commissioners of the district, with a deep mud hole in the road in front, saying that his own remonstrances to the

president on the subject of this hole, that the president ought to be ashamed of such a spot before his own house, had no effect—"the hole would be just as bad soon again even if it were mended." We skirted the town of Alajuela and finally took the road leading to the village of San Pedro de Poás. Although much traveled—and because of this—parts of it were in exceedingly bad condition. Even picking the best path through the mud, our horses frequently sank in it above their hocks. At one place several ox-carts were ahead of us, each cart drawn by two oxen as usual. The carts rocked from side to side, as one wheel or the other sank more deeply, so that from behind they looked like ships in a rolling sea. Mr. Clark asked one driver how much his team could haul and the answer was an equivalent of eight hundred and fifty pounds. The average cart was 60 inches long, 32 inches wide and 20 inches deep, equivalent to nearly 21 cubic feet or a space occupied by half a ton of anthracite coal. As oxen are so much stronger than horses it needs only the comparison with the weights drawn by our horses at home to show how transportation here is handicapped by these bad roads.

Our route to El Cerro was a constant succession of ascents and descents, nearly at right angles to five ridges and five valleys. Four of the latter were occupied by small rivers, the Alajuela or Maravilla, the Itiquís, the Tacacorí and the Tambór. The Itiquís and the Tambór we forded, the other two we crossed on covered iron bridges. The country through which we passed was occupied by pastures, fields of corn (maize) or coffee, or low woods. The María trees along the roadsides were very conspicuous. As we approached El Cerro we lingered to enjoy the fine views. To the north were the volcanoes Poás and Barba, to the east Irazú with its whole upper part in clouds, to the southeast La Carpintera and in line with Carpintera, San José, twenty

miles away, was clearly visible. South and west rose the ridges of Candelaria and Puriscal, behind them the hills of Santa María Dota and the great mountains of Herradura. Directly west were the rugged Aguacate mountains and between them and the Herraduras lay the valley of the Rio Grande de Tárcoles, through which we obtained a glimpse of the Pacific. Northwest of El Cerro were the villages of Sarchí, San Pedro de Poás, distinguished by its very long church with a bright red tile roof, and Grecia with a church painted a deep red. This latter edifice was constructed of boiler iron made in Belgium, and bolted together so that it might be turned over on its side by the next earthquake and yet be uninjured—in contrast to its predecessors damaged by this cause.

We reached the farmhouse at El Cerro at ten-thirty and decided to look over the finca before breakfast. My aneroid gave the altitude here as 3850 feet, while at El Brazil before our departure this morning it stood at 3100. We rode through the coffee fields and sugar-cane plantings, and along the edge of second growth woods, down to the “trapiche” or sugar-boiling establishment on the bank of the Rio Caracha. This building and its equipment and the clearing of the woods in which it and the surrounding cane-fields lay had all been built or made by Mr. Clark since January. “Building” is perhaps too large a word, for the structure had no walls, being merely a roof supported on wooden beams rough-hewn out of the removed forest trees. When we arrived, cut lengths of sugar-cane were being fed to a crusher whose essential parts were metal cylinders with transverse ridges and grooves on the outer surface, which pressed the juice out of the cane. One man pushed the canes in, another on the opposite side removed the crushed cane. The juice dropped to the lower part of the machine from which it was carried by an iron pipe to large iron pans

built into the top of a long brick furnace containing a wood fire. As the heating progressed a scum arose which was skimmed off and eagerly swallowed by some men and children, though it was evidently hot and dirty. Finally, when sufficiently thick, the brown liquid sugar was poured into large wooden moulds where it crystallized. The mandador mixed up and cooled some for us in water. It had the consistency and taste of soft caramel, as it had burned slightly. Nearly all the product of this trapiche went to the Government Fabrica de Licores to be made into rum. In the markets, at Cartago and elsewhere, there were always great quantities of brown sugar, moulded into truncated cones about six inches in diameter at the top. Moulds for producing it in this size and form were also here, a single piece of wood having two rows of pockets of this shape, perhaps ten pockets in each row. The power for operating the machinery of the trapiche was obtained by bringing water from a little higher up the river through a ditch running through the cane-field.

From the trapiche we walked down the river until we came to a fine waterfall of the Caracha, one hundred and thirty-five feet high, Mr. Clark said. At this fall the Caracha empties into the Rio Poás, which also has a fall, of less height but greater volume. Both falls are visible at once from below or from the top of either one, but we saw them from the top of the Caracha fall only. My aneroid read 3300 feet at this point, 3350 feet at the trapiche.

A rather long and tiresome climb back to the farmhouse succeeded, through newly planted cane and coffee, or old coffee with young plants between the old. It was 1.30 when we reached the farmhouse and had breakfast, of soup that looked like tomato, tasted like chicken and contained three balls of beef something like Hamburg-steak, a fried egg (eggs were scarce just now everywhere), frijoles, mazamora (a

sort of cornstarch), tortillas and coffee. The sky had become quite threatening during the latter part of our walk and by this time it had begun to rain, blotting out the beautiful landscape for the rest of the day.

On the way down to El Brazil we saw four mot-mots or "bobos" (fools) as the Costa Ricans call them (*Momotus lessoni*). These are highly characteristic tropical American birds, about the size of a pigeon with orange breast, blue-green wings and blue-green on the top of the head. They have the curious habit of stripping the barbules from each side of the two long tail feathers, leaving a tuft at the end of the feather and a stretch of bare rib which varies in length with individual birds. The effect of these mutilated feathers as the bird, sitting otherwise motionless, moves its tail from side to side, is very curious and somewhat resembles the pendulum of a clock.

With the exception of a few foreigners engaged in trade in Alajuela, the nearest English-speaking neighbors were at the finca of La Esperanza, four miles away, where the Clark family were frequent visitors. A. often accompanied them thither. At the time of our visit to Costa Rica this finca was still largely planted with coffee, but there was also a great number of grapefruit trees and it was the intention to replace the coffee with citrus fruit, over the entire finca. The house had been placed on a little knoll looking down the valley of the Rio Grande de Tárcoles to the gulf of Nicoya. It stood over a half a mile from the high road, and the approach from the main gate ran through a beautiful avenue of manzana rosa or rose-apple trees, belonging to the Myrtles. This tree grows in many places in Costa Rica and its fruit was often seen in the market at Cartago, but we saw no other avenue of it to be compared with this one at La Esperanza. The trees were forty feet or more in height. The old leaves are dark green and extremely shiny, the young

leaves are bright red and in September when we first saw them the trees were covered with large, conspicuous flowers with numerous extraordinarily long filaments, making each flower look like a tuft of pale green threads.

Another neighbor lived eight miles to the northward on a foothill of the volcano Barba and about two thousand feet higher than Alajuela. In December and January, when the roads were good, we frequently called at the B. farm, which was most charmingly situated—for scenery and crops but not for the convenience of the housekeepers. Our way led through the pretty village of Santa Barbara, a sleepy, almost dead little place. It has one of the few stone churches in Costa Rica in contrast to the usual adobe and plaster structures.

Early in December we spent three days at El Brazil. The roads were then in good condition, as the rains were over but the dry season was not old enough to produce much dust. The country still looked fresh and green. The great fiestas of the Immaculate Conception of the Blessed Virgin were celebrated during this visit. This is one of the chief fiestas of the year everywhere in Costa Rica but particularly in the "barrios" of Concepción, of which there is one in nearly every "distrito." We have already referred to Concepción de Cartago in our account of that town. El Brazil was in the barrio of Concepción de Alajuela and in the midst of celebrations by no means entirely religious in character. The chief day, December eighth, is a legal holiday. In Alajuela it was the custom to have bull fights, booths were erected around the plaza of the church of Concepción, the country people went to town for the day of the eighth (if not for all the days of the fiestas) dressed in their newest, gayest and cleanest, masqueraders sang and danced and after dark there was a general dance on the grass to the music of as many bands as could be mustered. This year,

owing to lack of funds, the bull fights and more elaborate celebrations were omitted—much to the delight of the employers of peon labor. During the fiestas no one will work and it meant the loss of several days in the height of the coffee season when every hour is precious, but this time only one day was lost. All morning we watched the people streaming past the gate of El Brazil toward Alajuela, the women radiant in stiffly starched muslin dresses of pink or blue or white, with gay silk rebosas of rainbow colors, the men in less striking clothes but with brightly colored handkerchiefs knotted about their throats; nearly all were bare-footed. Bombs and firecrackers began to go off at 5 A. M. and continued all day. As a great concession and because El Brazil is not far from town, Mrs. Clark's servants returned at noon to wash the dishes, then departed for the rest of the day. The coffee machinery stopped and the only workmen about were a few faithful peons who were induced to come at 4 A. M. to attend to some things without which much coffee would have spoiled. They were willing to work from four to six because no one would see them, but seemed to think they would lose caste if caught in the act.

It was the custom for the masqueraders to visit the farms or haciendas where contributions have been made for the fiestas and exhibit themselves, sing and dance. About 3.30 P. M. we heard shouting, sounds of a band, roaring as of wild beasts; then a crowd of men, women, and children—perhaps a hundred in all—poured through the gate. There were twelve or fourteen masks. A very fine and realistic devil with red and black face, big red eyes, long protruding red tongue, horns, a golden crown, red clothes and a thick red tail hopped about, flapped his wings and roared so naturally that the children were half frightened. A flax-haired "dude" was radiant in trousers of Scotch plaid muslin. Most of the costumes were grotesque and to us mean-

ingless, though they may have had some significance to the actors. There was a band and when it played the gay company danced, singly or in couples. One particularly lively dancer was a girl in pink crumpled tissue paper. The master of the ceremonies was a young man who wore no mask but was powdered quite white and had a pretty little pencilled mustache. He wore a gilt cap with a feather, a sort of belted Russian blouse, and close-fitting white breeches, and was a most exquisite and graceful dancer. He made little jokes and puns, ending each speech (which was always addressed to some one person) in a curious singsong voice. This was a signal to the band and as the music began he glided into a dance—a solo performance which seemed offered as a toast to the person addressed. After the toasts, alcoholic refreshments were served to the principals—all this according to immemorial custom—then there were more dances and all trooped off again. It is noteworthy that custom also settled who should be refreshed and there was no pushing or scrambling, or demanding.

While P. was in Guanacaste, A. spent the greater part of January, 1910, at El Brazil, returning to Cartago at intervals to feed the live stock, record moults and preserve exuvia. The dry season had then been long established. There was a great difference in the vegetation between this visit and our first in September. The higuerones had lost all their old leaves and now were covered with young leaves and leaf buds of brilliant red, most beautiful against the deep blue sky. The guanacaste in front of the office was entirely bare of leaves. Mangoes and urucas, in September past fruiting, were now in flower. Jocotes had lost most of their leaves and were full of small dark red blossoms borne in short clusters on the main or larger branches. The thick drapery of *Selaginella* and ferns on the banks was now withered and represented by a tangle of little blackened dried

midribs. The streams were of course much lower and the mud of the roads was beginning to be dust. Although the sun was hot, there was nearly always a high wind and the shade temperature was delightfully cool. The dry season is much more strongly marked on the Pacific than on the Atlantic slope and of longer duration.

By the end of March, which is toward the end of the dry season, the country about Alajuela had become very dry and hot, the fields and open plazas of the town being brown and parched instead of green with grass. The whole slope towards the Pacific, wherever cultivated for corn or grass, was hazy with smoke from the constant burning over of the dried vegetation. The coffee had begun to bloom, the madera negra trees, although sometimes planted in rows between the coffee bushes to yield shade to the latter, were by this time in bloom but quite leafless and entirely useless in this the hottest and sunniest portion of the year. The madera negra, in fact, although useful as a nitrifier of the soil and very easily rooted from stakes, is now planted much less extensively in the cafetales than formerly. Like the poró, it is a valuable living-fence tree and in March both of these along the fence lines were being pruned to the veriest poles and stumps. In the cafetales the madera negra is being replaced by the "Cuajiniquil" (*Inga edulis*) and by various "guavos" (*Inga* sp.) which are equally good nitrifiers and retain their leaves throughout the dry season. The Ingas are mimosaceous trees with six to eight leaflets and flowers rendered very conspicuous by the long, showy, feathery white filaments. The fruit is a huge pod, varying in shape in the different species but generally flattened like the pod of a lima bean. We photographed one in Cartago in June that was two inches wide and over a foot long, and contained beans two inches long. The beans of some species, notably *I. edulis*, are embedded in a sweet white

pulp which has a pleasing taste and is commonly eaten by children.

The usual idea of tropical America, particularly of the forests, is of perpetual verdure, of trees that are never leafless but drop their leaves and renew them constantly as most conifers do in the north. The absence of "spring" and other seasons, the consequent monotony of the forest after the first sensations of awe and wonder have been dulled by custom, have been dwelt upon by many travelers, notably Wallace and Bates. The "perpetual verdure" does exist over the vast regions which receive the tremendous precipitation derived from the Atlantic trade winds. We were never able to appreciate how the forests, as we saw them in Costa Rica, could become monotonous, because we only remained in Costa Rica a year and of that period not by any means the whole time was spent in the Atlantic lowlands and the forests seem still an inexhaustible mine of interest and fascination. But it is wholly erroneous to apply the descriptions of the Atlantic slope to the Pacific. There the divisions into seasons are as well marked as in any northern country, only the basis of the division is the amount of precipitation and not the amount of heat. The smaller vegetable forms often dry up completely, so that grass lands show only brown stubble, and roadside thickets bare branches. As Wercklé points out, many species of trees drop all their leaves at once and there are forest areas which are as leafless for a short time as our northern deciduous forests in winter, although the usual association of numerous species in a forest is likely to result in half the trees being green all the time. There is the greatest variation in the habit of losing the leaves. Some legumes and urticaceous trees drop their leaves at the beginning of verano (summer or dry season) and replace them immediately so that throughout the rainless season they show the freshest,

brightest green. A few of these, like the guapinol, even put out new leaves while the old ones are falling. Other legumes retain their leaves until near the end of summer, shed them quickly and at once reclothe themselves so that they are in full green leaf before the rains begin. Other trees again are bare and leafless through the greater part of the dry season but put out their new leaves about a month before the rains. The guanacaste belongs to this category. It is not the first shower of the rains that causes the new leaves to burst forth, neither is it always the trees with delicate foliage that are bare through the dry season, while some trees with leathery leaves such as the wild figs or higueros (*Ficus* sp.) drop their leaves entirely in the middle of the rainy season. The higueros, in fact, shed their leaves and present bare branches twice in each year, in many very different localities. Nevertheless many species await the beginning of the rains to shoot forth, and still others linger a month after the rains have begun. It is also to be noted that many trees which ordinarily lose their leaves will retain them if they happen to be growing in an unusually well-watered situation such as a stream valley.

Although January is in the dry season, occasional showers occur in some years. The January weather, from 6 A. M. to 6 P. M. each day, was watched with the greatest interest by the country people around Alajuela, as it was supposed to foretell accurately what the weather would be throughout the year. The "pintas," as they are called, have the following significance:

January 1 = January
January 2 = February
January 3 = March
January 4 = April
January 5 = May
January 6 = June

January 7 = July
January 8 = August
January 9 = September
January 10 = October
January 11 = November
January 12 = December

- January 13 = January and February
 January 14 = March and April
 January 15 = May and June
 January 16 = July and August
 January 17 = September and October
 January 18 = November and December
 January 19 = January, February and March
 January 20 = April, May and June
 January 21 = July, August and September
 January 22 = October, November, December
 January 23 = January, February, March, April
 January 24 = May, June, July, August
 January 25 = September, October, November, December
 January 26 = January to June
 January 27 = July to December
 January 28 = January to December (1 hour for each month)

At the end of the month the pintas were carefully averaged and the resulting weather condition was accepted, especially by the older people, as an absolute forecast of the weather to prevail in the corresponding month of that year.

While visiting El Brazil in January, Mrs. Clark, her little daughter and A. went riding nearly every day, with the comfortable assurance that no rain was likely to overtake them. We called several times at the B. farm, where coffee picking was the chief occupation. In January and February the air was laden with the delicious scent of the little whitish blossoms of the "nance" trees (*Byrsonima crassifolia*) growing by the roadside. On the twenty-second of January we rode to Carrizal, a village on the slope of Carrizal mountain some eight miles from El Brazil and two thousand feet higher. The mountain was almost covered with "farms" which were really great expanses of rich and fertile pastures that never dry up like the potreros lower down. It was full of cattle. Every farmer owned land in the uplands if he was able to do so, and kept most of his stock there in summer, only bringing down a few fresh cows from time to time to supply the

family milk. There was a little cabin within a small enclosure, part of a large potrero, and into this small enclosure we turned our horses while we picnicked by a charming brook overhung with anona and orange trees. Nearby was a cluster of *Sloanea*, large trees with big, glossy, entire, serrate stiff leaves, which rustled and roared in the wind. The fruit is a burr much resembling that of the chestnut in size and shape, but the prickles are much coarser and stiffer and the burrs are not lined with silky down. The species approaches *S. macrophylla*. Like many other plants with spiny or prickly fruits, it bears the native name of "peine de mico" or monkey's comb.

The numerous cattle in the large enclosure were of course much excited by visitors and the whole herd followed us about in a manner disconcerting to strangers. But Costa Rican cattle are usually mild and this big yellow bull in particular was so amiable that the preceding summer while Mrs. Clark camped here, her children hung upon his horns and played with him freely, so that he was in a way an old acquaintance. A pleasant feature of these mountain pastures was the freedom from ticks, so frequently the pests of grassy country in the tropics. We wandered up to the highest part of the potrero after a while and lay down in the warm deep grass under some big trees, while the delicious mountain air blew over us, and watched the beautiful panorama of the great central valley, bounded on every side by range after range of mountains except where the blue Gulf of Nicoya gleamed through the opening cut by the Rio Grande de Tárcoles. Only a few miles away the volcanoes of Poás and Barba lay like sleeping giants. All the time we were there, cloud and mist, looking like a huge white pennant streaming in the wind, poured through the Desengaño from the moisture-laden plains of Santa Clara, but always disappeared by the time they were over the flat top of Poás.

Three days later, on the afternoon of January twenty-fifth, 1910, the country about Alajuela was thrown into the wildest excitement by the sight of Poás in violent eruption, which began about 4.50 P. M. and lasted half an hour. The volcano is some ten miles away and the cloud of steam rose in puffs, spread out into mushroom shape, then, blown by the high wind, traveled rapidly toward El Brazil. In twenty minutes the cloud was directly overhead, looking by that time like any ordinary cloud, and at intervals there was a distinctly sulphurous smell. As it came puffing out of the volcano the soft white steam looked extremely beautiful in the afternoon sun against a perfectly blue sky. From 5.30 to 5.40 there was a second much less vigorous eruption, the cloud from which remained over the volcano as long as we watched it. No sounds were heard, nor was there any fire or dark smoke from the volcano.

About 6.15 began a fall of very fine but gritty ash, pale gray in color, acid and biting in taste and reminding me strongly of the "blitz pulver" we used in old flash-light days. From microscopic examination later, Prof. A. P. Brown pronounced it to be an enstatite andesite ash containing glass. It fell like a damp mist and soon formed a well-defined layer over everything—roofs, porch rails, coffee tarpaulins, leaves of trees. The cloud of ash covered the whole sky across the zenith. By nine o'clock the volcano was perfectly clear and free from clouds and there seemed to be no further precipitation of dust. The next morning the ash looked like a fall of fine snow, just enough to whiten the ground but not cover it.

An eruption of Poás of this force and accompanied by such quantities of ash was not common and the people were badly frightened. The usual eruptions are geyser-like spoutings of steam and mud. The native superstition is that the eruptions are caused by treating the volcano with

levity. Visitors on the road to Poás are always warned by the old folks they meet not to laugh and jest while on the mountain, above all not to laugh at the mountain because the volcano does not like it! Mrs. Clark's servants had gone to a christening picnic at San Pedro de Poás (on the lower slopes of the volcano) the very day of the eruption and she laughingly accused them of being too gay and hilarious and so angering the volcano. They took it quite seriously and asked her if she really thought they were responsible for the eruption!

We had often discussed a trip to Poás, where Mr. and Mrs. Clark had been several times but which was of course unknown territory to me. The desire we all felt to see the volcano as soon as possible after the eruption decided us to make a flying trip at once. On the 27th, therefore, after a few hours' rest, we had a cup of chocolate apiece and at 11 P. M. started off on horseback, the three of us and Cirilo, one of the workmen on the place. There was a fine moon—one of the reasons why we made the trip in this way—the night was cool and the horses fresh and lively after a long day of resting and extra feeding. As a rule Costa Rican horses are not grain-fed except in preparation for unusually hard trips.

After riding through the outskirts of Alajuela we traveled generally north to San Pedro de Poás, over roads which were now in fairly good condition. Before reaching San Pedro we passed the road leading to the "Cerro" visited by P. on September seventh. The Cerro is part of a long ridge with a valley on each side, running generally east and west and falling away sharply on the west end. On this ridge are situated this Cerro, Carrizal and the B. farm, while at the east end the ridge runs into the folds of Barba. Our road bent around the west end of the ridge and then up a long hard hill, leading at last into San Pedro which we

reached at 1.30 A. M. It is a well-built, clean, attractive town with a fine church. Mr. Clark pointed out an Italian mosaic set into the wall above the door, which he said was an excellent example of such work. Unfortunately we could not see much of it in the moonlight. The town is prosperous and progressive; the richest sugar-cane in the country is grown around it and we passed many trapiches on the edges of the town and for some distance above. The crop is not so heavy as in some lower places, but the proportion of saccharin is higher and the juice richer, and it produces a cleaner dulce. The cañales here have the further advantage that the cane never flowers at this altitude, consequently it can be left standing for months in the fields, if the state of the roads or of the market demands, without deterioration. In the lower fields cane will flower if left standing and if rained on in that condition becomes absolutely worthless. Moreover, if the field flowers freely, it must be replanted, as after flowering the young shoots from the roots are not so vigorous. It is said that everybody in San Pedro is rich and the houses looked prosperous with their glass windows and neat corridors. The municipality is also wealthy. Some years ago the government allowed municipalities to take up a certain amount of land—not necessarily adjacent or even near to the municipality. After holding these lands for a number of years it was discovered that they were salable, i. e., the town could use either the land itself or the money derived from its sale. San Pedro was the first town to sell its land and the resulting cash enabled the municipality to pave its streets, level its plaza, put in electric lights and a good system of waterworks supplying the whole town.

After leaving San Pedro the road climbed upward quite steadily. Half an hour above the town, about 2 A. M., we dismounted to rest a few minutes and eat some chocolate. It was very cold, fingers and toes being quite numb, and we



Volcano Poás.
Active Crater of Poás, from southern rim.



Eruption of Poás, January 25, 1910, as seen from "El
Brazil," Alajuela.

were glad to put on all our extra coats. Beyond this point the road grew narrower and in places it occupied the bottom of a deep straight-sided gully which grows deeper with each rain. In the course of time such a road is so completely washed out that it becomes impassable and the carts then hunt a new path and wear a road there. The upper part of this road ran through woods and picturesque it was in the moonlight. It was remarkable to see such tropical plants as palms and plantains apparently powdered with snow, for in the moonlight the resemblance of the ash to a light fall of snow was most striking. Among the mountains it was quite clear and even in the valleys there was not enough mist to obscure the view. Here and there were the lights of the towns—San José, the brightest, to the east, and Heredia, Alajuela and Grecia.

After traversing the woods we came out upon a large cleared potrero where there were a few houses and near the upper edge a lecheria—otherwise an unattractive cabin in bad repair, where lived the family that took care of a herd of cows. It was not a station from which milk was sent off daily like the lecheria on Irazú, which supplied most of the milk for Cartago. The path through this big clearing was in places quite washed away and new trails had been worn, which were by no means easy to see and follow in the moonlight, bright as it was. We reached the lecheria (2114 m.) at sunrise of Thursday, January twenty-eighth, and stopped there for half an hour or so, to rest the horses and have some hot coffee which was made for us by the people of the house.

From the lecheria we rode on up through the big potrero until we came to thick forest—the potrero being enclosed in wire fencing. In the forest the real difficulties began; the trail was steep, winding in and out among the trees, deep in mud and crossed in every direction by roots and fallen trunks. The horses had to step between the roots, their

feet sinking deeply into the sticky treacherous mud, plunge over fallen logs and scramble up steep slopes. The mud was black above, reddish below, the two quite sharply marked off. I suppose the black layer—which was gritty—was a mixture of vegetable mould and volcanic ash. Over the black and dusting the leaves and horizontal branches was a powdering of the gray ash that fell two days before. Where the trees were thick the undergrowth had received very little, but the exposed surfaces were thickly covered although it was not piled up at all. This forest looked very different from that on Irazú. There is none of the weird ghostly grayness of the Irazú forest, and the latter is almost exclusively of oaks. I saw fewer oaks on Poás among the trees whose leaves I could see clearly enough to distinguish at all. Here all trunks and branches, even the stems of small bushes, were thickly covered with soft bright green moss, and the epiphytes were mostly green bromeliads and orchids. On the lower edge of the woods by the potrero were large quantities of an epiphyte with orange-red flowers, growing high up on big trees, which was very similar to if not identical with, the *Loranthus* common on Irazú at the level of the Jimenez lecheria. Among the undergrowth there were quantities of *Siphocampylus thysanopetalus*, in flower.

From Alajuela to San Pedro de Poás we noticed the ash along the road in about the same quantities. Above San Pedro it was somewhat thicker, and at the lecheria the old man who talked with us said that little stones, from a sixteenth to an eighth of an inch in diameter had fallen with the ash, and that he heard a very loud rushing noise with the beginning of the eruption. When we finally came out of these woods, after two hours of hard climbing, we were on the edge of an irregularly circular “small potrero,” with a level, swampy floor, set in a cup-like depression with steep

sides. Here the ash was thicker and coarser and on the opposite side of this small potrero, where we reëntered woods, we began to find stones varying from one-quarter of an inch to an inch, irregularly shaped and some with sharp edges. As we went on up we found larger ones up to a foot or more, half buried in the soft ash.

We left our horses at the edge of this potrero and after crossing the swampy meadow walked three-quarters of a mile through forest, the trail leading up a ravine so that the ascent was there more gradual. Then came a slight drop into an old crater, larger than the present active one but shallower, its level floor ashy and yielding to the foot a little. Both floor and walls were covered with vegetation which was now whitened with ash. There were many large stones here and it is probable that the larger (one to three feet) may have been due to a previous eruption, as they were harder, whereas those undoubtedly deposited by the last eruption were compacted ash only, readily crumbling into powder. On the far side of the old crater the trail for the third time ran through deep woods and was here exceedingly steep, leading up by steps of varying heights over fallen logs and trees. The ash was now thick on leaves and stems and made it difficult to recognize plants. Some ferns seemed to be yellowed by the ash, but the leathery leaves, such as those of ericads and myrtles, did not show much spotting when the ash was rubbed off. It was too damp to be knocked off completely, although our progress through the branches was attended by a series of ashy showers. The vegetation extends almost to the edge of the active crater, and on the upper level around the crater rim consists almost entirely of Myrtles and *Vaccinium consanguineum* about as high as one's head. All these bushes were so covered with ash that the whole mountain top looked uniformly gray and dead. Even at the edge of the crater the plants were

not scorched by the ashes but their leaves when rubbed clean looked green and fresh. Evidently the ash was not hot when it fell upon them, but the amount was quite sufficient to choke the leaves. In these upper woods I saw just one insect, a large fly, and we heard one bird. Mr. Clark said that usually there were many birds and insects and probably the presence of the ashes on the trees had driven them away.

We came out on the edge of the crater, on the south side, about 9.30 A. M. The mountain was then entirely clear and we had an uninterrupted view although there were clouds near and before we left the crater was mist-filled.

Between the edge of the woods and the beginning of the slope down into the crater was a bare, rocky, ash-strewn slope five or six feet wide, often less. Poás has been called the world's largest geyser and its crater has the shape of an inverted cone. Although its exact dimensions are not known, the diameter of its upper opening has been estimated at about a kilometer (five-eighths of a mile) and its depth, to the surface of the lake within, at about three hundred meters (or nine hundred and ninety feet). The figures given by the Costa Rican Commission of 1910 for the area of the lake, fifteen hectares (or thirty-seven acres), imply a greater diameter than the one hundred and fifty meters (four hundred and ninety-two feet) which Sapper considered it to possess in 1899. The sides were deeply scored and gullied by the force of the ash-laden streams that rush down them after an eruption, particularly the recent one in which the ash was vastly more abundant than usual. Formerly the sides showed horizontal strata of varying colors and (to judge from the photographs) sharp outlines, but at this time the horizontal banding had almost disappeared, while the grayish white ash streams had rounded the edges, cut fresh gullies and modelled the sides with vertical scorings.

On the north side were a few faint streaks of greenish-yellow.

The bottom of this conical hole was occupied by a lake of ashy water, in color and consistency like a huge bed of thin mortar. Its surface was covered with a lighter gray scum, which was blown by the wind into little ripples and streaks. While we were there, there was no movement of the water that seemed to be caused by forces within the lake or beneath. Except for the rippling of the scum the water was perfectly still and placid. The sulphur smell was very strong and there was much sulphur among the rocks near the water. The trails down to the lake, always rough and dangerous because of dislodged stones and slipping ashes, were almost obliterated. There seemed to be absolutely no vegetation within the crater itself. Two little flies, a beetle and one butterfly were the only insects I saw while at the crater.

Some of the stones were quite large. We saw them as much as two feet long and a little narrower (most of them were slightly longer than wide) and some other visitors to the volcano, who walked about more than we did, told us of seeing stones a meter and a half long (four and a half feet) and half buried in the ash. Here and there were irregular holes in the ash, varying in diameter and often half choked, which have served as chimneys or additional outlets for the gases of the volcano. The usual outlet is supposed to be a similar but immensely larger chimney below the surface of the lake and the escape of the gases through the waters of the lake, accompanied by the steam formed under pressure from the water percolating down the chimney, causes the geyser-like eruption.

In addition to this present crater with its ashy lake, Poás has another crater-lake higher up on the mountain, whose water is normally sweet and clear. We were told that the ash

which had fallen upon it had given the water a decidedly acid taste. This lake we did not see, as it lies at some distance from the active crater and our stay was necessarily limited.

By eleven o'clock the crater was filled with mist and we reluctantly began the downward climb, which was of course much harder than going up. We passed the lecheria at three and stopped at the bottom of the big steep potrero to rest the horses. On this part of the downward ride we had magnificent views of the great central valley, with its patches of bright, beautifully green cane, darker coffee and velvety potreros, all rolling and hilly even in the central "meseta," while the depressions between the little hills were occupied by tree-bordered streams. At five-thirty we halted for a lunch, then on steadily downward. It was dark before we reached San Pedro de Poás and as the moon did not rise until nine we had over two hours of hard going in darkness, with only the brilliant stars to light the road. And brilliant as they were they did not do much. Mr. Clark knew the road well and of course rode first, and as his horse and his clothes were dark he tied a white cloth around his neck. Mrs. Clark followed the faint glimmering of this white patch, I followed the white tail and haunches of her big gray and white horse, Cirilo followed my white horse, and so we traveled in single file down long steep hills, through two eerie covered bridges, around the edge of the "cerro" range mentioned above and were well toward home before the rising moon gave us any assistance. The horses were marvelously steady and surefooted and plodded right along through the dark as if they could see—no doubt they could see much more than we did. Once a monster rose up under our feet making the riders jump although the horses paid little attention to it. It was a calf which had chosen the middle of a dusty road to sleep in. Perhaps the horses

smelt him before he scrambled up and realized he would not "bite."

We arrived at El Brazil at nine-thirty Thursday night and were most warmly welcomed by the servants, who had expressed the greatest fears of never seeing us again. To them it was tempting Providence to go to the volcano so soon after an eruption.

On Saturday, January 29, Mr. Clark visited the Poás crater again. The gray-white ash was then markedly yellow and the leaves were showing the blighting effects of the deposit. Even the thickest and most leathery leaves, like those of the myrtles and ericads, were spotted, yellow and withering. Many had fallen already. In the upper wood trail the ground was strewn with shrivelled leaves and in consequence the path was much lighter and many branches looked quite bare. This injury was only temporary, however, for in the winter of 1913 Mr. and Mrs. Clark went to Poás and found the bushes around the crater as green as ever, they having only dropped their leaves and sprouted out again.

CHAPTER XVIII

TURRÚCARES AND THE RIO GRANDE DE TÁRCOLES

Turrúcares, a small village on the Pacific Railroad, was the scene of three collecting trips, in August, December and April.

On August 13, Professor Tristán and P., taking the 9 A. M. train from San José, reached Turrúcares about 10.40 and went up the slope immediately behind (north of) the station to the house of the Custodio or caretaker of the "Diana Club," Alfaro by name. Professor Tristán bore a letter from Señor Assmann of San José, president of this club, directing Custodio Alfaro to allow us to sleep in the club's cabin. The Custodio was away when we arrived but returned in the afternoon and gave us the keys. In the meantime his wife gave us breakfast and we left our things in his house while we were collecting.

The walls of the Custodio's house were formed of boards certainly fifteen to sixteen inches wide; it had a red tile roof and hard earth floors. It was one-storied of course and contained four or five rooms. It had some windows but no sashes, no chimney in the kitchen, but some latticework between walls and roof facilitated the escape of some of the smoke. As usual the roof projected over the front wall so as to form a covered porch as one might almost call it. Some of the chairs were entirely of wood, but there were two called "tijeretas," having a piece of untanned hide stretched from the top of the back to the front of the seat so that seat and back were one continuous piece. The kitchen fire was built on a table within some bricks which were laid, without

mortar, in two parallel rows, separated by an interval greater than the width of either row. This space was closed at one end, but open at the other and also at the middle of one row of bricks. The cooking utensils were placed on the two rows of bricks; when in position, additional wood could be introduced through either of the openings. Water was boiled in an iron kettle of familiar shape.

I saw most of the stages of the making and baking of tortillas while staying here, excepting only the very first when corn (maize) is boiled with wood ashes to loosen the hulls of the grains. Modesta, the Custodio's eldest daughter, took the boiled mass in a basket to a little swift-flowing stream behind the house, where she washed it with her hands to remove the hulls. The pasty, starchy mass remaining was taken back to the kitchen and ground in an iron coffee mill. Formerly, throughout Central America, this grinding was done with the "piedra" and "mano de piedra," but the iron mill is fast superseding these stone implements. Professor Tristán told me that he had seen the disappearance of the latter between two visits to Santa Maria Dota, one of the most southern villages of the Pacific side of central Costa Rica. After grinding, Modesta put a small lump of the ground corn—of about the quantity proper for a single tortilla—on a flat stone, rubbed it a little with a smaller stone, to make it still finer, I believe, placed this upon a bit of plantain or banana leaf and flattened it with the palm of her hand into a thin round cake six or seven inches in diameter. It was then laid on a hot concave iron plate already in position on the rows of bricks, across the fire, where it was cooked and then stood up on edge against the outer side of the middle opening of one row. No doubt some of these details were individual peculiarities of Modesta's.

Our diet was of the usual Costa Rican style, but the ingredients were different from those I have mentioned for

Tierra Blanca. "Coffee" was accompanied by tortillas or small white bread loaves. Breakfast consisted of soup, beef, rice, frijoles (black beans) and potatoes, with coffee at the end. Dinner was almost the same as breakfast. Young pig sometimes replaced beef, and chayotes appeared in one form or another at some meals.

In December, when we were here again, the front room of the Alfaro house, where we had our meals as before, had a new case with a glass front, containing some new saints. On the ground just behind the house the family supply of coffee was drying. Under the veranda in front stood a section of a tree-trunk about two feet in diameter and two to three feet long. One end was hollowed out to form a bowl. It served as a mortar in which the dried coffee berries were pounded with a heavy wooden cylinder, narrowed in the middle, to break open the husks and release the two coffee grains within each berry. Three large pigs, which I do not remember seeing on our previous visit, occasionally passed through the house from front to back doors. Almost every member of the family—the only exception I am sure of was the baby about a year and a half old—smoked a cigarette occasionally, even little girls of five or six. The only really serious objection to the family habit was that they spat anywhere on the beaten earth floors of the house. Had we been obliged to sleep there instead of in the clubhouse, we might have been less comfortable. I must not omit the mention of a hand-run sewing machine and a neat white tablecloth of familiar appearance. The meat now was dried and mostly tough; several pieces of the dried article hung from a cord stretched across the kitchen. We had wheaten bread, baked in San José and bought in a local store, served to us with coffee instead of tortillas, more frequently than on our former visit, which may indicate a change in the habits of life. We still had tortillas at break-

fast and at dinner. The water supply was a stream of muddy water, which by filtering through an unbaked earthen jar became quite clear. When I drank it I added lemon juice as a precaution and Professor Tristán sometimes did the same.

The clubhouse in which we slept was about a hundred feet distant from the Custodio's house. It was of wood with a corrugated iron roof and had a triangular gable above the wall at each end, left open for ventilation, yet neither bats nor birds came in. There were two doors, one window with a shutter but no sashes and a small covered porch in front. The single room within had a wooden floor raised three feet above the ground, and contained a number of canvas cots or stretchers and uncovered pillows. Each of us had brought his substitute for blankets—mine was an old shawl. I folded it so that there were two thicknesses beneath and two above for covering, and found this sufficient and comfortable except for a short time before sunrise in August, and after about one in the morning in December.

On the second day of our stay here in August some young scorpions were found on Professor Tristán's cot. Professor Alfaro, who had now joined us, said that the young were usually not far from the mother so we all looked for her, as the sting of the larger scorpions is painful, although not fatal. We did not find her, but on this day and the next five of the young were found, some of which were identified as *Centrurus* (*Centruroides*) *margaritatus*. This is a widely spread scorpion occurring from California to Chile, and it has also been found in West Africa, where it is supposed to have been introduced by human agency. Professor Tristán has stated that it is common in the roofs of old houses in San José and we have mentioned in Chapter XIII its occurrence in epiphytic bromeliads at Juan Viñas. The adults reach a length of four inches. The scorpions of the genus *Centrurus* or *Centruroides*,

as these American forms are termed by different authors, are slender creatures, members of the family Buthidæ. The family is characterized by having two, not one, spurs or spines in the membrane between the last and next to the last section of each leg, and the sternum (or middle plate on the under side of the body on the line between the third and fourth legs) approximately triangular in shape. The pincers at the tip of the first long pair of limbs (pedipalps) by which *Centrurus*, like other scorpions, grasps its prey, have on the inner surface of each jaw, a number (seven to nine) of short rows of small uniform teeth. These median rows run slightly obliquely, so that they are not in continuation of one another nor, on the other hand, do they more than barely overlap. On each side of these median rows is another row of fewer, less closely-set teeth, where a larger tooth alternates with two or three smaller ones. Other genera of scorpions have the teeth of the pincer-jaws arranged in other ways—one wonders whether there is any advantage or adaptation in the arrangement to the special mode of life of the animal. *Margaritatus* belongs to a group within the genus *Centrurus* having seven or eight rows of median teeth, while *C. bicolor*, which appeared in the office at Philadelphia South farm (see page 319) has nine such rows.

When we arrived at the clubhouse on December 19, some members of the club were there but returned to San José in the afternoon. They had shot a doe that morning, about half an hour's walk distant; it was hanging under the veranda in front of the Custodio's house and went off to San José with the hunters.

West of the club's land were maize and plantain fields and pastures. In December the former looked like harvested fields at home after the crop has been removed and weeds have grown up, reached their prime and dried; some of the weeds were very familiar too, such as the "mozote" or

Spanish daggers (*Bidens*) and the "pega-pega" or beggars' ticks (*Desmodium*). The pasture west of this field had beautiful soft green grass.

Going down hill, behind—north of—the house, through a pasture with a single palm in the middle of it, brought us to the Rio Siquiares, a swift-flowing stream discharging into the Rio Alajuela, which is in turn an affluent of the Rio Grande de Tárcoles. The rocky bed of the Siquiares was in the form of steps so that the descent of the flowing water was well marked. The banks on both sides, shaded with medium-sized and small trees, produced a pretty effect. A short distance downstream, the river made a sharp bend, owing to a wall of basalt, about fifteen feet high, with a distinctly columnar structure, which jutted out from the left bank.

Professor Alfaro and his son spent the afternoon of August 14 fishing in the Siquiares and caught five fish. Four were put into alcohol. The fifth and largest, about six inches long, was cooked for my dinner; it was a *Rhambia*, of the catfish family, and good.

On my first visit, two features of the plant life around Turrúcares struck me as the chief differences from the Atlantic slope, which alone I had hitherto seen. One was the much smaller number of bromeliads and epiphytes generally on the trees, the other was the abundance of the bull's horn thorns in the woods. These plants ranged from bushes three feet high to trees of fifteen. In the preceding chapter mention has been made of their peculiarity in being frequently inhabited by small ants of the genus *Pseudomyrma*. I saw *Ps. belti* which is black and *Ps. nigrocincta* which is red with a dark band near the middle of the body, at Turrúcares. We had to be careful to avoid touching the bull's horn thorns in passing them, for if we did so we were almost sure to brush off some of the ants upon us, whereupon they proceeded both to bite and sting severely. In some places,

these plants were sufficiently numerous and close together to make passing them a matter of some discomfort. In his recent *Observations on the Central American Acacia Ants*, Prof. W. M. Wheeler has distinguished between the obligatory and the facultative ants, the former being those which live exclusively on the acacias. The facultative ants only occasionally live upon the bull's horn thorn, as they inhabit other plants also. So far as Costa Rica is concerned, Professor Wheeler lists three species of ants of the obligatory class (the two *Pseudomyrmas* just mentioned and *Ps. spinicola*), and three facultative species (*Ps. nigropilosa*, *Ps. sub-tillissima*, *Camponotus planatus*).

Thomas Belt, from his studies of bull's horn thorns and ants, came to the conclusion, set forth in his charming *Naturalist in Nicaragua*, that: "These ants form a most efficient standing army for the plant, which prevents not only the mammalia from browsing on the leaves, but delivers it from the attacks of a much more dangerous enemy—the leaf-cutting ants. For these services the ants are not only securely housed by the plant, but are provided with a bountiful supply of food, and to secure their attendance at the right time and place, the food is so arranged and distributed as to effect that object with wonderful perfection." He then describes the crater-formed gland, at the base of each pair of leaflets, secreting a honey-like liquid, and the minute yellow fruit-like bodies (since called "Beltian bodies") at the tips of unfolding pinnules, both of which are used as food by the ants which dwell in the hollowed-out thorns.

Professor Wheeler's observations in Panama and Guatemala have led him to write that although it must be admitted that some of these dendrophilous ants (*Pseudomyrma*, *Azteca*) sting and bite severely, and may therefore defend the plants, this is, of course, merely a coincidence or by-product, as it were, of the true defense which the ants exercise in

behalf of their own bodies and their brood, and, therefore, that we may adopt von Ihering's point of view, and say that the Acacias have no more need of their ants than dogs have of their fleas. "If this is true, the relation between the ants and plants is not one of symbiosis, but of parasitism."

About fifteen feet from the bank of the Siquiares there was a fairly large nest of the leaf-cutting ants and at one edge of the nest stood a bull's horn thorn with its *Pseudomyrma* inhabitants. I knew that the leaf-cutters cut and carry off pieces of the leaves of plants allied to this acacia. With my forceps I gently picked up a leaf-cutting ant from the ground and put it near the tip of a leaflet of the bull's horn thorn. There were only one or two *Pseudomyrma* on the leaflet and they did not seem to pay much attention to the leaf-cutter, which, after a little wandering, fell off to the ground. I picked up another leaf-cutter and placed it upon a pair of thorns where there were a number of the *Pseudomyrma*. Although the latter were much smaller than the leaf-cutter, they instantly rushed at it and one seized hold of one leg, one another leg. The leaf-cutter ran to and fro with the result that it finally fell to the ground, but whether pushed or thrown by the assailants or as a result of its own efforts to escape, I could not tell. I repeated this experiment several times, always with the same result except that once when the leaf-cutter fell, the *Pseudomyrma* was still clinging to one leg and the leaf-cutter dragged it around over the ground for some distance before it released its hold. I also put a *Pseudomyrma* among some leaf-cutters near an entrance to their nest, but no actual violence resulted.

On August 13 Professor Tristán found a *Peripatus* similar in appearance to those we obtained at Turrialba, and later in our stay found two more.

On the 13th, 14th and 15th we caught along the Siquiares both sexes of a pretty dragonfly new to Costa Rica. It may

be *Cora marina*, previously known from Mexico and Guatemala, or intermediate between it and *C. alcyone* of Bogotá. It was one and three-quarter inches long and had a wingspread of two and one-quarter inches. The males were attractively marked with black and sky-blue and had a reddish-brown patch on the middle of each wing. In the females pale green replaced the blue and the patches were absent from the wings. Presumably the larvæ are as interesting as those of *Cora chirripa* of Juan Viñas, but we did not find them.

In conversation with Custodio Alfaro about the things we were collecting, we learned that the local name for dragonflies was "reyes" (kings). I showed him a larger species (*Brechmorhoga*) and a smaller (*Heteragrion*); he said the former was "un rey," but for the latter he knew no name. There are many popular names for these insects in different parts of the world, but one analogous with that given by the Custodio is "rajah," reported by Mr. C. W. Andrews as applied by the natives of Christmas Island in the Indian Ocean to the still larger species, *Anax guttatus*.

On December 19, Professor Tristán and P. spent the afternoon along the Rio Siquiaries, whose waters were sufficiently lower than in August to permit our crossing from bank to bank on the stones. The leaf-cutting and bull's horn thorn ants were busy and there were many butterflies and dragonflies, although of different species, for the most part, from those of our previous visit. On the following morning we went north from Turrúcares, crossed the Siquiaries and a potrero north of the stream and reached a smaller stream not visited on our former trip. This brook flowed first through open pasture, then was bordered by a fringe of trees containing some wild figs with slender stems and trunks most fantastically shaped, due to their constrictor habit.



Bull's horn Thorn, *Acacia costaricensis*, Alajuela.

Ants from Bull's horn Thorn. 1, 2, *Pseudomyrma belti*;
3, 4, *Ps. nigropilosa*; Santa Cruz; all x6.3



Entire Tree and curled Pods of Guanacaste—*Enterolobium cyclocarpum*.

The banks of this stream were muddy, and in the open pasture the muddy spots attracted great swarms of butterflies which clustered closely at certain places. These butterflies were almost exclusively white or yellow *Pierinæ* but there was one almost white *Papilio* with long tails. In fact not only this day and here, but also at other days and places around Turrúcares we saw many such swarms over muddy places and on dung.

The potrero through which we passed had in it a number of fine cedro (*Cedrela*) and guanacaste trees. The cedro has nothing whatever in common with our cedar; it belongs to the family Meliaceæ. The guanacastes, unlike those at El Brazil, Alajuela, had not dropped their leaves.

Looking directly south from the front of the Custodio's house, the horizon was formed by a ridge of mountains sometimes called the Cerro de Puriscal, for to the south of the ridge lay the town of that name. At the eastern end of the cerro was a sharply conical peak, the Pico de Tinamaste, "tinamaste" being the name applied to the stones forming an oven as commonly built in this district, instead of bricks as I have described the one in the Custodio's kitchen.

On the morning of August 15 four of us, joined later by the Custodio, rode in the direction of the Pico de Tinamaste nearly to the town of Naranjo, which latter however we did not see. Professor Alfaro wanted to look for fossils and a few were found, chiefly *Scala* and *Pecten*, which are said to be of Miocene age. They would indicate, therefore, that this part of Costa Rica was submerged at that period. I found one fragment of a *Pecten* shell on a piece of stone embedded in the road over which we had all passed, and calling Professor Alfaro's attention to it, he dug it out and carried it off.

The road for much of the way, especially near Turrúcares,

was extremely muddy so that in many places the horses sank so deeply that the mud reached to their bellies, and the lower half of the tail soon became a solid stiff rope. My horse was small and gentle and at times seemed hardly able to pull its legs out of the slime and go forward, but slowly it succeeded. All of the road was not as bad as this but the bad exceeded the good.

Our route lay over a rolling country; the altitude of the point where we turned back was 1900 feet by my aneroid, therefore 300 feet lower than Turrúcares station. Professor Tristán rode with my net in his hand and caught several dragonflies while so mounted.

A walk to the southwest from Turrúcares on the morning of December 22 took us along dry shadeless roads and occasionally into potreros. Professor Tristán wanted some earwigs and termites but found few of either. An elderly peon left his yoke of oxen standing in the road to show us where he thought some large termite nests had been, but they had disappeared. On the way we passed through a rice-field from which the rice had been harvested but through the stubble were scattered rows of "maiz de Guinea"—Guinea corn. The plants were of the height of maize or Indian corn and with very similar stalks and leaves. The grains are smaller than those of maize and are not arranged on a cob or spike but in a compound panicle five to six inches long and three to four inches across. This plant is used only for feeding cattle and perhaps other live stock. It is planted before the rice and as it ripens later is left standing when the rice is cut.

Occasionally we passed a guácimo tree (*Guazuma ulmifolia*), a member of the family Sterculiaceæ, with downy asymmetrical leaves four and one-half inches long and one and one-half inches wide, acute at the tips and with serrated edges; the fruits were covered with conical points or tu-

bercles and were still green, hard and unripe. Professor Tristán told me that they remain hard even when ripe but have a pleasant acid taste. The name "guácimo" in combination with some adjective is also applied to some trees of the lime and linden family.

We went down a zigzag road into the ravine or quebrada of the Rio Tizate, a clear water stream with low banks where we struck it, and fairly well shaded. Close to the water was flying a bright red, exceedingly slender-bodied dragonfly which I had described in 1907 from specimens from Guatemala and Honduras as *Protoneura amatoria*. It was hitherto unknown from Costa Rica. The colors of its eyes are remarkable, although owing to their small size a pocket lens is needed to appreciate them. They form three horizontal bands on each eye, the uppermost bright red, the middle band dark brown, the lowermost pale green. At the same place was another dragonfly, *Argia ænea*, found throughout Central America and Mexico, the male of which is colored brilliant metallic copper on the upper surface of the thorax and has eyes of equally striking colors. Each orb is bright red above and in front, dark brown behind and in part of the middle, and gray below. The eye of the female of *Protoneura amatoria* is similar in color to that of the male although the red band is less bright and less extensive. The eye of the female of *Argia ænea* lacks the red altogether, being dark brown above and gray below. Unfortunately the eye colors fade almost completely after death, even when those of the body are fairly well preserved; their significance, if they have any, is unknown.

The following day (December 23) we went again to the Rio Tizate but higher up in its course. To do so we walked south through the main street of the very small and poor village of Turrúcares. But with this disparaging remark should be coupled the record of our experience on the day of

our return to San José at the conclusion of our August visit. The train was scheduled to leave Turrúcares about 2.30 P. M. We awaited it at the station, but as it had not arrived at five, we went back to the Custodio's house for some coffee, leaving our unlocked belongings inside the enclosed station with no one to watch over them, yet they were untouched when we returned to take the train.

Around Turrúcares, at this time, some of the peons were wearing shoes, some were barefoot and a few wore sandals consisting of a leather sole, larger than the foot, and held in place by a thong which came up from the sole between the great toe and the one next and was passed around the ankle and tied on itself. Among the soldiers in the streets of San José I saw both barefooted and shod, but do not recall these sandals, although we saw them sometimes near Cartago and in the market there.

Leaving the hamlet we reached the little river in some twenty minutes. The road was that over which we traveled in August on horseback toward Tinamaste, when it was fearfully muddy. To-day it was entirely dry but with very deep ruts and a month or so later was probably as deep in dust as it had been in mud. We found the potreros and fringes of trees bordering the Tizate good collecting ground and in consequence covered only a short distance in the four hours spent in its pretty valley. The surrounding country is uneven and rolling, with many small conical hills having rounded tops.

P. repeated this trip to the Tizate on April 10, 1910, coming by the extra Sunday train from Atenas station to Turrúcares in fifteen minutes and then walking southeast to the river. Along the road here and there were some noble trees (*Couralia rosea*). In early February, at Orotina, Professor Tristán had photographed one for me—all covered with pink flowers. These had but a few flowers left, but many

Pods looking almost exactly like those of our own *Catalpa*, which belongs to the same family, the Bignoniaceæ. The flowers of the roble are nearly the same size and shape as those of the cortess (see page 379) but pink, the inside of the corolla tube being a pale yellow. The flower cluster I was able to pull down had thirty-three blossoms and was imperfect.

Nearby was a tree with numerous clusters of small yellow and orange flowers, which a few days later a man at Cebadilla told us was the "caimito." Our Turrúcares specimen, however, proves to be the plant listed in Professor Pittier's *Plantas Usuales* as the "nance" (*Byrsonima crassifolia*, of the Malpighiaceæ), while according to the same authority the name "caimito" properly belongs to *Chrysophyllum cainito*, the "star-apple," of the Sapotaceæ. We met the name "caimito" at Alajuella applied to what is probably the same *Byrsonima*, for our notes made there from the living plant agree with the Turrúcares specimen—leaves entire, elliptical, bluntly acuminate, margin entire, upper surface highly glossy bright green, lower surface warm russet brown and covered with silky hairs. The ribs are prominent on the under side, each side rib connected with the side rib next in front and next behind so that just within the margin there is a series of scallops formed. The leaves from Turrúcares are up to four and one-half inches long and two and three-eighth inches wide.

On the other hand, we have leaves from a tree called "nance" at the Bonnefil farm at Surubres which are evidently *Byrsonima*, although possibly not *B. crassifolia*. Thus it would seem that there is some local difference in the use of the vernacular name "caimito," just as the name "cortess" or "corteza" was used at Cebadilla for the *Couralea*, although elsewhere more commonly applied to the yellow-flowered *Tecoma* described on a later page.

As I went down into the valley of the Tizate which was here no more than a small brook, I found the surroundings scarcely recognizable, for the fields had been cleared of brush, weeds, stubble, etc., and these burned. Only along the stream was there a strip of green. I went upstream a little farther than we had been in December and down as far, spending four hours along a stretch of less than a mile; most of the time I was at a charming shady spot where I ate lunch and where there was water oozing out of the bank and fit to drink. Good water was a serious question for clothing was washed in almost every stream, contaminating it below, and only where water could be seen coming out of the earth, and with no human habitation above, did I care to trust it. When tramping along the now dusty roads, with a blazing sun above, fondly did I remember these "ojos de agua"—eyes of water—as springs were called here.

Wishing to visit the Tizate at some lower point on its course, I walked on April 11 to the next station east of Atenas, Cebadilla, about two kilometers distant from which a road led southward and crossed the Tizate. At the crossing I asked permission to enter the potrero and go upstream, which was at once granted. The Tizate there and then (it being the dry season when all water courses were contracted in volume) was in places ten to fifteen feet wide, in others narrowed by the rocks between which it flowed to three or four feet, but where the channel was so reduced there was often another, sometimes under stone. It was a smaller stream than the Siquiaries north of Turrúcares, not so deeply shaded, but otherwise similar, forming pools at successive steps below each other, each pool emptying by a little cascade. Boulders were strewn more or less indiscriminately along the bed. Uruca trees formed much of the shade.

The return to Cebadilla station was painful on account of heat and thirst, for the water piped to Atenas was not

very inviting so that I did not carry it with me, the Tizate was not clean, and two oranges, welcome as they were, did not last long. I noticed two peculiar looking woodpeckers on the road back to Cebadilla—almost white on most of the body but with a patch of crimson on the front of the head above the beak.

Several times I walked westward from Turrúcares on the tracks of the Pacific Railroad. The roadbed was inferior to that from San José to Limón, the gauge often variable, and in some places one rail visibly lower than the other. The trains ran slowly and lurched from side to side. On August 16, four of us went a short distance beyond kilometer post 34, making many stops on the way. Near kilometer 33 the country on each side of the track was flat and wet, with many plants of *Mimosa asperata*, peculiar in its method of discharging its seeds. It forms a cluster of five or six pods, radiating from a common center. Each pod separates crosswise into sections holding one seed each, which shake apart and fall from the pod as they dry; but the ribs forming the longitudinal margins of the pod are left behind as the framework out of which the seeds have dropped. The pods have some short soft spines by which the sections adhere to the fur, hair or clothing of passing animals or of man.

I caught or observed three flying earwigs (*Doru lineare*) this morning along the tracks; these insects are not often seen on the wing. I kept one and turned one over to Professor Tristán who was specially interested in the group. He found the same species in maize between the stem and the leaf-bases, so that the flying specimens doubtless came from a corn-field in which they were abundant.

Between kilometers 33 and 34 from San José the whole country was covered with rounded or angular boulders one to ten feet in diameter, which had weathered to a dark dull brown or black color. In some places they were heaped on

each other, in others scattered but at intervals less than their own dimensions; in still other places they were yet farther apart. Owing to their dark color, in contrast to the gray boulders on Irazú and near Cartago, they gave a somber appearance to the ground which they cover. Where they came from I do not know, as there is now no peak or cone near. Specimens brought from here have been identified as porphyritic scoriaceous basalt with large plagioclase phenocrysts.

On December 21, Professor Tristán and P. walked along the railroad track westward to Atenas station, about seven kilometers distant, collecting some insects on the way. We passed some "poró-poró" trees (*Cochlospermum hibiscoides*), conspicuous objects wherever they grow because they blossom when entirely leafless. The flowers, bright yellow in color and two to four inches across, are borne over the rather flattened crown of the tree. The "poró-poró" is entirely different from the "poró" (*Erythrina* sp.) in spite of the similarity of the vernacular names. Nor must it be confounded with the "corteza" described below, a larger tree which also covers itself with brilliant yellow flowers in its leafless condition and is equally conspicuous. *Cochlospermum hibiscoides* belongs to the Bixaceæ; its leaves are palmate. The flowers have five sepals (two green, three pale yellow) five bright yellow petals, numerous greenish-orange stamens which are chiefly grouped in five masses opposite the petals. Sepals, petals and stamens persist as shrivelled remains at the base of the fruit. This is a five-valved ellipsoidal capsule, opening on the tree so as to show the papery ridges inside the valves, bearing the dark brown kidney-shaped seeds to which are attached masses of white cottony fibers. The mature seeds appear to be but a small proportion of the ovules as many more undeveloped seeds were usually found in the fruits. The poró-poró belongs to the lower Pacific slope; the highest point at which we saw



Pods of *Mimosa asperata*.

Fruits of Poró-poró—*Cochlospermum hibiscoides*, about one-half natural size.



Anacardium rhinocarpus. (?)
Marañon—*A. occidentale.* All natural size.

it was between Alajuela and Rio Segundo, where a group was in flower on March 12. The trees near Turrúcares were fruiting on April 9.

We stopped for a short time on December 21 in a rice field by the side of the track. The crop had been harvested but among the stubble were numbers of winged ant-lions—a greater number than either of us remembered to have seen elsewhere. The species was described by Mr. Banks from our specimens as new, under the name *Brachynemurus fenestratus*.

Where the Pacific railroad approaches the bridge over the Rio Grande de Tárcoles it describes several loops to descend to the bridge grade and the country people have cut off these loops by a well-worn path across some fields by which the walk is considerably shortened. Crossing this bridge on foot gives one more opportunity to appreciate its great height and the perpendicular rock walls of the river gorge. The gorge is by no means straight so that one cannot see far up or down the river from the bridge.

Before reaching the bridge on December 21 I captured one specimen of *Pseudoleon superbus* resting on the soil alongside the railroad track, and Professor Tristán took a second after crossing the bridge. This is a dragonfly with very peculiar and bizarre wing markings and colorings, hitherto never recorded south of Guatemala. The most northern specimen was taken in an Arizona cañon by Dr. Henry Skinner.

We went on to Atenas station where we breakfasted as described in Chapter II. This concluded we went east again for a short distance and descended the north side of the railroad embankment into a little ravine known locally as the Quebrada de Salas,—Salas being the name of the owner of a farm nearby. This ravine is occupied by a small stream of clear water flowing between moderate-sized rocks, one of

the prettiest of its kind that I saw in Costa Rica. The stream, for the distance visited by us, was shaded with high trees and bushes, beyond which on each side were open fields. We found a number of interesting adult dragonflies and the larva of *Heteragrion*, hitherto unknown and for which I had spent many hours of search in different places.

A small hotel near Atenas station was headquarters from April 8 to 13. It was in part two-storied, constructed of wood with corrugated iron roof and the front was colored light blue. In the lower story were kitchen, dining-room, bar and general store, with the owner's private room and enclosed porch. In the second floor over the store were also one or more private rooms while over the remainder were four tiny and one larger rooms; the latter held three beds, the others one bed each. All four rooms opened on a well-shaded porch but were windowless. A single thickness of rough-planed boards divided these rooms from each other and there was no whitewash or interior finish whatever. Their rear walls were of corrugated iron.

The building stood on a little elevation behind and above the station but within a stone's throw of it. It faced nearly southeast and commanded a fine view, as from the front the Candelaria, Santa Maria Dota, Tinamaste and other mountains were visible, and from the eastern end of the porch Barba in the distance and the bridge over the Rio Grande de Tárcoles were plainly in sight. From the bridge the deep cañon of the river passes westward on the other side of the station and parallel with the railroad, but only its upper part was visible from the hotel as the gorge is too deep to show the river.

Continuous with the station to the west was the bodega or freight house and to the east the eating shed. East of this again was a taquilla or drinking booth, while separated by a little interval from the latter was a well-built cylindrical

iron water tank, on a cut-stone base, for the locomotives. At one side of it was a cement water trough with constantly flowing water, where the population, both male and female, gathered in the mornings for their somewhat limited ablutions, some not forgetting to bring toothbrushes, some basins, while others came without anything in the way of implements.

There were a number of small, poor houses near the station. People coming from or going to the town of Atenas, eight kilometers distant, left their horses in a covered shed adjoining the hotel on the west, or had them brought thither.

Having placed my things in one of the one-bed rooms, I walked to the pretty brook in the Quebrada de Salas, two or three hundred feet east of the station, and went up its bed much farther than on the previous visit in December. For some distance its banks, which are of rock throughout, become higher and more vertical, then lower again farther upstream. A young man and a girl, sixteen to twenty perhaps, became interested in what I was doing and caught such insects as they could in their fingers and brought them to me. At one place where piñuelas made it difficult to follow the brook, I turned into a potrero where stood a "cortess" tree, which was a mass of golden flowers but had no leaves whatever. I broke off a flower cluster of twenty-seven flowers, each flower with a corolla of five partly united yellow petals streaked on the inner side of the tubular portion with pale purple lines. The flowers were two to three inches long and nearly two inches across at the mouth of the corolla. As one looked up to the Aguacate Mountains these golden-crowned cortess trees dotted the hillsides here and there, taking the place of the poró-poró trees blooming a few months before. According to Professor Pittier the cortess or corteza (*Tecoma chrysantha*, one of the Bignoniaceæ) is

also called "corteza amarilla" and "guayacán" in Costa Rica.

The potreros themselves were sun-burnt, while most crop fields had had their stubble recently burnt over with fires whose smoke was a marked feature of the western landscape at this time of year. In the midst of such brown or black stretches stood the guanacaste trees in fresh green foliage waving in the breeze and thickly covered with seed pods now turned to a rich Indian red. Many of the pods had fallen to the ground and when shaken their seeds rattled most vigorously. The pods are three to six inches in longest diameter, curved on themselves in a circle, the ends of the pods sometimes even overlapping. The seeds, ten to fourteen in number, are elliptical, three-eighths inches long, dark brown with a paler ellipse on each side. Although loose enough to rattle, the seeds are not unattached but each one is fastened at one end by a partly coiled yellow thread in its own separate compartment of the pod.

As I was about to get into my bed that night (April 8) I found a most curious animal running over it. As may be guessed, I found a variety of "animalitos" in beds in Costa Rica, some of them indeed rather too large to be entitled to that diminutive, but this was the most extraordinary of all I met in such situations. It was *Ammotrecha stolli*, one of the group of Arachnids known as Solpugids. Its body was three-eighths of an inch long, although when its legs were spread out as in moving it covered more than half an inch. Its short fore-body bore a pair of jaws longer than itself, pointing forward, each terminating in a pincer whose jaws, upper and lower, were of equal length, toothed along their opposing edges and had sharp curved tips. Behind these appendages was one pair of five-jointed palps and then four pairs of legs. The palps, on the whole, were thicker and longer than any of the legs except the fourth or last pair.

The first, third, and fourth legs were successively longer, the second were the shortest of the four. On the under side of the fourth legs, near their bases, were some curious projecting sense-organs. The upper surface of the fore-body possessed a pair of eyes near the middle of its front edge and only its hind portion was divided by cross-furrows into three small segments. The hind body, on the contrary, which was several times longer and lay behind all the legs, was clearly marked off into ten segments. Unlike the scorpions the hind end of the body was rounded and without any sting or spine. I quickly got cyanide bottle and forceps and secured the creature. Whether it would have annoyed me as a bed-fellow, I shall never know, as no others appeared. Another Solpugid was taken at Liberia in January in the school room where Professor Tristán and I slept.

About midnight the wind blew very strongly and suddenly and every loose corner of galvanized iron about the building rattled and the whole house shook perceptibly.

I wished to descend to the bottom of the cañon of the Rio Grande de Tárcoles. The information available at the hotel was that there were two roads, one, seven or eight kilometers distant, diverging from the road leading from the town of Atenas to Alajuela, the other the road from Cebadilla to the new electric plant under construction. I knew something of this plant from Mr. Clark and as this was the shorter way and also insured a water supply I chose it. As I went along the railroad to Cebadilla on April 12 I was able to add another species or two to my present collection. Indeed I had the same experience each day here, for apparently dragonflies came up from the river or other stream to hawk over the tracks in search of insect prey—as I did.

The road from Cebadilla for a mile at least was the one I had taken the preceding day to the Rio Tizate. It was probably the best in the country, well constructed, finely

graded and telforded. It was built by the Purdy Engineering Co., an American firm, to an electric power plant which they had begun in the Rio Grande cañon for new American owners of the Aguacate gold mine. After leaving the public road, which continues beyond the Tizate, this new road entered the grounds of the plant, wound down among watered and consequently bright green pastures (in contrast to the surrounding country) wherein horses and cattle were feeding. By the roadside was a guachipelín with deep pink blossoms. Where this road began the descent into the cañon, the altitude was 1550 feet. Halfway down, at 1300 feet, were wooden houses with wire-screened windows and running water piped from the rocky cañon side, recently erected for the manager of the plant and his assistants. The road then zigzagged down to the cañon floor, where were some workshops, storage sheds, the beginning of a tunnel for the water column which was to furnish the power and many lengths of iron pipe, five feet in diameter, bolted together and lying in position on the lowermost section of the road. I had heard from Mr. Clark that the heavy expenditures made here had been called in question by the stockholders, on the ground that they were much too great in proportion to the yield of the mine for which they were primarily intended and it had been charged that the stockholders had been deceived as to the real value of the mine. I was not astonished, therefore, to find no work going on. I had stopped at the manager's office to ask permission to go down to the river but there was no one there except native women and children, who told me the manager was in San José but would return about 10 A. M. As it was then about 9 I decided to go down and ask permission afterward. After passing the shops I went on to the actual water edge, here about 1060 feet above sea-level and did a little collecting. The dragonflies I obtained at the cañon

bottom were not different from those I had already found at the top, 550 feet higher.

Then I walked downstream as far as the clearing extended, climbed a quantity of loose rock and reached the mouth of the Tizate, which descended into the Rio Grande de Tárcoles through a gorge heaped with large boulders, while the cañon side overhung in a way unpleasantly suggestive when one thought of earthquakes. I clambered up the boulders for about a hundred feet to a very flat one, wherefrom I had a good view up and down the Tizate cañon. The forest here had not yet been cleared and some of the trees were two to three feet in diameter and quite tall. The walls of the Rio Grande cañon here were in part solid rock, in other places conglomerate of moderate-sized boulders in a reddish clay; still higher up above the manager's house were well-shaped basaltic columns. A specimen of rock from the bottom of the cañon proved to be of the same basalt lava as that found along the railroad near kilometer post 34, but less porous (see page 376). The geology of the cañon at Cebadilla has recently been described by Mr. Romanes. The cañon bottom was extremely hot, being shut away from the cooling effects of the wind perceptible at the top. A thermometer on the side of the manager's house registered nearly 94° F. in the shade, at 2.30 P. M.

Near the houses were some tall *Anacardium* trees (*A. rhinocarpus*?) one having a diameter of at least three feet at the ground. They were shedding their fruits, which came pattering down on the galvanized iron roofs making a loud noise when the stone struck the metal. Like its near relative, the marañon, the fruit has its stone outside the pulp—that is, the edible portion is technically the receptacle. The stone is quite hard, the pulp soft and green within and without. I saw the children picking and eaten the freshly fallen fruit, each of which was about two inches long, so later I made

the experiment myself; the pulp was sweet and pleasant-tasted, not astringent. The next day I bought three marañons (*Anacardium occidentale*) for five centimos at the eating stand at Atenas station, where they were sold as seasonable fruit. Each was about three inches long, the pulp making two inches, the stone one inch, of the length. The pulp was yellow and covered with a red or yellow skin, the red almost of the tint of a less "bricky" tomato. Its odor suggested the anona; its taste was very acid, astringent and somewhat sweet. The hard stone which hangs below the fleshy receptacle was pale purplish-gray externally.

Having learned the dwelling place of *Thaumatoneura* larvæ on the Atlantic side of Costa Rica, it seemed as if they or a similarly-constituted species should live in similar situations—more or less vertical rock faces in running or falling water—on the Pacific slope. To obtain data on this point I went on the morning of April 13 to the Quebrada de Salas, south of the railroad, where it descended steeply to the Rio Grande cañon. The white flowers of a guapinol, a mimosaceous tree, overhung the spot but out of reach. Dragonfly larvæ were in the swiftly flowing water, but not of *Thaumatoneura*, nor did they possess any of the peculiar features of its caudal appendages. They were chiefly of a species of *Argia*, recalling at first sight *Argia talamanca*, the associate of *Thaumatoneura* in the waterfalls of Juan Viñas. But on comparison they prove to have the caudal gills proportionally and absolutely longer and more expanded than those of *talamanca*, although not as slender as those of *Argia extranea* from the vicinity of Cartago, or as thin and leaf-like as those of *Argia* larvæ dwelling in the less rapid parts of streams in the United States. There was also a larva of *Archilestes grandis* there, with thin oblong gills, three-eighths of an inch long and rounded at the tip; in short, nothing which at all closely approached the modifica-

tions of structure which we had found in the Juan Viñas falls.

Although I went to bed early each night at Atenas, I rarely was able to sleep until some hours had passed. The first night or two this was due to sudden strong gusts of wind which rattled every loose thing around the house. One night a nearby accordion wheezed away for several hours and on the night of April 12 the Señora and a male voice had a loud and prolonged conversation, which easily penetrated to the second floor. Then after I had fallen asleep I was awakened by the shaking of the hotel just as it had been by the wind, but this time I knew from the absence of other sounds that it was due to earthquake. A second more severe shock came about one o'clock, but I did not get up and eventually went off to sleep again. In the morning the Señora asked if I had not been afraid of the "temblores." Rumors that this earthquake had been very bad at San José reached Atenas and I feared that the railroad might have been affected, but the train left Atenas and arrived in San José nearly on schedule. I left this train at the Sabana station, riding thence in the trolley car direct to the Atlantic station, and as we passed through the city many cracked walls, fallen plaster and brickwork testified to the work of destruction.

CHAPTER XIX

SURUBRES AND OROTINA

In October, accompanied by Professor Tristán, we spent a week at a charming farm on the Surubres River, about eight miles from the Pacific coast. We went by train to the terminus of the Ferrocarril al Pacifico, which was then at Orotina; there we hired horses at once to take us to the Bonnefil farm, which was "more or less two hours" distant—decidedly more in the wet season. Our way led at first along the Carretera Nacional. In the dry season, the time of shipping coffee, there was a steady stream of carts traveling down this road every night and early morning, but now in the deep mud of the winter we passed few carts and of course no coffee. Beyond the little village of San Mateo we turned to the right out of the Carretera Nacional into a much poorer and muddier road, which grew worse as the fine shower beginning soon after we left Orotina turned into a steady heavy rain. When we reached the edge of the Surubres valley the road was really bad, very steep with deep mud and deeper holes but the beasts behaved nobly. The Surubres River was deep and rocky with a swift current, and we were all glad when we had safely traversed the treacherous fording. Although so bad this last bit of road was extremely pretty, shaded by big trees, the banks draped with maidenhair ferns, *Selaginella*, *Tradescantia* and mosses, and in places the horses' hoofs sank into a deep carpet of the same plants.

The Bonnefil farmhouse, which we reached late in the afternoon, was built of wood and had board floors; there

were three rooms besides kitchen and outer sheds, and across the front was a porch where we ate our meals. The family consisted of Don Pedro Bonnefil and his sister, who received us most kindly and gave us their largest room, which I think they must have used as a dining-room ordinarily.

When the sun shone it was rather hot at Surubres but the shade was cool and pleasant and we were comfortable under blankets at night. The finca was beautifully located and I hope we can always keep a vivid picture of our delightful meals on the porch, particularly dinner, when the sunset light was shining redly through the big trees at the edge of the cane field and touching the new leaves of the higueron with color so that it looked like a huge candelabrum of which the lights were the buds of the tree. Across the Surubres to the east was a high hill, and on its very crest a large coyol, the last tree to lose the sunset light. The sunset glow was exceedingly short-lived here but wonderful during the few minutes of its existence. There were no mosquitoes and we sat on the porch with a lamp until supper—a meal of chocolate for us, coffee for the others, bread, fresh cheese and occasionally cakes, served about eight o'clock. Frogs and toads croaked, crickets chirped, colts whinnied, cows lowed and now and then we saw a pair of gleaming eyes as some inquisitive bull or steer came near the porch to stare at the light. Don Pedro and Don Fidel talked politics, Señorita, A. and P. talked plants and scenery as far as our Spanish permitted; or the Bonnefils retired and took a nap while we prepared the day's catch or wrote up our notes.

As we sat on the porch at dinner or during the afternoon rains, great macaws flew across the clearing, usually in pairs but once three together. These were the common species (*Ara macao*) with red, blue and yellow plumage. As the short twilight fell we often heard a bird with a high mourn-

ful note. This was the "cuyeo" (*Nyctidromus albicollis*), whose bones, dried and ground to a fine powder, are used by the Indians as a charm against their enemies. The powdered bone is mixed with tobacco in a cigarette which when smoked causes certain death, according to the popular belief.¹ Another strange mournful sound, like a woman's cry, is said to be the voice of the "woman of the river"—the Llorona. Every river has its Llorona, who is always moaning and crying for her little son, drowned in the river. Still another story is that at midnight on some nights there can be heard the rattle and rumble of a cart around the plaza, but always "una carreta sin bueyes." If a man stays too late and spends too much at the pulperia (saloon) he is very apt to see the "cegua" on the way home. This is a beautiful girl sitting by the roadside, who asks him to take her up on his horse as she is weary. When they have ridden a little way he speaks to her and she turns to him a mare's face, with flaming eyes, huge and horrible. Or he may be followed by the black "cadejos" whose claws rattle on the stones as he runs.

Education and government oversight are changing the outward face of things rapidly. Until fifteen years ago there were many of the Indian superstitions represented in the Fiestas Civitas, but at the time of our residence in Costa Rica there were but few. One which always appeared was the "dueño del monte" or owner of the forest, a man who had wandered off into the forest and was lost. As his clothes wore out he covered himself with mosses, lichens and ferns so that he was always green and leafy, and he became the owner or spirit of the forest.

Professor Tristán, to whom we are indebted for these tales, said that in Escazû and other less accessible parts of the

¹ Some other superstitions concerning the cuyeo are given by Cherrie in *The Auk*, IX, p. 324, 1892.

country there were still witches, but the government had so shadowed them that they were very shy about appearing as such. A typical example of their advice is the following:—a man consulted a witch to know how he could ride an unbroken horse without being thrown. She told him to call the next morning, when he received two dried leaves with the following directions. “Tie your horse so that he cannot jump. Get on and put one of these leaves between each knee and the saddle and press the leaves tightly against the saddle. Then have some one untie the horse and just as long as the leaves are pressed against the saddle you cannot be thrown.” The man followed the witch’s advice but evidently did not press hard enough to bring out the magic of the leaves for he was thrown and broke his arm, upon which he sued the witch but unsuccessfully.

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Around the edge of the clearing were many orange trees. Directly in front of the house and perhaps seventy-five feet away were two huge trees, one a higueron, the other a guapinol. The fig was in the act of losing its leaves, which it does twice a year, and was now half bare, as every gust brought down a shower of them, stiff and leathery. The “guapinol” has compound leaves of two leaflets, each leaflet having one straight and one convex edge. The straight edges of the two being close together and parallel, a symmetrical whole is produced. In the preceding chapter we have mentioned the white flowers of this tree in April near Atenas station. At Surubres in October the thick woody pods, three to four inches long, were in evidence. Such a pod (from near Liberia in Guanacaste) gathered in January, 1910, and kept whole and dry, weighs two ounces after nearly five years.

Except where it had been cleared and cropped, the country was heavily wooded with valuable timber trees. Left stand-

ing in the small clearing around the house were fine individual specimens of higuerones, guapinol, guachipelin, two sorts of "hule" (*Castilloa* sp.), the rubber trees of Costa Rica, papayas in flower, "cenízaro" (*Pithecolobium saman*) whose extremely hard wood is valued for spokes of wheels, manzana rosa, marañon, oranges, sweet and sour lemons and mandarins. The forest outside the clearing was magnificent, full of hule, nance, cedro and at least three kinds of cacao. One of these last had a large pod, red when ripe, growing on the main stem of the tree. Another had a shorter black pod about four inches long, which was borne on the younger branches (*Theobroma angustifolia*). The Costa Rican name for this species is "cacao silvestre" or in parts of the country "cacao de mico"—monkey's cocoa. And all the pods we found had a hole bitten in the rind, through which the monkeys had evidently thrust their hands and removed the seeds. The seeds of the cacao are in four irregular rows on a central placenta, and the whole mass is embedded in a rich white pulp which has a pleasant taste. It is greedily eaten by monkeys, chickens, birds and indeed anyone who can get at it. The cacao itself is contained in the cotyledons. The seeds or "cocoa beans" are soaked in water three days to clean off the pulp, dried, ground and boiled to get rid of the first "crop" of oil, after which the cacao paste is ready to be made into chocolate. Away from the towns it is always prepared in a jicara and is whipped to a delicious froth by a little wooden beater, the molenillo.

Immediately behind the house was a small fenced garden patch, with enough coffee to supply the family. "Balsam of Peru" (*Toluifera pereiræ*) was growing here and "gengibre" or the ginger of commerce (*Zingiber officinale*), while by the fence was a large clump of "Hoja de sen" or "clavelina" (*Poinciana pulcherrima*), whose medicinal properties resemble those of the senna of druggists. The plant grows

freely about habitations on the Pacific slope and although not actually cultivated is encouraged on account of its handsome red and yellow flowers, as well as its usefulness in the native pharmacopœia.

At the west of the house-clearing was a cane field, where several "calabacero" trees (*Crescentia cujete*) were growing. These are small trees with thick trunks, rounded or slightly flattened heads and exceedingly stiff spray. The large tubular flowers are borne on older branches and are followed by globular or elongated fruits six to ten inches in diameter, which have an extremely hard woody rind and numerous dry seeds. The fruits are very useful to the country people. Those of globular form, known as "guacals," are cut in two and when the seeds are cleaned out are used as bowls, or holes are bored and the shell becomes a sieve or colander. The elongated ones, called "jícara," have one end cut off and serve as chocolate pots, bowls, cups or dishes, according to size and shape. These vessels are often beautifully ornamented by cutting away the dark outer rind in patterns so that the lighter inner wood is exposed, and sometimes they are painted in addition. They all have round bottoms, however, and must have a little wooden stand, the "conejo" or "salvillo," to keep them upright.

There seemed to be a difference in the shapes of the leaves of the trees in this clump bearing the jícara from those producing the guacals. The jícara had entire leaves, eight to ten inches long, slightly acuminate; occasionally the margin was indented a little at the end of a vein. The leaves of the guacal were usually three-lobed at the tip, although some were entire. The lobing was irregular, sometimes only two lobes being present, or the margin might be entire on one side. However in January, P. saw, in the yard of the hotel at Filadelfia in Guanacaste, a jícara and a guacal tree, both laden with shining green gourds. The leaves of these two trees

were so often of the same size and shape, and not ternate in so many cases, that it was impossible to distinguish the trees by the leaves alone.

The river was reached most quickly from the house by a path toward the east, which soon dropped into the steep-sided ravine and led a beautiful course under guanacastes, palms, wild cacao, cecropias and bull's horn thorns, with many other trees we did not recognize. Many begonias, differing from those about Juan Viñas, were full of bloom, draping the rocks and tree-trunks, and the path was often ankle deep in ferns and selaginellas. At the bottom of the trail was an especially wide and dense mat of vegetation, mostly of a species of *Selaginella* strange to us, having more pointed fronds than those we had seen. Many of the forest trees had an abundance of aerial roots which formed networks outside of the trunk and between the buttress-like ridges of the trunk where such ridges existed. As usual there were numerous aroids in the undergrowth and not a few in the form of vines climbing the tree-trunks. The bright green of fresh new *Heliconia* leaves relieved the dark green picture. One morning one of these, a fresh, young, perfect leaf, was "smoking" conspicuously; the sun had just begun to fall on it, and with such force that the leaf transpired or lost water vapor as a visible mist some inches wide and rising several feet above the leaf tip before it was lost in the air.

Termites' nests, high on tree-trunks, and with covered trails leading up and down, were common. A typical forest tree with a stem immensely tall before it branched, bore a termites' nest at a height of more than forty feet from the ground. The brown line marking the covered gallery was very distinct against the pale bark and visible for quite a distance. Bits of broken termites' nests were abundant on the ground in this part of the forest.



Bonnefil Farmhouse at Surubres.
Coyal Palms, *Acrocomia vinifera*, Surubres.



Surubres River below Farmhouse.
A Fumarole of Cerro Guachipelín.

There were relatively few bromeliads on the trees here and we found no dragonfly larvæ in any of those we were able to examine, although the adults of *Mecistogaster ornatus* were seen in these woods. The yet unfolded leaves of the numerous *Heliconias* formed cornucopias often filled with water, and perhaps may take the place of the bromeliads of the Atlantic slope as breeding places for these forest dragonflies; with this in mind we frequently searched among these leaves for larvæ. In pulling down one to examine it P. found that a bat was disturbed from somewhere and flew off. Later another bat disappeared from the same vicinity, so suspecting that they had come from this leaf he pulled it over more cautiously and looking in saw a third still within. It was a small bat, with the body about one and a half inches long, exclusive of the tail. Its most striking features were the suckers on its limbs; each wing had a sucker on the front edge where ordinary bats have a claw, and each hind foot bore a smaller sucker. It was a species of *Thyroptera*, probably *T. discifera*. Subsequently I unrolled the remainder of this leaf finding in the bottom bat excrement and numbers of very small flies, *Leptocera* (or *Limosina*) *bromeliarum*, of the family Borboridæ. They were from one-fiftieth to one-thirty-third of an inch in length, with a black, almost shining body and clear, somewhat yellowish wings. As the specific name indicates, this insect was first found in bromeliads. It was discovered at Córdoba, Mexico, in March, 1908, by Mr. F. Knab. As many of the Borboridæ are scavengers, these individuals may have fed on the bats' excrement. In all twenty-three species of this genus of Borboridæ have been detected by Mr. Malloch among the small flies which we collected in different parts of Costa Rica, and sixteen of the twenty-three he has described as new.

I looked through other unfolded *Heliconia* leaves, finding within them more of the small flies and a few beetles, but no

dragonfly larvæ. The beetles were of two species and a variety of *Cephaloleia*, family Hispidæ. The smallest species, *C. 4-lineata*, was seven millimeters long, with the head dark brown, the prothorax orange with a dark brown middle spot narrowed where it reached the hind end of the segment; the elytra brown, with a longitudinal yellow stripe on the middle of each but not reaching the hind end, and a narrower yellow stripe on the outer edge. *C. stenosoma* was nine millimeters long, its head and thorax similarly colored, but the elytra orange-brown in the anterior half and black in the posterior half, the black reaching farthest forward along the suture. A variety of *C. stenosoma* was also present, similar in size, in color of head and of thorax, but having the elytra uniformly reddish-brown. In May, we found a third species of *Cephaloleia*, *C. placida*, in an unfolded *Heliconia* leaf near the Reventazón at Juan Viñas. This was six millimeters long, reddish-orange above, yellow beneath, including the legs. Each elytron had ten rows of dark punctures. The antennæ were for the most part blackish, but the first two joints and the tip of the last joint were yellow or orange. The species of *Cephaloleia* feed on the tender leaves of their host plants, according to Mr. G. C. Champion.

Along part of the river bank which we explored, bull's horn thorns were abundant and close together so that one had to be extremely careful to avoid them; for as we have said the bite and sting of the ants inhabiting them are very severe and on P. at least raised a little welt lasting perhaps half an hour. I noticed that the plants inhabited by ants ranged in height from one to thirty feet, but not all were tenanted although the great majority were. It was not evident why some were not. We obtained an attractive little Chrysomelid beetle (*Megascelis lacertina*) on these thorns. It was but one-sixth of an inch long; its head and

thorax were brownish-yellow, but with a metallic green reflection, and were finely punctured, the punctures not in rows. The elytra were metallic green, each with ten longitudinal rows of punctures, the under surface of body and legs clay-colored. We made no observations on its relations to the ants—if it have any.

One day, while sitting quietly on a stone by the river, A. saw a "nutria" (perhaps *Lutra latidens*), an otter-like animal with gray fur and a long tail, run out of the woods upon the stones a short distance upstream; then it entered the water and swam across the river, seeming quite unaware of her presence although she was in full view.

It was impossible to follow the stream for any great distance either up or down, as the gorge had steep sides and going downstream the many little tributaries increased the volume of water so rapidly that the ravine bed was full. At these points therefore we had either to return or scramble up the side of the ravine into thick charrál where we rarely saw dragonflies and which was difficult walking. But the little bit of wider river valley produced several valuable finds. Dragonflies new to the Pacific slope of Costa Rica were taken here: a new species of *Philogenia*, a small form of *Palæmnema nathalia* and a little *Progomphus* (*P. pygmæus*) not previously recorded from anywhere between Guatemala and Bogotá. This last was hardly one and one-quarter inches long with a wing-spread of one and one-half inches. Its colors were dark brown and green. Its eyes, bluish-green above and paler below, did not nearly meet on the top of its head and the hind wings were distinctly wider than the fore pair. It was swift of flight, wary, and difficult to follow with the eye because its colors so nearly coincided with those of the sand and reflected bottom of the river. Better still, we found one transforming *Progomphus* and its exuvia, and, on later days, the living larvæ. The latter,

five-eighths inches or less in length, were taken with a small water net from a bit of sandy bottom over which the current was upstream as the result of a partial whirlpool due to a curving of the stream-bed. The larvæ lived entirely buried in the sand. A. found that merely skimming the surface of the sand was unsuccessful, but by taking the sand to a depth of half to three-quarters inches the larvæ were secured. On placing them in a bottle of water with sand at the bottom they frequently stood end on, head in the sand and tail up, and they probably take the same position in the stream-bed. At other times they assumed the horizontal position in the sand, completely covered by it, and the only indication of their presence was when a grain of sand suddenly rose in the water, probably as the result of a slight spouting of water from the rectum in the respiratory process. They moved swiftly through the water in the bottle from time to time, returning to the sand. They also burrowed rapidly through the sand with the legs, throwing sand out behind. We were never able to keep these *Progomphus* larvæ alive in captivity for more than a day or two, which is no doubt correlated with their habit of burying themselves in sand under swiftly flowing water.

Near where the road forded the Surubres stood a small trapiche or sugar mill, not in use at this season, and along the river bank below the ford was a cane field surrounded with tangled masses of a morning-glory or "churristate." The trapiche having a roof, was a favorite place of retreat if we were collecting near it, when we were caught in a shower or the sun grew too hot. The lovely bit of shady road was a delight, with its banks hung with maidenhair ferns of at least five species, Selaginellas of at least three kinds and the whole luxuriant drapery shot through with begonias—begonias with tall red stems, smooth, thick rounded leaves and red or white flowers; begonias with hairy pointed leaves and

white flowers; dainty little begonias with long narrow leaves and pink flowers. The last two we saw only on the Pacific side, the first we found in profusion in the Reventazón valley at Juan Viñas. The bull's horn thorn was common along this road and we watched the ants sipping the nectar from the glands on the petioles. On the leaves of roadside plants were a number of flies (*Scepsis* sp.) some of which, reddish-brown in color, had the abdomen contracted to a narrower stalk where it joined the thorax and the wings folded down over the back. These features gave the fly a very ant-like appearance and it ran over the leaf in quite ant-like fashion.

Leaf-cutting ants were very active at Surubres, and along the road from Orotina. We noted one column of ants nine inches wide, formed by the junction of several smaller columns. The pieces of leaves which they were carrying had become so wet, owing to the rain, that the ants were dropping them in a great heap.

Behind the house, and in a general northerly direction, the land rose considerably so that the highest part of the farm was 1000 feet according to our aneroid, while the farmhouse stood at 800 feet and the river a little below the ford was only 550 feet. This upper part of the farm was either forest or old pasture growing up into charral, through which we climbed on October 20 with little José and his big machete to cut a way for us. From the highest parts of the charral we obtained fine views toward the southwest, where the Gulf of Nicoya and the Pacific could be clearly seen: Puntarenas was hidden by nearby hills but our view extended from a little south of that port to the Herradura Mountains, and included the lower part of the Gulf with a number of its islands, the peninsula of Nicoya and the Rock of Caldera. One of the best of these views we had from a hillock marked by a single tall tree which José said was a corteza. Above the corteza was a "rancho," a hut with a steeply-sloping gable

roof constructed very neatly of palm stems in two layers, the inner parallel to the ridge pole, the outer at right angles thereto. We rested a few minutes at the rancho, glad of the shade for the sun was shining brightly and it was about one o'clock. Thence we continued upward behind the rancho to the forest, making our way back to the farmhouse by a different and higher path through brief showers.

Much of our way lay through charral where the tangle was composed of escobilla, "quiebra-plato" (*Crotalaria vitellina*), zorillo and an appalling number of thorny, spiny plants. Of these the most conspicuous, because of its numbers and its spines, was the "rabo de iguana" or lizard's tail (*Mimosa velloziana*). With its pink balls of stamens, long stems climbing over other plants or sending out canes like blackberries, and its highly sensitive leaves of eight leaflets, this plant is a pretty thing—until one touches it. But all the stems are set with four rows of terrible thorns, strong, sharp, recurved, and it is a serious matter to be caught by them, not to mention having a branch sweep across one's face or neck. Another is the "lagartillo" or little lizard, a bushy herb with compound leaves, numerous pointed leaflets and strong spines on the under sides of the midribs. The small common creeping sensitive plant is also spiny but it does not usually grow high enough to give much trouble. All these were bound together by morning-glories and other creepers and threaded by innumerable cow-paths less than a foot wide and often so arched over and grown up that they were extremely hard to follow. Here and there were fine groups of guanacastes, wine palms and other taller palms, giving patches of welcome shade. In the wine palm or "coyól," *Acrocomia vinifera*, the dead leaves are retained, attached to the tree but hanging downward, their withered brownish color forming a gradual contrast to the more erect, green, younger leaves. The bases of the old dead leaves remain on

the trunk even down to the ground, giving the tree a scaly appearance. Among the taller palms was one called "palma real"—royal palm—which is probably the *Attalea gomphococca*. It has no drooping leaves and its smooth trunk apparently reaches to a greater height than does that of the coyól. The other royal palm (*Oreodoxa regia*), said to be originally from Trinidad and the northern coast of South America but which has been cultivated in Costa Rica, is distinguished by its trunk being swollen in the middle and tapering thence both upward and downward. The "pejibaye" palm (*Gulielma utilis*) also grew on the Bonnefil farm, and is similar in shape to this *Attalea*, but is easily recognized by the bands of long sharp spines around its trunk, separated by narrower spineless bands. The coyól also has spines on the attached leaf-bases, but these spines are not in bands but scattered irregularly; they are three-sided and five or more inches long.

Another palm of this region was the "palma de sombrero," a round-leaved species of *Inodes*; it is apparently without erect stem so that the leaves and fruit seem to spring directly from the ground. The better kinds of hats were made of the fine fibers, the cheaper of the coarse ribs. "Escobas" or brooms were also made of these ribs and one of the stations on the Pacific Railroad was named Escobál from the broom factory there.

The Surubres River, and the Bonnefil farm particularly, were favorite collecting grounds of the late Professor Paul Biolley, a connection by marriage of the Bonnefil family. He, however, visited it only in the dry or summer season. Our visit was therefore planned for the wet season in order to supplement his collections, and in spite of the drawbacks of deep mud, regular rains and in addition a bad "temporál" we found the results most interesting and valuable. If we had had the morning sunshine usual in the rainy season, we

should certainly have taken many more species, for whenever the sun did shine a number of dragonflies appeared, only to be invisible again when the clouds once more obscured the sun.

Professor Tristán's leave of absence having expired, he was forced to return to San José on the twentieth of October, but we remained two days longer with Señor Bonnefil. We left Surubres at 7 A. M., our kind hosts furnishing us with horses to go to Orotina. We had stayed with them a week; they gave up their best room to us, entertained us with the best they had of everything, made chocolate especially for us because they discovered we liked it, sent the small José with us as path-cutter almost every day, supplied us with horses for our return,—and all this because we were strangers to the country and friends of a friend of their niece's husband! They were most delightful people to visit, too, for they loved country life, loved and knew the trees and plants and beasts and gave us much information about these things.

Owing to the temporál the roads were much worse going back to Orotina, and the hill up from the Surubres was really terrible, it was so steep, so deep in mud and so slippery. P. rode a mare with a colt at home, and she had to be forced the whole way. The main carretera was unspeakable. Partly from these delays, partly because of a difference in time-pieces, we missed the daily train at Orotina. This meant staying all night there, which was not in our plans at all. However the Hotel Internacional might have been worse. The temporál continued all day and night and we sat on the balcony—luckily the hotel was two-storied—reading *Cymbeline*. (We tried to carry something to read and something to eat wherever we went.)

Most of Orotina (called Santo Domingo until recently—the railroad tickets still bore that name) was along two streets; one was occupied by the railroad, the other was at

right angles to the first. The houses were built with very wide boards for walls but had roofs of heavy tiles or of corrugated iron. One store, the Hotel Internacional and the Government building were two-storied, all other buildings had but one. The grass-covered plaza lay south of the tracks. Its east side was occupied by the church, which was quite un-Spanish looking. It was long and low, but the plaster-covered west façade was two-storied and surmounted by a peaked cupola; the numerous windows were filled with clear glass and had round heads. The church stood in a pretty garden, with boundaries of square brick pillars and iron bars, while before the entrance porch were two rows of cocoanut palms. Within, the ceiling of the church was paneled lengthwise with a dark wood. Altogether—leaving the chancel out of consideration—this church rather suggested some colonial edifice of the United States. On other sides of the plaza were the green-painted frame Government building already referred to and the neat school for boys (*varones*).

Cocoanut palms occurred in other parts of the town. Across the side street from the hotel was a fine group very heavily laden with nuts, and near them a papaya with four or more large fruits near the top of its trunk. Across the railroad from us were scattered ten or fifteen coyól palms. The rain prevented us from seeing much of Orotina and its surroundings but there were some picturesque hills or mountains to the north, the Aguacate Mountains, and to the southeast the Turrubales.

CHAPTER XX

GUANACASTE—PUNTARENAS TO LIBERIA

La Información, a daily paper of San José, said in its issue of January 6, 1910, "The Commission for qualifying the teaching personnel, composed of Professors Obregon, Tristán, Perez Martin and Orozco, leaves today for Guanacaste to examine and qualify the teachers who offer service in that province. The Commission goes to Liberia where it will pass some days and thence to Santa Cruz where it will pass others in fulfilment of its duties. The Commission will be joined in Guanacaste by Don Salvador Villar."

This Commission was sent out by the Ministry of Public Instruction. Professor Tristán told me that the Subsecretary of this department learned that he and I had been planning an excursion to Guanacaste, the northwestern province of Costa Rica, at this time (the long vacation in the schools here) and gave orders, after receiving the consent of the President of the Republic, that I should have the privilege of accompanying the Commission. The expenses of the journey were paid by the Government for me as well as for the members of the Commission and as I had had no thought of such a thing and had made no requests of any kind this action came as a great surprise.

The railroad ride from San José to Orotina (which we reached at 12.15 P. M.) was uneventful. At the latter place the Jefe Politico called on us and we accompanied him to the municipal building on the plaza. It was a two-storied wooden structure, the lining of the walls and the ceilings being of the same material. Repairs to the ceiling were in

progress, owing to the damage done by termites, which had reduced much of the panelling to a mere shell. Some of us climbed up into the air-space beneath the galvanized iron roof and found that the termite galleries ran along the wooden roof beams to the very summit of the quadrangular pyramidal roof. The ceiling joists of the second story where the uprights of the roof beams rested bore termite nests composed of the chewed and partly digested wood. One of these nests, broken up, was swarming with the termites, with which we filled a vial. The attempt was being made to destroy the termites by putting corrosive sublimate into the top of the nests in the hope that it would be gradually carried downward, and swallowed by the insects in their gnawing.

We delayed our departure from Orotina in order to avoid riding in the hottest part of the day. Most of the members of the Commission had considerable baggage and this was started on its way to Esparta in an ox-cart. We followed on small mules and one white horse, leaving at 3.10 P. M. There were six of us, as the Commission had a secretary. During the afternoon there were frequent clouds and occasional sprinkles but we seemed to be on the edge of the rain so that we received none of any consequence.

Our route from Orotina was the same as that to Surubres as far as a place called El Higuito, on the Carretera Nacional. We went through San Mateo so as to pass the church, a plaster-covered building with a dome looking more like that of an astronomical observatory, except for the absence of an opening for the telescope. Near San Mateo I noticed a breadfruit, a tree which seemed to be less abundant here than on the Atlantic side. There were many jícaras and guacals with large shining green gourds.

Beyond El Higuito was to me unknown country. The road was in good condition from Orotina, in agreeable contrast with its state in October; it was now dry, hard and

not dusty. We descended into the great beautiful tree-filled barranca of the Rio Jesus Maria, from which stream, in previous years, I had received many specimens collected by the late Professor Biolley. The Intercontinental Railway Commission give the elevation of the bridge at the river as 438 feet above sea-level.

Beyond the barranca we stopped for a few minutes under a large tile-roofed shed by the roadside, erected by the Government for the shelter of the many travelers on this road. Ox-carts in great numbers passed in both directions, being then the only means of transportation of goods between Esparta and Orotina, just as they were over the whole country for three centuries. At Orotina I was introduced to a Costa Rican artist and his wife, people of sixty or more; they left before we did and we overtook them during the afternoon. They were traveling in an ox-cart, sitting on a mattress placed on the floor, while over the top of the cart was a waterproof covering. Needless to say travel by ox-cart is very slow, as may be judged by our overtaking them, for even we took five hours for the supposedly fifteen miles as the darkness forced the latter part of our journey to be performed at a mule walk.

After leaving the shed we descended, then ascended another but less deep barranca, of the Rio Paires, and after that I could tell nothing of the road or country for it grew so dark that I could hardly see my mule's head and I was only able to distinguish any one of our party by their white straw hats or the white horse which Prof. Pérez Martín rode. As for riders approaching us I saw nothing of them until they were alongside. Carts or droves of pigs traveling in the opposite direction were accompanied by lanterns which, so far as we were concerned, served to blind us to everything else. As there was no rule of the road as to passing and as it was impossible to see the width of the road,

one could not tell on which side an approaching light was except by hearing the sound made by cart or pigs. This traveling in the darkness was not pleasant, but I relied implicitly on my mule and the creature did not fail me.

Finally we reached the hotel in Esparta about 8.15 P. M. and tired with the long slow ride I was glad to dismount. The streets of Esparta were lighted with oil lamps, the houses were built of wood. The accommodations at the hotel were limited and the four members of the Commission and I slept in one room, the secretary in an adjoining one. We were glad to turn in soon after our nine o'clock dinner. Some time during the night the ox-cart came in with the luggage and delivered it at the railroad station in the morning. My own baggage was so compact that I took it all on my mule with me.

On January 7 after coffee, we left Esparta promptly on the 7 A. M. train for Puntarenas. The locomotive had a very old-fashioned smokestack; the train was composed of a couple of box freight cars, a second- and a first-class passenger coach. A few days earlier, while still in Cartago, I had read Dr. Sapper's account of his travels in this part of Costa Rica in 1899. His train from Puntarenas to Esparta consisted of a single first-class coach and some flat cars without sides or top on which latter the freight and second-class passengers traveled, one of these unfortunates being thrown from the car as the train rounded a curve. He has some severe criticism of the accommodations furnished as being unworthy of the otherwise civilized condition of Costa Rica, and it was pleasant to see that they had been bettered.

Until the gulf beach was reached the railroad passed through much rather open woods, in which here and there the poró-poró was conspicuous by its bright yellow flowers and almost leafless branches. The jocote continued to sea-level and there were scattered palms. We crossed the Rio

Barranca on a new iron bridge and soon after stopped at the station of that name near the right bank of the river; between railroad and river was a cattle-farm. After stops at two small stations we ran out in sight of the Gulf of Nicoya and parallel to the beach, only a few rods above high tide, so that breakers rolling in were plainly visible from the car windows. Soon an estero or arm of the sea appeared at a slightly greater distance on our right, so that with the gulf on our left we ran out on the long narrow peninsula near the tip of which is situated the town of Puntarenas. According to Professor Tristán the estero is the former mouth of the Rio Barranca which now empties some miles farther south. Reaching Puntarenas soon after 8 A. M. we established ourselves at the Hotel del Pacifico, at the corner diagonally opposite from the railroad station. Here a number of the local school authorities greeted the Commission; I was introduced to them and also to Señor Romagosa, the Captain of the Port, a very agreeable young man, educated in Germany and speaking English, French and German. We walked to the gulf side of the town where were the custom house, the ice-factory, ocean-going steamship pier and a recreation pier with bath houses. Then we crossed to the opposite water edge on the estero where the pier for steamboats plying on the gulf is located. Puntarenas was larger than I expected, with wide streets laid out at right angles and more ample sidewalks than San José. The streets were sandy and unpaved, but lighted with electric arc lamps. Nearly all the buildings were of wood except for the tile or galvanized iron roofs. A church with a single tall spire looked as if it were of a yellowish stone but it may have been painted wood—it was off the line of our walks so that I did not examine it at close range. The cuartel or barracks was a plaster-covered and presumably stone or adobe structure. Most buildings were one-storied, but on the principal street

two-storied ones were not rare. The population at this time was about 4750.

Three of us returned to the bathing pavilion where I had a sea-bath, inside a wire net enclosure on account of the danger from sharks. It was at such a distance from the beach as to be just beyond the breaking of the waves and too deep to stand on the bottom, consequently not available for those unable to swim. There were ropes to rest on and a plank walk around the edge of the netting ten or twelve feet above the water from which one might dive. I enjoyed my swim, the water being of an agreeable temperature. The charge for a sea-bath, suit, towel and ample well-ventilated dressing-room with shower-bath was 25 centimos (12 cents). After breakfast some of us went to the Municipal building, on the estero side, to make inquiries concerning our departure, as it was hoped that we might go in a gasoline launch; instead we received orders for our transportation on the steamboat leaving at 2 A. M.

In the afternoon we went to the pier to see the Pacific Mail Steamship "Peru" which had just come in. The water is not deep enough to permit vessels of her draft to come up to the pier, which extends far beyond the surf. Passengers and cargo must therefore be carried from ship to pier or vice versa in small rowboats. We watched some passengers and trunks brought ashore in this way. Although the sea was smooth there was enough swell to necessitate some agility in passing from the rowboat to the landing-stairs and still more exertion required of the boatmen to put a heavy trunk on these steps and drag or lift it up by main force. It is advisable—for the sake of the contents—that trunks making this trip be perfectly strong as well as light. Later, at Captain Romagosa's invitation, most of our party went out to the "Peru" in his boat rowed by three Costa Rican sailors in white duck uniforms.

The Gulf of Nicoya as seen from the south side of the town is very picturesque, as most of the horizon is bounded by mountain-ridges, the Aguacate Mountains to the east, the Herraduras to the south and the hills of the peninsula of Nicoya to the west. The highest conical peak of the Herraduras is known on the maps and at Puntarenas as the Volcan Herradura, but its volcanic character is doubtful. In the gulf are a number of islands with more or less precipitous sides, like much of the mainland south of the sandy peninsula of Puntarenas. One of them is the prison island of San Lucas, the buildings on which were clearly visible in the daylight. The mouth of the gulf lies to the south.

After an eight o'clock dinner we were escorted to the club on the estero side where there was very moderate drinking and story-telling. One of our hosts showed us a human figure made of gold, about two inches long, which had been brought from an Indian cemetery in the region of the Rio Grande de Terraba, in the south of Costa Rica.

On February 2, 1910, after our return from Guanacaste, Professor Tristán and I walked eastward along the railroad two kilometers from the Puntarenas station and between the tracks and the estero found a mangrove swamp where the soil was firm enough to walk upon. The "palo de sal" trees (*Avicennia nitida*) here were about fifteen feet high; even at the estero's edge there was no great root development such as is described on a later page in the account of our voyage up the Tempisque. The ground beneath these trees was covered with little shoots three to five inches high, the air-roots or pneumatophores of the *Avicennia*, and with small fleshy-leaved plants, *Conocarpus erecta*. As one went farther from the estero toward the railroad the undergrowth became denser by the appearance of various weeds of greater height.

In this tract we collected four species of dragonflies. All

four belonged to the subfamily of the Libellulinae, having the bases of the hind wings wider than those of the fore wings, the eyes meeting each other on the top of the head and the conspicuous triangle of veins dissimilarly shaped on the fore and hind wings. Two of these four species were of the purely tropical American genus *Micrathyria*, but while one of them (*schumanni*) is known only from the Pacific side of Mexico and Central America, the other (*ocellata quicha*) has been found on the Atlantic side in Mexico and Guatemala as well. They were about one and one-quarter inches long with a wing-spread of two and one-eighth inches. The wings of the female *schumanni* were pale brown at the tips, of the other sex of this species and of both sexes of *ocellata quicha* almost colorless.

The other two species were of *Erythrodiplax*, also an emphatically tropical American genus, although some of its representatives are frequently found north and others south of the tropics. The specimens of *E. ochracea* which we took here were of nearly the same size as the *Micrathyrias* just mentioned. They had the bases of the wings brownish-yellow which becomes darker with advancing age. In Mexico and Central America *ochracea* is known on both coasts and occasionally up to 5000 feet altitude although it is chiefly a lowlander; in South America it is known east, but not west, of the Andes.

The fourth species, *E. funerea*, is in some respects the most interesting. It is one and three-fourths inches long and has a wing-spread of two and one-half inches. Our Puntarenas specimens had but recently transformed and the immature coloring of the males and one sort of females consisted of a pale yellowish-brown extending over the whole width of the wings from the bases outward for two-thirds the wing-length, while the extreme tips were edged with darker brown. There was also another sort of female here, with the same

darker edging to the wing but elsewhere the yellowish coloring was confined to the front edges. These two sorts of females have been observed in many places where the males have been found. That sort which is colored like the male has been termed homœochromatic, the other the heterochromatic female. Of the 152 individuals from California (where one male has been found), Mexico and Central America listed in the *Biologia Centrali-Americana*, 77 were males, 53 heterochromatic females and 22 homœochromatic females. *Erythrodiplax funerea* thus exhibits a different kind of sexual dimorphism from that which we have described for *Thaumatonera* at Juan Viñas. As *funerea* becomes older the yellowish-brown darkens until it is blackish-brown. In this mature stage there is usually a clear uncolored area at the bases of the fore wings of the males and homœochromatic females. The wing-colors of the heterochromatic females do not become as dark as do those of the other sort or of the males, but some of them acquire a dark brown patch at the bases of the hind wings. We have found *funerea* in various localities in Guanacaste, near Turrúcares, near Alajuela, and at Juan Viñas. Mr. Lankester has taken it at Cachí and Professor Tristán on the Golfo Dulce and at Oricajo. In general the individuals taken from December to March show the immature colors, while from April to August they have those of the fully adult, but there are some exceptions on both sides of this rule. On the whole *funerea* is chiefly an inhabitant of the Pacific slope of Mexico and Central America, but as indicated above individuals are found not rarely on the Atlantic slope as well.

We returned along the sea beach to the town; there was much driftwood in small pieces above high water mark, few shells but many burrows of small sand crabs, an occasional tiger beetle, probably *Cicindela panamensis*, with markings resembling those of *C. ancocisconensis*. The body was eleven

millimeters long, the hind legs very long (17.5 mm.) and very slender, especially the tibia and tarsus. There were also small gray asilid or robber flies (of an indetermined genus of the *Dasygogoninæ*) about three-eighths of an inch long. They had many white, gray and pale yellowish hairs over the body, the most striking being those of a pale dirty yellow which formed a thin flat brush stretching across the face below the antennæ between the relatively large eyes, and projecting downward and forward.

At 1 A. M. of January 8 we went to the wharf on the estero where was lying the small cabinless steamboat "Cariari" bound for Puerto Ballena, Guanacaste. The boat was already well filled with men, women, children, baggage and freight, but somehow we and our not inconsiderable luggage were piled aboard and we found seats on the bench running around the bulwarks.

To my agreeable surprise we left almost on the minute of the announced time of departure—2 A. M. The stars were brilliant, the Southern Cross (which I had not seen for many months owing to the prevalent cloudiness in the interior) and Orion being conspicuous, and later the Dipper. The estero was very smooth, the Gulf not disagreeably less so. We snatched a little sleep in various uncomfortable positions. About 5.30 we landed a few passengers by row-boat at Manzanillo on the mainland; it is the port nearest the Aguacate gold mines, to which a road leads. It was now the very early dawn and it was difficult to distinguish more than the dim outlines of the houses on shore.

Our course in general was northerly, passing near to some islands which, like much of the eastern shore of the gulf, have precipitous sides. Later, off to the left, we passed the island of Chira, the largest in the gulf, whose surface is a constant succession of wooded and usually round-topped hills. I saw no houses and I was told it was not inhabited.

A short distance east of the northern part of Chira, a large bare rock projects from the water, possibly a couple of hundred feet high; it is known as Yuca and is a conspicuous object for a long distance owing to its yellow color. Several schools of porpoises were seen near the boat.

The Gulf gradually narrowed to form the mouth of the Rio Tempisque, which we now ascended. This, one of the large rivers of the country, was known to the Chorotega Indians (whose descendants have mixed with Spaniards and others) as the Zapandi, often spelled on old maps Çapandi. Some distance above its mouth it forks, the east fork being known as the Rio de las Piedras, navigable by these small steamboats as far as the town of Bebedero. The west fork retains the name of Tempisque and this was our course. The steamboat left Puntarenas near the end of each week for Puerto Ballena on the Tempisque and near the beginning of each week for Bebedero. Mail for Liberia went by both of these routes so that Liberia received two mails a week.

Soon after entering the mouth of the river we stopped at a place on the right or west bank whose name I could not learn, to land a couple of passengers but more especially to take on wood for fuel for the engine. Only a single thatched-roofed hut was visible here. To the west appeared two bare gray hills, one of which was not inaptly compared to a church on account of its resemblance to a high-pitched roof. At this fuel station the banks were of clay, honeycombed with crabs' burrows not unlike those formed by the fiddlers in the inlets on the New Jersey coast. As we waited we could see the honeycombed soil broken into masses of the size of a man's head by the action of the small waves and dropped to the bottom. Here and elsewhere the water of the Tempisque was muddy and it is said to be always so on account of the clayey banks.

As we went up the river, the channel lying often close to

one bank or the other, we had a good opportunity to see the mangrove trees which are abundant here. There were two species. One, the "mangle" or red mangrove, from the color to which the wood turns (*Rhizophora mangle*, family Rhizophoraceæ) has a trunk of uniform diameter from which the roots extend at all heights and angles up to a distance of twenty feet in the most extreme case that I noticed. In the other species, the "palo de sal" or "culumate," the black mangrove (*Avicennia nitida*, family Verbenaceæ), the trunk thickens markedly below and the much shorter roots are given off from the thick base. Looking at the usually wooded river banks from the opposite side, one noticed that the mangroves had foliage of a much paler green than the other trees. These woods are not high, as cutting has evidently been in progress for a long time and the growth of very tall trees prevented. There was much tangled undergrowth which, with the confusion of mangrove and other roots along the shore, made a landing difficult except where the vegetation had been cleared. Other noticeable plants along the Tempisque were the poró-poró, cereus cactus (which here and on the gulf comes down to within a few feet of the water's edge) and an occasional guayabo.

The birds visible were egrets (*Herodias egretta*), blue herons (*Florida cærulea cærulea*), gray herons (*Cochlearius zeledoni*), sandpipers (species of *Pisobia*) on the occasional beaches and, near the mouth, pelicans. Now and then the cry of "Lagarto, lagarto!" was raised on the boat, usually by some of the boys or young men. This indicated that a crocodile (perhaps *Crocodylus americanus acutus*) was visible or at least the upper surface of the head of one as it floated in the stream. We saw about half a dozen during our voyage up the river.

After passing the mouth of the Rio de las Piedras, a narrower stream, our party estimated the width of the Tempis-

que proper as from 400 to 450 meters. The channel was very narrow, however, even for our small steamboat, as we learned near Puerto Humo. This was a collection of twelve or fifteen huts with high-pitched thatch roofs, on the west bank of the river. As we approached, the steamer suddenly lurched to one side, causing some consternation, but quickly righted again; we had run on a mud bank but soon slid off. Some passengers and freight were landed at Puerto Humo by a boat putting off from shore for the purpose. Like the smaller boat accompanying the steamer, it was pointed at both ends and hollowed out of a single log. From Puerto Humo we crossed again to the east bank but ran on another mud bank about 11.30 and it was nearly two hours before we proceeded farther upstream. To clear this bank, or rather banks, upon which we grounded, a rope was taken from the steamboat and tied to a root or trunk at the shore and by alternately backing and going forward, the boat being warped shoreward by hauling on the rope from on board, we were eventually freed, but the operation had to be performed repeatedly. Several times as we ran close to the shore the projecting branches of trees armed with thorns reached into the boat, catching on clothing or other objects and onceswept out a blanket; it was rescued, however, with no worse result than a partial wetting. About an hour after leaving the mud bank we turned westward from the Tempisque into an arm known as the Estero de Bolsón, much narrower but deep enough to allow the steamboat to run fairly swiftly. We passed a sister ship going in the opposite direction, the only craft we met on the river except a sailing vessel called a "bongo," anchored opposite Puerto Humo. About 3 P. M. we reached our destination so far as navigation was concerned, Puerto Ballena (whale-port—but why "whale" no one seemed to know). The steamboat landed us at a little wharf. On shore, beneath the trees,

horses were waiting for us and ox-carts for the steamer's cargo and we were greeted by Señor Chamorro, Inspector of Schools of the Province of Guanacaste.

In half an hour we were on our way on horseback, soon climbing a few feet around some conical very dry hills whose sides were ridged horizontally. After passing a beautiful green enclosed pasture with grazing cattle (Guanacaste is chiefly noted for cattle) we entered an imposing forest of great trees so spaced as to give the impression of a park rather than an uncultivated forest. It was not a continuous forest but there were alternating areas of scrub and savannas. Several times we heard the deep call of the howling monkey, known here as "mono bramador" or "congo." When I first heard it I thought it the bellowing of a distant bull. Twice we passed close to some monkeys of another species, "mono de cara blanca," which paid no attention to us although we all stopped to look at the second group, apparently a mother and family, feeding on leaves as they leisurely hung by tail or legs and put the leaves into their mouths with the hands. Elsewhere bright blue and red macaws sat on the boughs of the trees or there were flocks of chattering green parakeets.

The only drawback to the ride was the dust, which our cavalcade of eight stirred so that the strong wind carried it about to the discomfort of all but the first riders. And yet a mark on a tree-trunk, six feet from the ground, was pointed out to us as the height reached by the water in the preceding rainy season, along this very road. At such times—September and October—there is of course no traveling here.

The principal trees along the road were guanacaste, cenízaro and cedro amargo. The guanacaste seemed to be of a different species from those I had come to know farther south, reaching a larger size and having a finer leaf; many

of them were in fruit.¹ After we left the forests we found many of the hedges or living fences bounding the fields and pastures composed of madera negra trees lacking most or all of their foliage but bearing along their branches clusters of beautiful pale pink flowers. Some madera negras bore also fruit as well as blossoms. A characteristic of this tree is the perpendicular way in which many of the smaller branches are given off from the larger. Occasionally there was a poró (*Erythrina costaricensis*) in the hedgerows; these differed from the porós of the central plateau (*E. corallodendron*) in having larger leaves and paler red flowers.

At 6.30 we rode into the yard of the primitive hotel of the village of Filadelfia, formerly known as Siete Cueros. The village was celebrating its fiestas and after dinner we walked around the fenced-in plaza. At nearly diagonal corners facing the plaza—in each case in a room adjoining a store kept by a Chinaman—a dance was going on to the music of a marimba, an instrument suggesting a xylophone. The marimba consists of wooden slats of graduated length arranged horizontally all at the same level, while beneath each slat is a resonator made of a jicara. It was played by two persons seated side by side who struck the slats with sticks. It is found in Guanacaste and northward and is said to be of African origin, as many people here, the so-called Zambos, are descendants of African slaves and Indians. The dances were all round dances, mostly of familiar figures, waltzes and polkas, but one, called “el punto,” was peculiar in that the partners do not hold each other but walk side by side, turn around each other and so on. Some of the dancers were graceful in their movements and good-looking. Before one of the dance rooms, several tables were set out in the street, where passers-by could gamble upon the throw-

¹ Pittier mentions only one species for Costa Rica, however.

ing of rough dice, an inch on a side, by a man in charge. The stakes were small, usually five and ten centimos.

The former name of Filadelfia—Siete Cueros—means “Seven Oxhides,” but the word cuero is also used as a vulgar name for the human skin. One explanation of this old name is that the inhabitants suffered from a disease of the heel in which the skin thereof was shed seven times! Siete Cueros is the name given for this place in the 1903 map of Costa Rica published by the Bureau of American Republics in Washington.

The start for Liberia, announced the previous evening for 5 A. M., was really made about 7 A. M. on January 9. We rode northward over a level country (Filadelfia is about fifty feet above sea-level) with large potreros and three villages, Los Jocotes, Paso Tempisque and Palmira (formerly Los Boquerones). Many of the poorer houses have walls built merely of upright sticks two to three inches in diameter and not always straight, bound together by lianas, and with a distinct space between each stick and the next. These palings did not always reach the thatched or sometimes tiled roof, which was supported on corner posts. Even such a house was usually provided with a sewing machine, kept outside under a veranda or some projecting shed.

Along the road we noted some long-tailed blue-jays and a pair or so of curious-looking birds called “carga huesos,” mostly black but with a white head and neck and a red patch of skin at the base of the bill (*Polyborus cheriway*).

Near the village of Palmira we crossed from the west to the east bank of the Rio Tempisque at a place called Chica de la O. The river was here too deep to be forded, so the horses were stripped of their loads and saddles, leaving on the rope bridles, and the rope rein then unfastened at one side to make it long enough to serve as a guiding rope. The saddles and loads were placed in one of the single-log boats

paddled by the ferryman. Señor Chamorro, who seemed to be an expert in the business, stood in the round-bottomed boat and held the guiding ropes of the horses in his hands. The horses were pushed off into the water and swam to the opposite shore pulling the boat with them while the ferryman steadied it with his paddle. This crossing, with the unsaddling and saddling involved, occupied the greater part of the hour around nine o'clock, as four trips each way had to be made. The first took a load of saddles, Señor Chamorro holding five horses; the next the remaining saddles and three horses; the third and fourth trips carried half the men each time.

The banks of the Tempisque here are sandy and have scanty vegetation, instead of clayey and tree-clad as where seen from the steamboat. While waiting for the passage we saw some men and boys cross the river on horseback a little farther downstream. The horse ridden by one of the boys was so completely submerged that its body was out of sight, only the head and neck showing, while the boy held on to the horse's ears. The other horses were not quite so deeply covered, their backs showing.

Soon after resuming our ride we passed a number of trees bearing orchids with medium-sized pinkish flowers, which were called "guarias"; the same name is applied to *Cattleya* in the interior of the country, but these orchids were not *Cattleya*.

The road from here on to Liberia was through more or less open, yet not treeless country, very sparsely settled, and rising very gently except at one place where the road zig-zagged over deeply grooved and worn rocks. We made a short halt for rest about 11 A. M. at a solitary house, where a whole basket full of oranges, grateful to the tired and dusty cavalcade, was bought for five centimos (two and one-half cents).

We crossed a great open plain with more or less dried grass and few trees, called the Llano Grande. Similar plains are said to be scattered all over Guanacaste. Professor Tristán supposes that they owe their origin (for they are natural and not due to deforestation by man) to large areas of volcanic rocks too thick to be penetrated by the roots of trees and yet bearing enough soil for grass. At some spots on this llano are a few trees whose presence is accounted for on the supposition that cracks or breaks in the rocks exist at those places.

From the Llano Grande we could see two of the volcanic masses of the Cordillera of Guanacaste—Volcán Rincón de la Vieja, toward which we were riding, and farther away to the north Volcán Orosi. The summits of both were veiled by clouds. In crossing the Llano we rode almost directly against a very strong wind, which, however, had the advantage of keeping the air much cooler than it would have been otherwise with the sun shining brightly.

About an hour from Liberia we were met by Señor Villar, Inspector of Schools of Liberia and the remaining member of the Comisión Calificadora. The San José members were astonished to learn from him that only six teachers would present themselves for examination instead of the expected forty. Perhaps the other four and thirty felt as did the cook at the hotel in Liberia, who on hearing that we were coming declared that she could not cook to suit us and promptly left. It takes such experiences to teach us our own greatness!

We rode into Liberia about 1.15 P. M. The roads leading into the town were bordered with pastures and as the cattle of Guanacaste are only half-tame and have a reputation for fierceness—they are “bravos”—this road was shut off by wire fencing stretched across it with gates in the middle which were closed at night to prevent stray cattle from roaming the streets.

We rode straight on to the schoolhouse where two of the class rooms had been cleared and fitted up each with three canvas camp beds or "tijeretas" for our use. With a tap of running water in the patio we were much more comfortably placed than we would have been in the Hotel Joséfino where we had meals. The schoolhouse was two-storied on the front with a one-storied wing running back on each side; one wing was for boys, the other for girls, and the patio was divided down the middle by a wall. The class rooms were high, well-lighted, with wooden floors, while the "corredor" had a cement floor. This building was said to be the best schoolhouse on the Pacific coast from Mexico to Panama and Señor Obregon added that Lima had not as good a school building.

Soon after our arrival the Governor of Guanacaste called on us—don Antonio Alvares Hurtado, a pleasant, unassuming man less than forty years old, who later walked around the corner with us to the hotel where we ate our first Liberian meal.

Next to the schoolhouse on the west was a fairly large—but as usual one-storied—house, with a shower-bath in a separate room which was placed at our disposition—and very glad I was to avail myself of it while here. The garden of this house contained some royal and cocoanut palms. While we were still in Puntarenas Professor Tristán had bought two cocoanuts, unhusked except for a small segment, just enough to expose an area of the white pulp about the size of a quarter dollar. With their husks, each cocoanut was as large as a man's head and I suppose almost as heavy. How the traditional monkeys manage to throw them with ease at the voracious traveler below I don't quite understand! However that may be, with a penknife we cut through the circle of white pulp and poured out the "milk" into a glass and drank it, and later drained our cocoanuts directly into

our mouths. The liquid was only faintly whitish, a little cool and a little sweet. If these cocoanuts were average, "milk" is an inappropriate name for this liquid and indeed the name applied here is "agua de pipa" (water of the pipa). This word pipa is used in Spain to denote a large vessel for containing liquids, analogous to the "pipe" of old English liquid measure. A certain Spaniard, newly arrived and settled in Guanacaste, sent an order to Puntarenas for "fifty pipas" without further explanation and was amazed to receive in response fifty cocoanuts.

Growing along the streets of Liberia, as well as on the street near the estero in Puntarenas, were curious-looking trees called "quelite," members of the Euphorbiaceæ; they mostly consisted of a few branches bearing leaves only at the tips. The dull green leaves are deeply divided, the divisions sharply pointed; the trees rarely grow more than fifteen feet high. In answer to our inquiries, Professor Pittier wrote us in December, 1914: "'Quelite' is the general name for the tender edible shoots of certain Cucurbitaceæ, Euphorbiaceæ, etc. In the present case you refer evidently to *Jatropha aconitifolia*, the real Costa Rican vernacular name of which is chicasquil (quil-quelitl)" This plant was collected near Puntarenas by Oersted, as his specimens were cited by DeCandolle in 1864.

The streets of Liberia had a natural paving of volcanic rock said to be pumitic in character, whose surface is black when simply exposed to the weather, but which by wear becomes white and breaks down to a white sand. White was consequently the prevailing color of the streets, and as most of the one-storied houses and shops were whitewashed, Liberia was indeed a white city with a very strong glare in the middle of the day. There was nothing particularly old-looking about the town. However, Von Seebach was here in January, 1865, and Noriega states that it was erected into a "villa"

July 19, 1831, and into a "cuidad" September 3, 1836. I saw two churches, the larger of which was a temporary structure with an unfinished west façade of stone standing detached. West of this church was the plaza, with some fountains, a band pavilion and young fig-trees. The town had a number of general stores, two of them kept by the ubiquitous Chinese, two drug stores, post office, telegraph office, government building with governor's office, *alcaldia* and *juzgado civil y crimen*, a *cuartel* or barracks and a *comandancia de policia*. Other than the Chinese I believe that there were no foreigners in Liberia. The population of Liberia on December 31, 1910, is officially stated as 2404.

On the morning of January 10, Professor Tristán and I went east along the main street to the smaller church, where we turned aside and walked to the Rio Liberia, now quite low. It was unbridged and we crossed on a log placed for the purpose. A road led eastward from the river, between *potreros* and *charrals*, wherein we collected although the sky was clouded and insects were not abundant, while most of the butterflies seen were faded and tattered. As we returned to the river the sun was shining brightly and we caught a number of interesting dragonflies by this clear-water stream. In places the sand and clay banks were fifteen to twenty feet high; in other parts there were flat sandy beaches through which the stream meandered. The current was not rapid and there were few rocks.

Señor Enrique Cortes, a resident of Liberia, had furnished the horses which brought us here from Puerto Ballena and had accompanied us hither. He had given us permission to collect in his *potreros*, so on January 11 we went to his house near the western end of the main street and with a young man who had studied in the Liceo in San José as guide, walked southwestwardly toward the Rio Liberia—for south of the town this river makes a semicircular bend from east to

west. In the midst of the mostly open potrero was a grove of oaks with ovate, entire-margined leaves about two inches long, belonging to a species very abundant throughout this part of the country. From one of the trees of this grove was hanging a wasps' nest with a long tubular opening on the lower side. The insects were small and said to sting severely.

Along the banks of the river, in the grass and low herbs which fringed them, were webs of spiders (*Tinus nigrinus*) containing numerous wings and other dry parts of the bodies of dragonflies. As many of the fragments were of mature individuals they showed that numbers of the *Hetærinas* and *Argias* occurring here come to their ends as spiders' prey. These spiders had bodies up to half an inch in length; the pale abdomen bore a broad dark band on the middle of the upper surface for its entire length, the band markedly narrowed behind the middle, then widened again and tapering to a point at the hind end.

As we went farther westward, we left the actual river bank for the shrubbery and low woods bordering it. Some of the trees and bushes here were the "pica-pica" (*Mucuna* sp.), leguminous shrubs whose pods, at this time two to three inches long, were covered with a brown velvety pile irritating to the human skin, hence "pica-pica"—"sting-sting"; a melastomaceous tree closely resembling that called maria near Alajuela and here known as "sotacaballo"; the guácimo; guayabo; guachipelin and palo canela with small greenish flowers clustered along the woody twigs, green fruits of the size and shape of acorns without the cups and clusters of rather soft thin leaves. Bull's horn thorns were abundant, some with red, others with black, ants. There were many dry composites and other weeds, while lantana and escobilla were in bloom.

Turning northward into the charral we discovered a large

grasshopper, whose dark-colored body looked to be six inches or more in length, and whose hind wings were bright red. It did not alight upon the ground, like most grasshoppers, but upon the branches of trees upon which it walked with ease. We were not able to catch it and ultimately it flew off, giving us at least the opportunity of witnessing its strong powers of flight. In the last days of January, in a forest north of Santa Cruz, we secured one of these large insects which may have been of the same species. This Santa Cruz grasshopper, a female *Tropidacris dux*, has the body four inches long, each wing, fore and hind, and each hind leg three and three-quarters long. Since the wings when folded, as in the act of walking, project an inch behind the body, the total apparent length is four and three-fourths inches. At the time of writing the colors have been lost to a great degree because the insect was preserved in alcohol. The hind wings still have a markedly reddish tinge throughout and are bordered with blackish-brown externally. This latter color is not sharply defined, as small patches of it extend toward the wing base, occupying the centers of the "cells" enclosed by the veins. The median dorsal ridge of the prothorax is hardly arched, when viewed in profile, although showing a division into five or more successive teeth or rounded lobes. In the allied *Titanacris* this same ridge is very distinctly convex.

As usual, this charral was enclosed by a barbed wire fence. On one of the wooden posts at a distance of four feet from the ground was a termites' nest, which Professor Tristán photographed. The nest was 75 cm. high and 45 cm. thick. After taking the picture we cut into the nest with a machete. It contained thousands, if not a million termites, of which we found nasuti, workers, and immature larger individuals with rudimentary wings, but no true royalties or termitophiles (insects living in amity or at least neutrality with



Quebrada de Panteon, Liberia.
Laguna Garzal.



Rio Tempisque at Filadelfia.
School Children at Santa Cruz.

the termites). After the nest had been cut into for a considerable depth it was a curious sight to see the termites leaving their habitation in a column, several inches wide, passing down a branch of a tree which had been built into the nest to the ground. To do so the insects had to expose themselves to the direct rays of the sun—which the eyeless castes of termites (workers and nasuti) do not ordinarily do.

When we returned to breakfast—almuerzo—we were offered among other viands papaya and tiste. Papaya is the fruit of a tree (*Carica papaya*) some fifteen feet high, unbranched and bearing at the top of the slender trunk whose diameter is two to three inches, a cluster of deeply divided leaves; their shape recalls the leaves of the bread-fruit but they are smaller and less glossy green. Beneath the leaves is a cluster of fruits which when ripe are flask-shaped, about a foot long and of a yellow color. Under the yellow rind is a salmon pink flesh with numerous small pale seeds. The taste is indescribable, suggesting somewhat a canteloupe, moderately sweet, pleasant, but to me less attractive than that of the banana or mango. The flesh is said to contain pepsin. Tiste is supposed to be of Indian origin. It is a drink made by grinding cake-cacao, Indian corn and sugar in cold water, in a jicara with a molenillo and, especially when the water is really cold, is agreeable and refreshing.

In the afternoon I went again to the Rio Liberia east of the town and was able to find some additional species of dragonflies, here commonly known as "pipilachas," a Chorotega Indian word whose significance we do not know. An Indian name in common use for grasshoppers is "tapichiche," literally "covering for the breasts," but the application is unknown.

To the bank of the river were attached some small spherical clay vessels about one quarter of an inch in diameter, and with a little straight rimmed spout; from analogy I

supposed them to be the nests of a potter wasp but I saw no insects near them. A few of the nests were preserved dry in a vial and long afterward some fragments of adults were obtained among the broken nests. These fragments indicate an insect two-fifths of an inch long with a slightly clouded fore wing one-quarter inch long. They are certainly those of a potter wasp, of the genus *Eumenes*, and possibly of the species *E. placidus* originally described from Panama. Both sexes are represented in these fragments; the male possesses a curved claw-like hook at the tip of each antenna while this hook is lacking in the female. Most of the body is black with some reddish-yellow markings, and is pitted over the surface; some parts, like the face and hind (meta-) thorax, have short white hair, glistening in some lights and invisible in others. The abdomen is attached to the thorax by a relatively long slender stalk which is enlarged rather suddenly in its hind half. The potter wasps are solitary in their habits, that is, each spherical vessel represents the work and offspring of but one female. Yet some of the adults closely resemble certain social wasps of the genus *Polybia*, a case similar to that described on page 226.

Hovering over the water and then over a high bank was a flock of dragonflies which moved thus to and fro for at least two hours until sunset. When I first saw them the flock was composed chiefly of the widespread tropical American species *Miathyria marcella*, but as sunset approached this species was gradually replaced by two species of *Macrothemis* (*pseudimitans* and *hemichlora*) and two of *Brechmorhoga* (*vivax* and *præcox*) and yet there was no apparent break in the continuity of the flock. The cause of these flocks is not clear; I saw many of them in Guanacaste and in the Banana River region. There seemed to be no special abundance of food in the places where the flocks were seen. Two females of *Miathyria marcella* belonging to this day's flock which

I caught discharged eggs within a few minutes after capture. I placed them in water at once but they were probably not fertilized as they did not hatch, or turn yellow or brown within a week, like fertilized eggs. Both sexes of the participating species existed in this flock. In Chapter XV in describing the finding of intermingled individuals of two species of *Palæmnema* on the banks of the Rio Guápiles, reference was made to the view that the two most closely allied forms in the same genus do not occur together. This flock of dragonflies on the Rio Liberia supplies both positive and negative evidence on this point. *Pseudimitans* and *hemichlora* are not the most nearly related species of *Macrothemis*, but on the other hand *Brechmorhoga vivax* is considered by those who have written on this genus to find its nearest relative in *B. præcox*, and these last two species have been found together at the same places and times in Mexico and Guatemala as well as in Costa Rica.

As the sun set and twilight came on I waited by the river on the lookout for dragonflies which might be peculiar to that time of day. I saw none but, suddenly, as the sun disappeared, close to the water's surface came dancing black-winged caddice-flies (*Heteroplectron maculatum*) like witches of the advancing night.

When I returned to the Commission I learned that the Governor had invited us to his house at eight o'clock. We went and met his wife and her two sisters, the younger of whom, a very pretty girl, had studied at the Colegio de Señoritas at San José. In answer to my questions Professor Tristán told me later that he thought her greater conversational powers, in contrast to those of her two sisters, were a result of this training, her sisters not having had this advantage. The dressing of the ladies and the furnishings of the house were plain; during the evening a refreshing fruit ice was served to us.

On January 12 I went alone to the north of the town, to the Quebrada de Panteón de Liberia, a walk of hardly more than five minutes from the school. A small brook flowed along the south side of the cemetery, hence the name. The little ravine had rocky banks of the same character as the streets of Liberia, with here and there little sandy beaches. The rock of the bottom was grooved or worn into holes, some of them apparently pot-holes; some of the grooves, a foot or more deep, had been made or at least deepened by man. The water at this time was low and although still flowing slightly was more or less separated into pools. The stream was spanned by a small wooden bridge, evidently for the use of those going to the cemetery, but just now one could step across the water from bank to bank and both sides were shaded with low trees and shrubs. On the rocks were numerous adult and immature "grouse-locusts" or Tettigids, representing at least two species (*Telmatettix aztecus* and *Clypeotettix schochii*) all colored more or less in correspondence with the gray or blackish rocks, in the tiny depressions of which they were nestling. I gathered over seventy of them in about fifteen minutes. Exuviae of Odonata, a shed snake's skin, a tiger beetle and a few butterflies were other objects seen on these rocks.

Late in the afternoon we came again to this Quebrada, taking a photograph or two; one was of a zapote tree (*Lucuma* or *Calocarpum mammosum*) we passed, growing behind the barracks. It had undivided shining green leaves in clusters and russet-colored fruits the size of an orange, which are said to be delicious when ripe. Those I found on the ground under this tree were pronounced unripe. Farther north on the same street was a tree called "carao" (*Cassia grandis*) remarkable for the length of its thick and woody pods, which is no less than two to three feet.

On the morning of January 13 I followed the telegraph

wire northward and in about three-quarters of an hour from the schoolhouse came to the Quebrada Clara occupied by a stream larger and deeper than that in the Quebrada de Panteon but fordable on horseback and with similar banks. Here I found some interesting dragonflies including at least one species (*Progomphus clendoni*) new to Costa Rica and *Enallagma cultellatum* new to the Pacific side. The latter, which we had taken near the mouth of the Banana River in November, we subsequently obtained on the Rio Tempisque and near Santa Cruz in Nicoya.

On the road to the Quebrada Clara I had the chance to examine closely and make some notes on the flower of the poró-poró, which have been included in Chapter XVIII. Another tree noted along the road was *Apeiba tibourbou*, one of several plants which bear the name of "peine de mico" or monkey's comb. The fruit reminded me of a green sea-urchin or of a green chestnut burr which has been flattened above and below. The leaves are soft, hairy and pointed at the tip. There were also a few wild cotton shrubs, ten to fifteen feet high, their dry pods open and displaying the mass of fibers within.

This walk gave me a good chance to see some of those birds referred to as blue jays (*Calocitta formosa azurea*) in the account of our journey from Filadelfia to Liberia. Here they were known as "urracas." They are slaty-blue on the upper surface of head, body and tail, white on the lower surface of the same, but with a black "cravat" and a rather long, curved, tapering black top-knot; the tail is as long as the body. They have much curiosity and little fear of man and here and elsewhere I frequently saw them on the trees stretching their necks and surveying me from various angles with apparently great interest. They have a number of unmusical notes.

At the Quebrada Clara was a spider (*Trechalea convexa*)

with a body only three-fourths of an inch long and spiny legs two and three-quarters inches long, which when pursued ran over the surface of the rocks and then below the water's surface, clinging to the vertical face of the stones; it was easily dragged forth from this position.

Returning from the hotel after breakfast one day by a new route we passed in a garden a tree whose fruit was new to me; Señor Villar called it "seso vegetal" —vegetable brain—and gathered a few for us to examine. They were three inches long, two and one-quarter inches thick and had three grooves running lengthwise on the surface so that in lower end view each fruit was distinctly three-lobed. Along the middle of each lobe ran a slight ridge. The outside was pale yellow and red, like certain apples. The surface grooves and lines branch, and red fibers, which may be fancied to represent arteries, pass inward, so that the resemblance to a small cerebrum is striking. The whitish pulp is eaten when cooked but is said to be very poisonous in the raw state. It contains a single shining black seed in each of the three compartments which correspond to the external lobes. The upper surfaces of the large compound leaves are a shining green. The leaflets are six and one-half inches long and three and one-quarter wide, rounded at the tip and arranged in even numbers. The tree (*Blighia sapida* or *Cupania akesia*) is a native of West Tropical Africa.

The examinations of teachers which the Commission had been holding were threefold for each teacher—written, oral and practical. The last consisted in the candidate's giving a lesson before the Commission while her efficiency, methods, etc., were noted. A number of the school children, both boys and girls, were assembled for this purpose and the lessons given to them under as normal conditions as possible. These examinations were now sufficiently advanced to enable Professor Tristán to go with me on an excursion lasting sev-

eral days and we therefore planned a trip to Hacienda Guachipelín. Señor Villar obtained permission from the owner of this farmhouse—Señor Elias Baldiocedo of Liberia—for us to stay there for a few days and also gave us a letter from the owner to the mandador in charge. The Governor detailed as a guide Luis Padilla, No. 237 of the Federal Police, in neat khaki uniform with dark blue cuffs and collar, and Señor Cortés supplied us with three horses. Taking only necessaries and collecting apparatus, we left Liberia at 2.35 P. M. on January 14, rode north along the Carretera Nacional, fording the streams in the Quebradas de Panteon and Clara, crossing the Rio Santa Ines by a wooden bridge and turned off from the Carretera (which continues to Nicaragua) to the right about 3.30, our path running for a while alongside a hedge of piñuelas. We descended into the valley of the Rio Colorado and reached its bank about four o'clock. Padilla rode first through the swift current which was running over many large rounded stones. Professor Tristán followed but had gone only a little way when his horse refused the ford and finally Padilla had to come back and lead the stubborn beast by the halter rope which these animals constantly wear on journeys. Padilla then returned for me and led my horse in the same way. It was not a pleasant sensation, while Padilla pulled and I spurred my horse on, to feel the water rising higher and higher as we reached the deepest part of the ford until, on the upstream side, it was halfway up my thigh and consequently almost at the horse's back. The wetting of course mattered nothing for the water was not even unpleasantly cold, but the current was swift and strong and if the horse slipped on one of the many polished boulders and went down there was a good chance of ugly bruises from the rocks or kicks from the horse before we could get to our feet again. However we made the passage with no ill results and even the wet clothes

were nearly all dry by the next hour—but I would prefer not to make that crossing again.

From the valley of the Colorado we climbed up to a ridge which separates that river from the Rio Blanco and runs in a general northeasterly direction. At times the roadbed was of the same character as in the streets of Liberia and worn by the wheels of the ox-carts into two ruts often a foot or more deep; or the whole roadbed was worn down the width of an ox-cart two or three feet below the rock on either side. The horse usually traveled in one of the wheel-ruts so that when the roadside was so much higher it was necessary to look out for one's leg to save it from being rubbed or scraped on the rock. At other places the road was a faint track over flat open ground covered with the pinkest of dry grass or with sedge. Again it led through woods of the small-leaved oak noted above, where projecting roots and loose volcanic stones made it necessary for the horses to pick their way carefully. Human habitations of any kind were very few and far between after leaving the Carretera Nacional.

Hacienda Guachipelín was said to be four hours distant from Liberia, but on these journeys I had to spur my horse frequently and tiresomely to keep it to the jog that seemed the usual pace here and which was, on this occasion, set by our guide. Rarely did we make a journey within the pre-announced time. No doubt the horses took advantage of their stranger riders. I was therefore astonished when we drew up at Hacienda Guachipelín at 6.35, four hours to the minute from Liberia. I was glad that it was no later, for the latter part of the way was through the woods and as it was growing dark our horses were stumbling. We received a hearty welcome from the mandador, Genaro Espinosa, who was ever ready to do all he could for us during our stay. As we came unexpected, we brought some food with us from

Liberia and although comida was long over, our host added hot coffee and frijoles.

The next morning, January 15, having partly dressed, we walked some three hundred yards down the hill on which the house was situated to a nameless brook of clear water, where we washed, as the pigs also did at any hour of the day. All the water for drinking and cooking was carried in jars from this brook uphill to the house, causing us to wonder why the latter had been placed so far away. Lower down it would also have been shielded from the tremendous easterly winds.

Hacienda Guachipelín is the highest human dwelling toward Volcán Rincón de la Vieja, although its elevation is but 1700 feet by my aneroid, which gave Liberia as 500 feet.¹ It lies not far from and south of the Rio Blanco. Near the house and not very much higher is Cerro San Vicente, 30° west of north, on the other side of the Rio Blanco. Farther away and 60° west of North is Cerro Gongora, which is different from a "Gongora" that some maps put near Volcán Orosí. Volcán Rincón de la Vieja, we were told, is not visible from Hacienda Guachipelín, being hidden therefrom by another mountain known as Cerro Guachipelín, lying to the west and south of the Cerro de la Vieja. The highest part of Cerro Guachipelín so far as I could see it—for it was always more or less cloud-capped—was 10° east of north from the Hacienda. The location of Hacienda Guachipelín is much more nearly that shown on the map of 1865, accompanying von Seebach's account of his journey through Guanacaste, than as displayed on Pittier's map published in 1912. On the latter, the Hacienda appears as "H. Guachipelín" and to the north of the Rio Blanco, the name Rio Colorado not being used for any river in the vicinity. The Rio Blanco of the 1912 map is the Rio Colo-

¹ The Intercontinental Railway Commission gives Liberia as 496 feet.

rado of the map of 1865 which latter agrees with the local usage as we found it at the time of our visit. Von Seebach's map, however, represents Cerro San Vicente as south, instead of north, of the Rio Blanco. The sketch map accompanying this book has been drawn to agree with our findings.

The Hacienda, which stood on the top of a small hill, was L-shaped, the inner angle of the L with a southerly exposure. Its walls were built of wide boards and the roof was partly of tiles, partly of corrugated galvanized iron. The front or south side had a veranda to which one ascended by some tumble-down tile steps; the floor of the veranda was likewise tiled while the house within had wooden floors. There were three rooms in the main part of the house and a kitchen in the shorter arm of the L. The main room opened both at front (south) and back (north) with rather heavy wooden doors; here we ate and here our host and Padilla slept, while Professor Tristán and I slept in a little west room. The windows had wooden shutters but no sashes and of course no glass—only the better and more recently built houses in the towns have glass windows. Every now and then a pig ran in at one door of our dining-room and out of the other; two cats regularly came to beg at our table at mealtime, but the three or four dogs were less frequent visitors.

This first morning we walked along the wide grass-covered road that ran northeastwardly from the Hacienda, paralleling the Rio Blanco and in places within a few yards of the stream. Its clear cold water flowed swiftly between banks of conglomerate—boulders embedded in a red clay. Between river and road was a strip of dry woods, having very few epiphytic plants. At places fairly large trees stood within the road itself and the trail used by men and horses wound among them. On the opposite side of the road were mostly charral and low trees. We walked but a short distance, a mile or so, up to 1900 feet. Individual grasshoppers

were abundant in this road. They were chiefly of two species, *Osmilia tolteca* and an *Abracris* (or *Omalotettix*). The former was the more abundant; the males have the body one inch long, the total length to the tips of the folded wings being one and one-quarter inches, while the corresponding figures for the females are one and one-quarter and one and five-eighths inches. The general color is a pale ochre brown, relieved by a rather conspicuous and relatively broad, dark grayish-brown stripe extending lengthwise on the middle of the outer surface of the thigh (or femur) of the third leg. This stripe tapers to a point near the articulation of the femur with the tibia or shank; above and below this stripe the edges of the femur are a pale reddish-yellow. The hind wings are bluish- to greenish-yellow, paling toward the edges. *Osmilia* is a very characteristic tropical American grasshopper; we also have specimens of *O. tolteca* from localities so different in character from Guachipelín as Guácimo and Peralta.

The female of the *Abracris*, the only sex represented in our collection, has almost the same dimensions as the male of *O. tolteca*. It is likewise of an ochreous color, but the femur of the third leg has two darker brown spots extending from its upper edge halfway across its outer surface, dividing the femur into approximately equal thirds. The hind wings are almost colorless, very pale greenish at the base. The angle formed in profile view by the front and upper surfaces of the head is decidedly more oblique (less than a right angle) than in *O. tolteca*.

In the afternoon we went to our ablution brook, which unites with the Colorado, and while Professor Tristán went downstream I went up. It was like the Rio Blanco in miniature but its water was warmer because shallower and its source was much lower down. Along its banks there were many tree-ferns seven to eight feet high, which were very

troublesome owing to the many sharp spines covering trunk and frond-stems. It was often necessary to make quite a detour to pass a place where these ferns grew. Black flies (*Simulium*) were also troublesome but an oil of citronella-cocoa butter mixture which we had brought from the United States did good service when smeared on face, hands and especially ears.

During the night and the following morning there was much wind and frequent showers, the first rain we had had since leaving San José. We were consequently kept indoors for several hours, but when the sun came out Espinosa, Padilla and we two set off on horseback for the fumaroles, or solfataras, of Cerro Guachipelín. We followed the road taken the preceding morning and reached a llano across which we rode for half an hour. The sun shone brightly yet we had constant rain owing to the furious northeast wind which carried the rain horizontally for long distances; having this wind directly "head on" made our journey much slower than it would otherwise have been. At times the wind blew so strongly that I wondered to see the horse stand up against it. I kept my hat on but Professor Tristán removed his and said afterwards that the rain beating on his head felt like small stones. Finally we reached a low woods where there was some shelter and rode through it to the Rio Colorado, which had to be forded. Although the river was much narrower and shallower here, it was very swift with plenty of slippery stones in river bed and banks, and again Padilla was obliged to pull each of our horses across the ford. After another stretch of woods we came out on a rolling grassy tract with a few scattered trees and arrived at the fumaroles a little after noon. Locally the fumaroles are known as "las pailas" or "las hornillas" but there were said to be other nearby hornillas to the north of the Rio Blanco, which latter we never crossed.

These fumaroles or solfataras are pools of warm or hot water, in the latter case bubbling and boiling, all more or less clouded with the white clay in which they lie. They are of varying sizes. The largest one occupied a basin whose rim was 2400 feet above sea-level, whose depth was about 30 feet and whose diameter at bottom I estimated to be about 80 feet in its longest (N. E. to S. W.) dimension. Its sides were more or less sloping so that one could easily ascend and descend and here and there little jets of steam were given off, or hot water bubbled up and trickled down to the pool in the bottom of the basin. I noticed two small openings, each two to three inches in diameter, within which a thick milk-like liquid could easily be seen rising and falling as it bubbled and made a snorting sound. At intervals the "milk" rose a little higher than usual and a few spurts flew out of the opening. In this as in other fumaroles were patches of the white clay mixed with red or yellow sulphur, in some places firm enough to stand on, in others soft and pasty. Some fragments which we brought from here have been identified as limonite or goethite with some basic ferric sulphate. The largest fumarole had a small outlet draining eastward to a brook. On the other side of this brook and nearly 100 feet lower than the largest fumarole was another, much smaller, remarkable because it was so near the brook—probably not more than ten feet away and above it—and for the considerable amount of steam constantly rising from it. We were unable to cross this brook to examine this little fumarole more closely. We had no thermometer with us, but the water in some of the pools was so hot that one could only endure to dip a fingertip and instantly withdraw it. We perceived no difference between the vegetation surrounding the pools and that growing farther away. I saw a single grasshopper on the side of the largest fumarole but insects in general were scarce—

perhaps because of the very strong wind which prevailed here also.

While at the fumaroles, in a fleeting break of the clouds the Cerro de la Vieja was pointed out, lying somewhat west of north. I tried to learn why this volcano is called "Rincón de la Vieja"—Corner of the Old (Woman)—but without much success. The explanation that "perhaps sometime an old woman lived somewhere up here and that her residence came to be referred to as the corner where the old woman lived," may have been invented after the name came into use. At best the story is exceedingly vague. I was sorry that we had not time and opportunity to attempt the ascent of this volcano but owing to its distance from any house it would be necessary to take supplies for four days on packhorses and to go in April or May; then only was the summit free from clouds, according to Espinosa, who had lived three years at Hacienda Guachipelin.

The geologist Karl von Seebach has given an account of an ascent which he made on January 9, 1865, of what he termed "Rincón de la Vieja," but whether of Cerro Guachipelin or of Cerro de la Vieja, I am unable to determine. He came to Guachipelin in company with the Governor of Guanacaste, Don Manuel Esquivel, and describes it as "the picturesquely situated Guachipelin, a farm of the extensive hacienda of Don Manuel's, 'La Queva.'" He speaks of "Hornillos, Salsen und Solfataren" at the foot of Rincón and, as his map places them to the north of the Rio Blanco, they are doubtless those of which we were told but did not see. He continues: "From here I rode up with three men on one of the small ridges into which the bare western part of the long drawn out Rincón divides, to about $\frac{2}{3}$ of the entire height, where we were obliged to dismount and go on foot. The way continued up the ridge which is not very steep and only rendered difficult by the constantly increasing ashes

mixed with lapilli and pieces of lava. Although the summit was again veiled in clouds, these were not yet very thick and one often saw the summit. About one o'clock we had reached the main ridge of the mountain and could hardly stem the fury of the raging northeast wind. We followed the main ridge for a short distance toward the east southeast until we halted opposite the last peak where my guides assured me that it was impossible to go farther. And indeed going farther was not easy. Often one must walk along a ridge hardly a foot wide, falling away steeply on both sides, where the loose lapilli and the raging northeast wind increased the difficulty, and then it was necessary to climb up an almost perpendicular cliff. Twice was I compelled to turn back here, but the third time I found a better ascent and soon was standing at the very crater. For three days, in August, 1863, this crater had emitted strong smoke and I was therefore not a little astonished to find in the crater a shallow, plate-like, completely enclosed basin in which the rain from the driving clouds produced a rippling and which sought exit through a small cleft toward the north. Under these circumstances I believed that a second crater, more to the southeast, must be expected, but in vain. On all sides the crater fell away steeply and I could not discover any other as far as the mist permitted seeing. I estimated the crater on which I stood to be 500 paces in diameter and hardly 100 feet deep at the highest, south, summit and only 5 feet at the north edge. From the edges of the crater, when the wind tore the clouds apart, I had a glorious view of the wide plain of Guanacaste and of the Pacific Ocean on the one side and on the other toward the north and east, of the forest wilderness of the Rio Frio as far as the beautiful Lake of Nicaragua. . . . A measurement of the height of the crater was not to be thought of; I was glad that I escaped with my life."

As we rode back from the fumaroles the rain ceased about us, although evidently continuing higher up. After we had recrossed the Colorado we tried, but unsuccessfully, to find some insects in the woods. When we came out on the llano we found that Espinosa had shot a doe, which was fastened behind Padilla's saddle and so carried to the Hacienda. Stephens, who came through Guanacaste on his way to Nicaragua, in February, 1840, was much struck with the great number of deer which he saw. As we looked up at Cerro Guachipelín from this llano we could plainly see a deep barranca or ravine on its southeast side with a fine waterfall. Cerro Guachipelín was wooded to the top but its outlying western ridges, plainly visible from the Hacienda, were bare of trees. As we rode westward we could easily see the Pacific from the llano. A little later when we looked backward (east) toward the mountains, there was a beautiful double rainbow, the lower bow very wide and apparently resting throughout its entire length on the ground; the colors at the yellow side were chiefly visible. We had left the fumaroles at 1.30 and reached the Hacienda at 3.30. Espinosa and Padilla skinned and cut up the deer and most of the meat was salted and hung up on a cord under the veranda—the only way meat can be preserved here. Some of the venison, toasted, was given us as an extra supper shortly before we went to bed and again at “café” next morning and was very good.

At sunset I sat behind the Hacienda watching Cerro Guachipelín, over which the easterly winds were constantly blowing great masses of clouds illuminated by the rays of the setting sun; the summit was never visible. Near the house, in line with the same cerro and lower than where I sat, horses and cattle were grazing quietly in a green potrero. Very high up in the blue sky overhead swifts were circling as they do at home, while much below

them, from tree top to tree top flew twittering green parakeets.

The café which the venison accompanied the next morning was a kind humorously described by Professor Tristán as "café de Guachipelin," for we had exhausted the real coffee on Saturday and since then it had been replaced by brown sugar cooked in hot water; it had at least something of a coffee color! The menu at Hacienda Guachipelin was never extensive, eggs, rice, black beans and tortillas being the staples for all meals. Meat was not, until the appearance of the venison. Little seemed to be grown on the farm—beans and plantains were the principal crops. The situation of the people dwelling here and at the other few scattered haciendas between the Rios Blanco and Colorado is an isolated one for the greater part of the year; during the rainy season the Colorado is impassable, thus cutting off communication with Liberia, the only town of the region from which supplies, medicines or a doctor can be obtained. Mails and telegraph service extend northward from Liberia to the Nicaraguan frontier, but their line is some miles westward from Hacienda Guachipelin.

On January 17 we left the Hacienda at 8 A. M. for Liberia; soon after starting we passed a carablanca monkey sitting quietly on a tree in the road surveying us. This time we crossed the Rio Colorado by a shallower ford higher up, which the horses took without hesitation. Almost immediately the road—an impossible one for ox-carts—ascended steeply to the ridge separating the valleys of the rivers Colorado and Santa Inés. The altitude of the Colorado at this ford is probably some 300 feet lower than the ridge, which at first was very narrow at the top (in places only twenty to thirty feet), and descended steeply on each side. It was composed of the same white pumitic rock, deeply worn into a rut just wide enough for a horse to

pass along. Farther southwestward the top widened. The highest point we reached while riding on the crest of this ridge was 925 feet, where we paused to photograph the ridge-road and a strikingly-shaped hill to the north, across the Colorado valley, known as Cerro Cañas Dulces. Owing to the narrowness of this ridge we had fine views of all the surrounding country and for this reason, as well as the easier ford, this route is preferable to that which we followed in going to Hacienda Guachipelín. We made a number of short stops to collect insects and reached Liberia about 12.30.

CHAPTER XXI

GUANACASTE—SANTA CRUZ

At 7.30 on the morning of January 18 Professor Tristán and I left Liberia on horseback and as we were riding out of the town we were joined unexpectedly by Señor Chamorro, who was likewise going to Filadelfia; the members of the Commission had preceded us. Our route was the same as that by which we had come to Liberia. Before nine o'clock we entered the llanos and by nine-thirty were fairly on the Llano Grande. The altitude was about 275 feet. As we left it we stopped to look back at the Volcanoes Orosi and Rincón de la Vieja, cloud-capped as usual. Dr. Sapper ascended Orosi in clouds (February 1, 1899), waited half an hour on the summit to get a view and adds, "I purposed in the future to leave the volcanoes of the province of Guanacaste in peace as long as they were almost always covered with cloud-caps just as they were then."

Shortly beyond the Llano Grande the road descended by the three zigzags previously mentioned to 125 feet and from here to the crossing of the Rio Tempisque the aneroid registered a further descent of fifty feet. Our party, consisting of three only, was able to cross the river, all at once, in the same way as on our outward journey. Two hours more, or almost six hours from Liberia, brought us to Filadelfia. The journey was a tiresome one since much of the road was unshaded, and carrying an open umbrella was not very satisfactory on account of the frequent uncertain gusts of wind. The gorgeous red, blue and yellow macaws or "lapas," the green parrots—"loros," and green parrakeets

—"periquitos," frequently enlivened the journey; all three are abundant in the country through which we traveled. Along the roadsides from Los Boquerones (or Palmira) to Filadelfia were many iguanas, lying in the road or high up on the branches of large trees, the former scuttling into hiding as we came near.

Professor Tristán had telegraphed from Liberia to Filadelfia and there the Jefe Politico, don Pablo Villar, brother of the member of the Commission, lodged us in the Casa Municipal; we had meals in the nearby house of Señora Ramirez, who had a granddaughter in the Colegio de Señoritas at San José. Don Pablo showed a mark on the inner wall of a room in the Casa Municipal about two feet above the floor, as the level to which the waters of the Rio Tempisque reached in October, 1908. Yet at this time the river banks nearest this house were thirty feet above the water level, giving some idea of the extent to which this country is flooded. This day everything in Filadelfia was dust, driven to and fro by an intermittent wind.

After some hours' rest we went to the Tempisque, only a few minutes' walk, where Don Pablo secured a dugout and paddled us across stream to a beach of mingled sand and small stones, on which we spent an hour collecting. Near the water's edge were many "frog-hoppers" (*Gelastocoris flavus?*), one-quarter inch long and three-sixteenths wide, Hemipterous insects of the family Galgolidæ. They were colored so nearly like the small stones as to be discovered with difficulty.

On January 19, we left Filadelfia at 7.10 on horseback for Santa Cruz. Don Pablo accompanied us as far as the village of Belen and the remainder of the way we had a guide supplied by Señor Chamorro. At Belen we crossed a tributary of the Rio Bolsón and followed its bank for some distance. Here the guide stopped to speak to some one, telling us to go

on as the road was straight. We did so and in attempting to cross a brook on the "straight" road Professor Tristán's horse, which was leading, mired up to the body. The guide now came up and explained that we must make a detour here! We were then able to cross the brook without further adventure and almost immediately began to ascend some low hills which the guide called Cerros de Guiz(?). Beyond them we forded the fairly wide Rio de las Cañas and followed it for some distance, most of the way thus far being shaded. Houses occurred here and there; some had walls of upright bamboo or other stems with chinks between the stems, and very high-pitched roofs of palm thatch. Now and then we stopped to collect insects without dismounting from our horses. After crossing the Rio Medio several times we reached Santa Cruz at 11.45. The Commission had preceded us by two days. All of us were lodged in the schoolhouse, a one-story wooden building completed in 1908, much less pretentious than that at Liberia but having a fenced-in playground behind. It stood in the middle of the north side of the plaza, which had the two-spired white-washed church on the east side and the one-storied wooden municipal building on the west.

The schoolhouse, like many other houses in the villages of Guanacaste, had walls a single board in thickness, each board eight to twelve inches wide and with beveled edges fitting over each other to shed rain. There was no interior finishing except that these boards and the completely exposed uprights and wooden partitions were planed smooth. There were few if any sawmills in this province and boards were sawn by hand. A squared log—and many of the men can square a log with a thin-edged axe with surprising accuracy and rapidity—was placed across a staging six to seven feet above the ground. One man stood on the staging, one on the ground below, each with one end of a long

saw in his hands, and so working the saw up and down the plank was separated from the log.

The water supply of Palmira, Filadelfia, Belen, Santa Cruz and doubtless other towns of this country was largely, but not entirely, drawn from town wells in the centers of the plazas. In the first three towns named there was a windmill over the well to draw up the water, but in Santa Cruz buckets were let down on a rope and hauled up by hand. There was *at least some* sediment, etc., in the Santa Cruz water and the schoolhouse was not provided with one of the stone filters to be found in the Liberia schoolhouse and in many even rather poor houses of the central plateau of Costa Rica. To these town wells came the women and children from all directions to fill and carry off earthenware jars or galvanized iron buckets of water.

In one of the outhouses within the playground of the school I caught, on January 24, a specimen of the large roach *Archimandrita marmorata*. The body proper measures two inches long and the widest part (of the abdomen) one inch, but the shield on the upper surface of the prothorax is greatly expanded forward and to right and left so as to conceal the head completely when the insect is viewed from above. The fore wings, each one of which is two and three-eighths inches long and a little more than one inch wide, when folded in the position of rest, mask the remainder of the body and give it a total length of three inches and a width of one and one-half. The prothoracic shield and these wings curve downward along their outer edges so as to form a smooth convex cover for the insect and, as it ran over smooth boards, made picking it up a matter of some difficulty, and I would not have succeeded without the aid of my net. The body was marked with various shades of dark and light brown, the darkest areas being a double-lobed spot half an inch wide on the middle of the prothoracic shield, a streak of about the

same length running lengthwise from near the middle of the base of each fore wing, and a much smaller spot on the front of the head between the eyes.

On two successive mornings (January 21 and 22) when I arose, I found on the floor beside my bed in the school room a reduviid or assassin bug, and on one at least of these occasions there was a marked though not painful swelling on one ankle. Since these individuals are members of a group known to suck human blood, suspicions as to a cause and effect relation were naturally aroused. The group of insects mentioned contains the "blood-sucking cone-nose" (*Conorhinus sanguisuga*) of the United States and the "barbeiro" (*Conorhinus* or *Lamus megistus*) of Brazil. The latter has been found by Dr. Chagas to serve as a transmitter of a trypanosome parasite of the blood of monkeys and of man. The trypanosome, introduced into a healthy person by the barbeiro sucking his blood, gives rise to a number of serious disorders, especially in children. These reduviids have a long and very narrow head, but my Santa Cruz specimens appear to be of the genus *Meccus*, instead of *Conorhinus*, because of the greater length of the head behind the eyes. The eyes of *Meccus* being rather small, the length of one eye can be contained two to three times in the length of the postocular region, while the larger eyes of *Conorhinus* can be contained but once therein. Although the two specimens from the schoolhouse are one inch and half an inch long and have a maximum width of seven-sixteenths and three-sixteenths inches respectively, neither is mature. The adult possesses wings; the larger of my two has wing rudiments one-eighth of an inch long, the smaller none at all. This immaturity makes identification of the species difficult; they resemble *M. phyllosoma*, recorded only from Mexican localities, as much as any other. The color of these (alcoholic) specimens is brown or slaty

brown with small orange spots along the edges of the body.

My explorations of the vicinity of Santa Cruz began on January 20, when twenty-five minutes' easy walking along a dusty road to the east brought me to the Rio Medio, here flowing toward the northwest; in the afternoon I went west to the Rio Diríá only five minutes away. Both were at this time shallow, clear-water streams with a gentle fall. They wound among sand and small stones, the Diríá having a narrower and much shadier bed than the Medio.

On the following day I spent some time along the west bank of the Diríá. There were several flocks of dragonflies here, chiefly both sexes of *Macrothemis hemichlora*, but no *Miathyria*. Associated with one flock of *hemichlora* was a male of *Macrothemis inacuta*, a somewhat larger species (one and three-quarters inches long, wing-spread two and one-half inches) with a pale ochre abdomen whose edges bear black lines. An individual of *Pantala flavescens* also was in one of these flocks.

In the fringe of woods here I almost stepped on a snake some four feet long, striped lengthwise with black and yellow. It was the first experience of the sort I had in Costa Rica, and as I was in so many places where snakes might be expected without even seeing one, some record of their unobtrusiveness may be interesting. This particular snake made off rapidly and I saw it no more.

A little over a mile west of Santa Cruz are some hills known as Cerro Las Pilas. I followed a road up into them and by accident found a dry brook bed apparently a favorite place with dragonflies of the genus *Gomphoides*, never very abundant anywhere. The *Gomphoides* (near *G. ambigua*) of both sexes were resting on the tips of twigs, usually bare ones, and closely associated with another species, *Orthemis levis*, which was more abundant. There was no

water anywhere near. This *Gomphoides* is two and one-quarter to two and one-half inches long. The general colors of the body are dark brown and pale green; the latter, mixed with pale brown, occupies much of the lateral surfaces of the abdomen, leaving only a narrow mid-dorsal band or stripe of brown. The eyes do not nearly meet on the top of the head. At the hind end of the abdomen is a single pair of appendages, about three thirty-seconds of an inch long and curved as forceps in the male, but straight and one-sixteenth inch long in the female. The colorless wings spread three to three and one-quarter inches. *Orthemis levis*, a smaller species two inches long, wing-spread three inches, has the eyes meeting on the top of the head and immediately in front of the eyes of the male is a patch of brilliant metallic purple, only a trace of which exists in the female. There are two wide pale green or yellow bands on each side of the brown thorax, as well as pale lines, and the slender abdomen is red or reddish-brown.

This brook bed lay within a dry woods of rather small trees. One tree by the bank was a "cedro pochote" (*Pachira fendleri*¹), remarkable for the short thick spines on the trunk. I measured one of the largest spines finding it to have a diameter of one and four-fifths inches and an equal height. Normally these spines are solid and hard and I was unable to cut one off with my knife; some of them, however, were burrowed into by insects.

At another place on this bank was a swarm of Phalangids (*Liobunum biolleyi*) or "daddy longlegs," here called "indios"; they were hanging together by hundreds in a dense mass, their long legs waving like a bunch of horsehair. I gathered some of them, the others separating and moving off in all directions. A couple of hours later when I repassed the place, they had again massed themselves. Professor

¹The cedro pochote may be the *Bombax nicoyense* of Pittier, 1914.

Tristán told me that he had seen the same behavior among these Arachnids but knew no reason for the swarming, nor could I discover the cause in this instance.

The altitude of Santa Cruz is probably between 150 and 170 feet above sea-level,¹ my aneroid varying to that extent on different days. When I had reached 250 to 275 feet this dry brook bed had shallowed and above this point there seemed to be no more of the *Gomphoides* dragonflies, so leaving it I set off to climb to the top of one of the lower Pilas. The side up which I went was steep, with mostly small bare trees whose fallen leaves, together with dry whitened selaginellas, covered the ground and made it slippery. Among the trees were, here and there, clumps of a few-branched cereus cactus twenty to thirty feet high. Half an hour's climb brought me to the top of the northern end of the Pilas next to Santa Cruz. The elevation was only 600 feet; other parts of this Cerro are much higher, probably 1000 to 1200 feet. They were apparently tree-clad to their tops while the point I reached was almost bare and for my purpose—to view the country about Santa Cruz—quite satisfactory. If the higher parts give a view of the Pacific to the west they would be better of course, but the climb must be a fatiguing one unless there are paths, absent from my hill. To the north and west of north from this hill was a cerro or ridge some ten or fifteen miles away, I judged, probably Sardinal; 5° west of north was the volcano Orosi, 5° east of north Rincón de la Vieja, 30° east of north the volcano Miravalles, all three, as usual, with their tops in a long bank of white clouds. In line with Orosi and over the low eastern part of the Cerro de Sardinal appeared a little of the Pacific. To the east were ridges some miles beyond Santa Cruz, while south and west the view was cut off by the higher parts of the Pilas.

¹ Dr. Sapper gives it as 35 meters = 115 feet.

Everywhere I went this day lizards of various species and sizes, from three-foot iguanas down, were very abundant and every few minutes a rustling among the dry leaves or weeds meant one of these active reptiles—perfectly harmless and yet always causing me to turn and look in the direction of the sound.

With Señor Bonilla and Pedro Alfredo Cuendies, an intelligent schoolboy who fetched water and ran errands for the Commission, we went southwest from Santa Cruz, crossing the Rio Diriá, to a more southern part of the Cerro Las Pilas. In a dry brook bed, instead of *Gomphoides* dragonflies as at the other locality, I found a species of *Micrathyria* (*M. ocellata quicha*) which I had not previously taken although, as already related, we subsequently obtained it at Puntarenas. At Cerro Las Pilas both sexes were fairly abundant, sitting on bare twigs of the mostly leafless small trees, and sometimes impossible of capture on account of the interference of the numerous small twigs with the movements of the net. Associated with this species were *Erythrodiplax funerea* and, rarely, *Orthemis levis*. I saw no *Gomphoides* anywhere this day.

Although we were very little above Santa Cruz, from one spot we had a view of the four volcanoes of Guanacaste at once—Orosi, Rincón de la Vieja, Miravalles and Tenorio, far away of course, but, for the only time in my experience, Orosi was free from clouds and the others had less than I had ever seen.

Bull's horn thorn was very abundant around Santa Cruz, being found both near the banks of rivers and also in dry places like this cerro. There were at least two species, both tenanted by ants; one (*Acacia costaricensis*) which we have already mentioned for Alajuela, etc., had a single gland or group of glands on the petiole of the leaf; the other (*A. nicoyensis*) with glands in raised tubercles on the upper side

of the midrib opposite or just below the bases of each pair of leaflets. Both kinds produce the yellow fruit bodies at the tips of the pinnules of the young leaflets, and both may be inhabited either by black or by red ants. Our Santa Cruz specimens have been identified by Professor Wheeler as *Pseudomyrma belti*, *Ps. nigrocincta* and *Ps. nigropilosa* (larger than *nigrocincta*, reddish with black hairs especially near the hind end, facultative). The second species of *Acacia* mentioned sometimes had the thorns abnormally enlarged so as to be four or more inches in length and half an inch or more in diameter except at the free end, where the tip of the thorn retained its usual dimensions. The enlargements like the unmodified thorns were hollow but I do not know their significance; they were not found on all plants.¹ The popular name of the bull's horn thorn is "cuernezuelo." On several occasions I saw empty birds' nests lodged within these spiny plants, although never the birds which had built them. Señor Bonilla said that the birds choose such locations in order that the thorns may serve as a defense against owls and hawks. How the nest-builders and their young defend themselves from the ants I do not know.

Another location for birds' nests which we saw near Santa Cruz was the abandoned nests of termites, into which the green parakeets had made a hole, or, in one case at least, a tunnel open at both ends.

As we returned to Santa Cruz from the Pilas, crossing the Diriá at another point, we passed a swarm of Phalangids similar to that described for January 21 but smaller; this swarm was very close to the river bank.

The Commission, having been invited to call on Señor

¹ I have allowed these notes on the Acacias to stand as written when the observations were made, adding the botanical names later. It seems possible that the plants near Santa Cruz with "the thorns abnormally enlarged" may really have been *Acacia hindsii*. I have no specimens which will determine the point.

Andreas Bonilla one evening, went to his house for about an hour spent in conversation. Later at the invitation of Dr. Eduardo J. Trejos, the municipal physician (who had spent seven years in the United States, studied medicine in New York City and was one of the very few English-speaking persons in Santa Cruz), we went to his house to a dance. All the ladies sat in a row on one side of the room when not dancing, the men elsewhere. When a lady arrived somewhat later than the rest of the guests all the company, if seated, arose in recognition of her presence. The music was furnished by three fiddles and an accordion. The uninvited part of the community stood outside the house looking into the room through the open doors, which as usual were not separated from the street by any vestibule or passage.

Another day the Commission called on Padre J. M. Velasco, a former priest, known for the collections which he has made of Indian pottery and other artifacts obtained by excavating the graves of the earlier inhabitants of this region. One of his collections is now in the Museo Nacional in San José; another was purchased by the Carnegie Museum of Pittsburgh, Pennsylvania. Padre Velasco showed us a copy of Volume III, Number 1 of the *Memoirs of the Carnegie Museum*, published in 1907, wherein these collections are described and figured by C. V. Hartmann under the title "Archeological Researches on the Pacific Coast of Costa Rica." At the time of our visit the Padre possessed very few such objects; among them was a small number of jade ornaments similar to those figured in the Memoir mentioned. Padre Velasco did not speak, nor, I believe, understand English; he was apparently between fifty and sixty and his face reminded me somewhat of Professor Edward D. Cope.

On January 23, I walked downstream along the Río Diría until completely barred by a dense hedge of piñuela extend-

ing to the very edge of the almost perpendicular bank. Two young men came wading along the river, each armed with a slender wooden spear eight to ten feet long and tipped with a sharp and very tapering steel point. They were looking for fish and, while I was watching them, speared two "barbudos" six to eight inches long, from among the roots of a large tree which reached down into the water. These fish are members of the catfish family, probably a species of *Rhamdia*. My two questions as to whether the fish were for food and were good were both answered affirmatively, and before I left Santa Cruz I had opportunity to assure myself of the good taste of barbudo.

This day (Sunday) was the first of a three days' fiesta in Santa Cruz. The preceding afternoon an image of the saint, which had been making a circuit of the neighboring country, was brought into the church, followed by a long procession, chiefly of women, whose bright-colored rebosos of various shades of reds, blues, yellows or greens made a vivid contrast to the background of whitewashed houses and church and dust-colored roads. Sunday's procession was of different, non-religious, character and consisted of the local brass band, a decorated chariot drawn by two oxen, with a canopy under which sat the "Queen" (queen of what I could not learn nor what she represented) with an attendant page; boys and men in masks and clown's attire on foot and a "giganta" or giantess about twelve feet high. This last was a figure representing a woman, the face rather crudely moulded and painted. She was dressed in pink, with a wide-brimmed fashionably trimmed straw hat and long white gloves. The skirt, and perhaps the bodice, were simply stretched over a light wooden frame inside of which walked the man who carried the whole, and of whom only the feet were visible. The upper part of the giganta was inclined to topple over so that usually a man walked on each

side to straighten her when she grew faint. This procession passed around the plaza and through the principal streets.

When we first arrived in Santa Cruz the grass-covered plaza, with the town well under its shed in the center and its border of fairly large higuerones, was entirely open and in the late afternoons was the scene of lively games of "Association" football among the boys and young men. Professor Tristán told me this game was first introduced into Costa Rica about eight years before among the boys of the Liceo in San José and that the latter have carried the game to many parts of the country. On Friday and Saturday the plaza was enclosed by a fence of tree-trunks and boughs, posts being set into the ground and rails tied to these by means of lianas. This was in preparation for the "toros"—bulls—which were one of the chief attractions of the fiestas, beginning each of the three days at one o'clock. Two raised platforms were also constructed on the north side of the plaza and on one of these we were invited to sit, most of the spectators hanging on to the enclosing fences. Some fifteen bulls had been brought to town for the occasion and a separate pen constructed for them next to the churchyard, where they were lassoed and led singly into the plaza by a horseman. The bull was tied in one corner of the plaza while a piece of leather was fastened on its back; a man then seated himself on this saddle and the animal was released. The bull usually rushed away prancing and kicking, the man holding on tightly. Often the bull succeeded in throwing its rider who was then in considerable peril from the fall and from the hoofs as the creature rushed about the enclosure trying to find an opening. Men with pieces of hide or cloth, not often red in color, held or shook these in front of the bull's head as he charged them, the men although on foot leaping aside with much dexterity. If the animal was not very spirited and stood still, a man twisted its tail or prodded or teased

the victim in various ways. When any bull was adjudged to have afforded the maximum of amusement and entertainment, it was lassoed round the horns and led off to the pen and another brought in to take its place. No attempt was made to kill or seriously injure the animals. The principal danger was to the men taking part, especially to him who rode the bull. We saw one man thrown violently to the ground; he arose immediately but as he walked off a crowd gathered around him and hid him from sight; we learned that he had received a severe blow on the chin when thrown. Professor Tristán left the platform at this time declaring he could not look at the spectacle any longer and I took advantage of the opportunity to do likewise. To me it was painful to see the risks run by the riders of the bulls as well as the teasing to which the animals were subjected, but the popularity of the show proves that the majority of the spectators did not feel this. Each day the "toros" lasted from about one to five or five-thirty.

During the fiestas rockets, bombs and firecrackers might be expected at any hour of the day or night, while at eight o'clock in the evening fireworks—some quite elaborate—were set off in the plaza. There was even a small saluting cannon, with a Spanish crown on its barrel, mounted on a pair of cart wheels, to add to the din, and from time to time the church bells clanged furiously. Night and day, in several houses in different parts of the town, the marimba (here usually in the hands of a single player) and other instruments furnished music for an endless succession of dancing couples. There was much drinking, and drunken men reeled about the streets, occasionally taking up their station in front of the schoolhouse in the wee sma' hours and making sleep impossible. There was no violence within my observation, although one could usually see the heads of several men pressed against the window bars of the carcel. Police



Young Spoonbills (*Ajaia ajaia*)— and one nest.



“La Giganta,” Santa Cruz Fiesta.



Veiled Dance, Santa Cruz Fiesta.
House at Santa Barbara de Santa Cruz.

were on duty in the streets and when awake in the night I heard the whistles of those on guard, as the town clock struck the hours or half hours.

Sunday's procession was repeated about noon on Monday, an additional feature being a man who rode a mock bull as a boy does a stick with a horse's head at one end. This mock bull consisted of a cow's skull fixed to one end of a framework of sticks, over which was stretched some brown fabric, representing the bull's body. Mounted on this the man pranced among the crowd, who on their part took off coats and waved them before the "bull" as they did to the actual bull in the plaza. Others beat the bull with anything at hand, all in the greatest hilarity, and the animal soon proved too weak to withstand dissolution. There were no fireworks this evening, but on Tuesday evening a very few in the plaza brought the fiestas to a close, although on the following afternoon the boys held mock "toros" in the plaza with young bulls. There are all sorts of mixed descents here between whites, Indians and negroes, and at the fiestas, which brought together many people from the surrounding country, one saw a great variety of physical features.

On January 24 I went south to the panteon or cemetery which, as is so often the case, was a dreary collection of mounds, weeds and wooden crosses, the latter bearing some names or inscriptions relating to the deceased. Animals strayed in to graze and a sadder and more desolate place it would be hard to find. On the road to the cemetery an iguana watched me as I approached and finally took refuge in a hole therein. I had not set out for the cemetery; I was simply looking for new collecting grounds, but everything was dry weeds. Turning off to the east I stumbled upon the road to Nicoya, distant six hours by horse from Santa Cruz, and followed it southward to a point on the Rio Medio farther upstream than previously visited and spent some

time along its stony beaches. On these different occasions I saw fairly large squirrels, with reddish bodies and long thick gray tails, on the trees near the river; they were perhaps *Sciurus adolphei dorsalis*.

When we arose on January 25 it felt decidedly cold, yet the school thermometer measured 19° C. (=66.2° F.) at 7 A. M., showing how we had become acclimated to this warm country. The same thermometer registered 31° C. (=87.8° F.) at 4 P. M., both measurements being in the shade. The shade temperature, therefore, was not excessive, but the usually slight daily range made a morning temperature of 19° C. seem cold.

The Comision Calificadora, having finished its work here, started for San José on the morning of January 25, but Professor Tristán and I remained for further collecting. The members of the Commission were very agreeable, and traveling with them added much to the pleasure of the journey as well as saving us the trouble of arranging for transportation and lodging, and assuring us better quarters than we otherwise might have enjoyed.

The Commission having departed we went north a kilometer or two from the town to the house of one Rollo Jaen, whom Professor Tristán knew, where we took breakfast. The walls of this house were one board thick, the tile roof supported by upright beams at the corners and two in the principal room under the ridge pole. As usual the windows were without sashes but furnished with wooden shutters. The earthen floor was now hard and dry, but in answer to my question they told me it grew quite damp in the rainy season. The principal room contained two or three bedsteads, as many chairs, a hammock, a table, some heaps of unhusked maize and other products, tools, ox-harness, bridles and saddles. A small part of the wall was covered with pages—chiefly pictures and advertisements—from

magazines, principally American; I recall a portrait of J. Pierpont Morgan from a magazine of about 1901 posted with the others. The bedsteads were iron or wooden frames with an oxhide stretched tightly over each; I slept on such a one at the Hacienda Guachipelin and found it as hard as a board. The chair seats were also of oxhide stretched over the frame and fastened down with strips of wood nailed over the hide. The most inconvenient feature of this room, and a rather unusual one I think, was a horizontal beam a foot above the floor which braced the uprights under the ridgepole and which must be stepped over every time one passed from one side of the room to the other. A smaller back room served for kitchen, etc. We had plates, saucers, cups, knives, forks and spoons at breakfast, but when we asked for water it was brought in a guacal, as is customary here. For breakfast we had fried eggs, tortillas, frijoles, rice, meat, and finally coffee. It was cooked and served by the wife, a decidedly brown woman, probably with a large proportion of Indian blood.

On January 27 we walked past Rollo Jaen's house (which was on the left side of the road to Timpate) and farther into the forest north of it than on our previous visit, following a private road after securing permission to do so. The forest was quite dry at this time and there were very few orchids, bromeliads or other epiphytes. There was a great variety in the trees, both as to species and size, and much undergrowth both of shrubs and herbs. While passing through this forest we made frequent short excursions from the road to one side or other and in one of these came upon the small slender dragonflies of the genus *Metaleptobasis*, securing in all some half a dozen specimens representing both sexes. In the preparation of the *Biologia Centrali-Americana* only two specimens were available from all Central America and Mexico, one being from Guatemala and one

from Nicaragua, and the South American examples mentioned in literature up to that time were very few in number. It was interesting to learn that these rare little dragonflies are inhabitants of dry forests such as this—no information of a definite character being hitherto at hand on this point. The male of this species is most curious in possessing two slender horns each 1.18 mm. long, on the forward upper surface of its mesothorax and directed upward and forward and curved toward each at their sharply-pointed tips. Their relatively great length is only appreciated when it is known that the greatest height of the thorax at any point is but 2.16 mm. I am sorry to be unable to record any observations upon this insect while alive which would give some clue as to the function of these peculiar, and, for males, rare structures. The females have, in the place of these horns, two conical tubercles each .11 mm. in height. The total length of the body in both sexes is one and three-quarters inches, the wing-spread about the same. The thorax is yellowish-green in life with a mid-dorsal dark metallic green stripe.

We had some excellent views of monkeys in this forest; I heard the howling of the congos many times in the distance at Santa Cruz as well as on our journey thither, and this morning we heard them frequently from the first moment we entered the forest. At last we were so fortunate as to meet a troop of eight or nine in the trees immediately over and alongside of the road and not too high to be seen distinctly. The congo (*Alouatta villosa*) is the largest of the Costa Rican monkeys and is entirely black, the males with a heavy black beard. This troop included individuals of different ages and sizes. They showed no special signs of fear at our presence. We stood beneath them and called to them in our deepest tones, some of the congos replying in a roar not unlike a lion's.

A second species of monkey seen to-day, the "cara blanca" or capuchin, is smaller, dark brown with white face and throat. We came upon half a dozen on the ground, although they speedily took to the trees. We enjoyed seeing them swing by limbs or tail from branch to branch, or leap across an open space. Sometimes one would pause upon a bough and stand upright to look at me and then jump up and down two or three times in the same place as captive monkeys often do, apparently in excitement. I lingered for some time to watch their amusing antics.

After walking some three miles through this forest we crossed a potrero and entered another piece of timberland where the soil was blacker and in drying had cracked into polyhedral masses. A mile or so more brought us to a swamp, locally known as "Laguna Garzal," which was said to extend to the Rio Cañas (or de las Cañas). As far as we could see, most of this swamp was then not open water but covered with coarse grass, sedge and a spiny leguminous shrub about three feet high. At the corner where we emerged was a small area of open water of an irregular L-shape, whose greatest length might have been twenty feet. The water here was widely known in this part of the country because it was said to be warm throughout the year, and it was the object of to-day's excursion to visit it. We had brought with us the school thermometer ("Hachette & Cie, Paris") from Santa Cruz and with it obtained the following results: temperature of the air in the sun, 11.30 A. M., 45° C. (= 113° F.); temperature of the (unshaded) water, 11.35 A. M., 40° C. (= 104° F.); temperature of the air in the shade of the nearest trees, 1.30 P. M., 30° C. (= 86° F.). The sun shone brightly all day. At almost all times bubbles could be seen rising at one spot or other from the floor of this pool, which was a fine, slightly greenish mud. The water was quite clear. We all drank a little, to which we added a

few drops of lemon juice, and without any disagreeable consequences. The banks of this pool were of soft mud, into which I could easily thrust a stick for two or three feet, and covered with coarse grass. Some logs and planks had been laid by previous visitors so that it was easy to reach the edge of the clear water. A number of dragonflies were flying about this pool and although none of their species were seen in the neighboring forest, they were all of forms widespread throughout tropical America.¹ Floating in the warm water were two fore wings and one hind wing of still another species, *Miathyria simplex*, ally of *M. marcella* which we so often saw in flocks,—the only evidence we obtained anywhere of its presence in Costa Rica! Owing to the treacherous character of the banks it was impossible to explore more than a few feet of the pool's area and I was unable to find larvæ of any of these species by means of my water net. A hemipterous insect and a small fish were seen swimming in the water.

We ate our lunch under the nearest edge of the forest and rested afterwards, while we made short trips to the hot pool one at a time, including Pedro who had accompanied us, to try to catch some additional dragonflies. We were only able to remain a short time in the blaze of sunshine there, however. We returned to Santa Cruz as we had come. In the potrero between the two tracts of forest the cattle had gathered to the number of fifty or so, but although one young bull was inclined to show off at our expense he was easily frightened away and his companions gave us no trouble.

We revisited the forest north of Santa Cruz beyond Rollo Jaen's on January 29, spending our time in looking for

¹The pool species were the slender *Ischnura ramburi* var. *credula*, with the 8th and 9th abdominal segments sky-blue, *Orthemis ferruginea* with magenta abdomen, *Micrathyria ocellata quicha* and *M. aqualis*, maturely-colored males of *Erythemis peruviana* with pruinose purple thorax and stout red abdomen, and its slender-abdomened congener, *E. verbenata*.

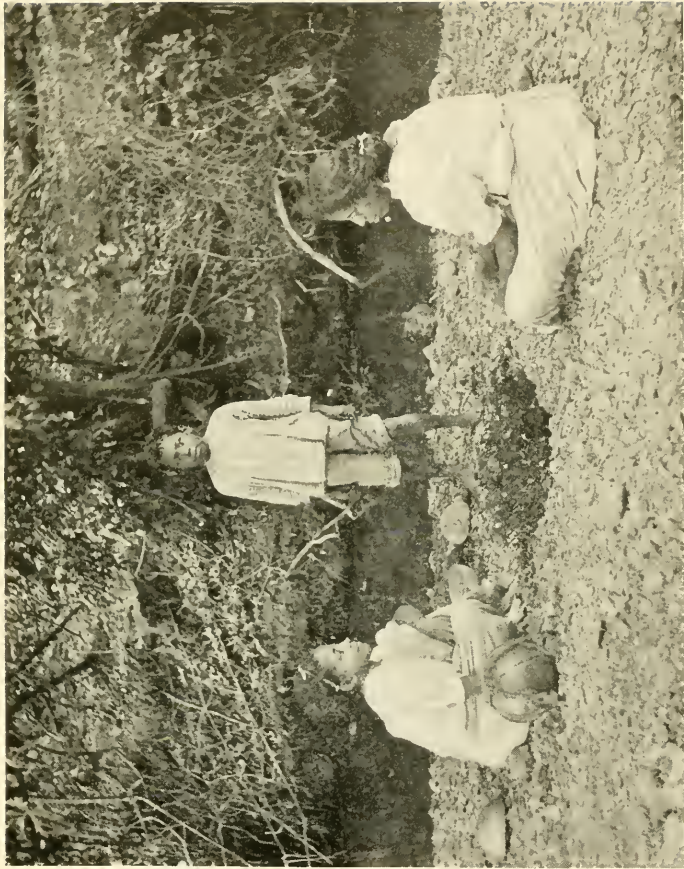
additional specimens of *Metaleptobasis*. This dragonfly was less abundant than previously, but Professor Tristán was able to catch a female of *Staurophlebia*, one of the largest of the stout-bodied forms, and we found a few others of interest. The *Staurophlebia* female, apparently of the same subspecies as the males seen or taken at Guápiles in June (*S. reticulata obscura*), was four inches long and had a wingspread of nearly six inches. Its great eyes were bright green in life, the remainder of the head a greenish-blue, the thorax and abdomen pale blue, the wings uncolored. Both sexes have the fore surface of the thorax (mesepisterna) studded with short, pale, rather stout spines. The name *Staurophlebia*, literally "cross-vein," was applied to this insect in allusion to the peculiarity, rare among dragonflies, that the subcosta, or second of the long veins of the wings (that on the front edge being the first) crosses and goes beyond the nodus, i. e., the stout transverse vein where the front border of the wing "dips in" at about mid-length. In most dragonflies the subcosta stops at the nodus. Most of the time was occupied in walking through the undergrowth trying to examine every twig and branch for the insects desired, and after several hours of such minute search both eyes and attention were unable to do more. We returned to Santa Cruz for our breakfast and the afternoon was spent, as was often the case here, in preparing and making notes on the specimens gathered.

On January 28 Padre Velasco took us on an excursion to the village of Santa Barbara, lying to the east of Santa Cruz, to witness the excavation of an old Indian grave. Señor Bonilla lent horses to Professor Tristán and me, and his son, a student in the Liceo at San José, went with us. We crossed the Rio Medio and a smaller stream, the Frio, and then went over the Cerro Tamarindo. The road here was simply a sort of gutter of rough and irregular shape worn in more or

less soft, usually pale-colored rock, and in many places very steep. On the level, my horse could only be induced to go faster than a slow walk by constant spurring, but when it came to these ascending trails almost took my breath away by literally galloping up them without any persuasion from me. Indeed it would not be held back and I could not avoid thinking how ugly the fall would be for both of us if he slipped, so, as each mad rush uphill began, I confess I caught hold of his mane firmly with one hand! We had crossed the cerro when we passed directly under a large black-bearded congo monkey looking down at us with no apparent concern from a large tree whose widespreading branches overhung the road.

We went through the little village of Santa Barbara to its eastern end and on the outskirts stopped at a house somewhat inferior to Rollo Jaen's already described, the walls being of upright sticks or boughs with chinks between. Furniture was not very different, but the interior formed one undivided room. The cooking place in this house was a bed of sand in one corner on which sticks were ignited, and pots for boiling water or iron dishes for baking tortillas were propped among or upon the embers. We brought most of our breakfast with us but they gave us some very strong coffee. The family consisted of a grandmother, her son-in-law, three granddaughters and a grandson, the mother having died. Their physical features appeared to be chiefly Indian, but in one or two of the granddaughters there were unmistakable signs of African blood. Most of the family were able to read, Santa Barbara, like nearly all villages in Costa Rica, having its schools for both sexes.

Hardly six feet from the rear wall of this house a hole, already five feet deep, had been dug. Many Indian graves had previously been opened within a radius of a few hundred feet, and scattered mounds of earth indicated where they had



Waiting for Water-hole to fill, Rio Santa Barbara.



Plaza, Bare Hills and Schoolhouses, Bolsón.
Bamboo House with Palm-thatched Roof at Bolsón. Sawing Stage in left
background.

been refilled. We gathered round this opening from which some pieces of broken pottery had already been taken. The men used a pole with a square-ended steel tip to loosen the earth and a steel spade to throw out the soil. Then the Padre descended and with one of the men carefully scraped away the bottom soil with his machete. Of course there is no predicting what—if anything—will be discovered in one of these excavations, but we were fortunate; from time to time during the day a number of entire earthenware vessels of different sizes and shapes were uncovered, all standing upright, embedded securely in the soil and filled with earth. One of the vessels possessed a neck and its walls were perforated on all sides with holes, so that it had, no doubt, served as some sort of sieve. Some vessels were decorated in black. A celt or spear head of a white stone and a few other stone implements were found. Of the human being only the smallest fragments were discovered—a bit of cranium an inch across, a phalanx or finger bone, an end of a bone of the forearm and a few molar teeth. When further search seemed useless the grave was filled again. Not far off were some large trees while a smaller one extended its roots to the grave we had seen opened, and it was hard to realize that of all the objects visible around us—house, road, trees—none except the soil and the nearby Rio Santa Barbara had existed when these vessels were placed beside the dead body in the ground. The objects found in the grave were wrapped in paper, placed in Padre Velasco's saddle bags and carried to Santa Cruz. But some days later, when we said good-by to him, he gave to Professor Tristán some of the vessels and to me one of the fragments bearing a curious face, which I coveted, as souvenirs of our visit to Santa Barbara.

Professor Tristán and I did not spend our entire time at the excavation but went for an hour or so, with some of the family, to the Rio Santa Barbara, here a rather dirty stream

which flows east directly into the Rio Tempisque instead of into the Cañas as do the Medio and Diríá, rivers of Santa Cruz. On the way to Santa Barbara, I had unfortunately lost my insect net but was able to rig up another from a net always carried with me—but never yet used—to protect my head from some ferocious swarm of mosquitos or gnats that I might meet. The substitute, in the hands of young Señor Bonilla, who took to catching dragonflies over the water with ardor, proved good enough to land the hitherto uncaught female of a species known to us at Santa Cruz, and as usual Professor Tristán aided vigorously in securing specimens of the local odonate fauna. He also photographed two of the granddaughters in characteristic attitudes of these people, for they had brought with them earthenware jars and guacals for the household water supply. It is the custom here and elsewhere in Guanacaste for the people to take their water not from the flowing stream but from holes which they make, each time they go for water, in the stone and sand beaches through which the river winds. As pigs and cattle frequently wander over these beaches and soil them, the water from such holes is not likely to be as clean as that taken from the middle of the river. At this place, being below the village, the water was certainly dirty and not very inviting as a beverage. The Medio and Diríá, just above Santa Cruz, are very clear and when extremely thirsty I have drunk from them although I could never be sure that some family wash was not in progress around a bend upstream. Usually while in Guanacaste I drank Apollinaris which, wonderful to relate, could be bought in almost every village; a large bottle furnishing two glassfuls, cost 60 centimos (=\$.30), a smaller bottle 30 centimos. This was expensive but at least safe.

The elevation of Santa Barbara is about the same as that of Santa Cruz and the ride from one place to the other took

an hour and a half, irrespective of direction. We left Santa Barbara at 5.30 P. M. and reached Santa Cruz at 7 when it was growing quite dark. The yellow twilight produced a beautiful color effect on the dry and burnt up grass of the hillsides.

On January 30, at the invitation of Padre Velasco, we accompanied him to the Rio de las Cañas. After some difficulty Professor Tristán secured a horse, through the druggist—a former pupil in the Liceo—and the Padre lent me the most comfortable mount I had in all Guanacaste. The Padre's little daughter Dora and Señor Rinaldo Jimenez, of Santa Cruz, completed the party of five.

We rode north from Santa Cruz along the Belen road but before reaching the Rio de las Cañas turned off to a private road to the left and went through woods to a clearing close to the river where the stumps of large trees were still standing. At a house here our horses were turned loose to graze and going to the river, we got into a dugout, which was a little too small for six, a boy from the house having been added to our party as a helper. The Rio de las Cañas was wider here than farther downstream (east) where we forded it on the Belen-Santa Cruz road, and contained several small islands. The banks were low and muddy with low twisted trees and small plants standing in the shallow water. The water-hyacinth (*Priaropus* or *Eichhornia*) of the Atlantic side was replaced here by a plant whose name was unknown to all of our party but which likewise becomes at times so abundant as to block up the stream. It may have been *Pistia stratiotes*, a variety of which increased enormously in Gatun Lake, Panama, a few years ago. Each plant consisted of a rosette of about half a dozen pale green leaves, lying on the water's surface; each leaf was now about four inches long, with a broadly rounded tip. I saw no flowers. As we paddled upstream many cirujanos walked or flew

over these plants of the river edge. In flight the long legs trail behind and their outspread wings, rich brown in the nearer, yellow in the farther half, are very pretty. Indeed this part of the river was a paradise of water birds and our objective point was one of the islands where several species build their nests in large numbers. As we approached this island many of the old birds rose in a cloud and flew to the opposite bank. The majority were the beautiful Roseate Spoonbill (*Ajaja ajaja*) which stand three feet high, with rose-colored plumes except on the middle of the wings and above the base of the tail where there are patches of glistening metallic crimson. The tip of the bill is widened, suggesting a spoon, whence the Costa Rican name of *espatula*.

Dora, Professor Tristán and I were landed on this island while the other three went to look for ducks. The island was perhaps a hundred feet long and not so wide, and only a few feet above the water level so that it is probably submerged in the wet season. Most of its surface was covered with gnarled, twisted, spiny-branched trees about fifteen feet high. In these trees the spoonbills and other birds had built their nests of sticks and twigs. The young of two species were in nests at this time—the “cuacu” or Night Heron (*Nyctanassa violacea*), occupying nests four to seven feet above the ground, and the spoonbill whose nests were six to twelve feet above the ground. The young spoonbills varied in age from those whose plumage was simply down of a very pale pink and the tip of the beak not widened, to those which in size and plumage approached the adults and were about ready to leave the nests. Indeed these latter frequently did leave the nests and crawled awkwardly out on the branches of the tree, but without attempting to fly, when we approached to within a few feet. From time to time the old birds returned singly to the island and then some movement on our part or a passing canoe startling

them, they rose and left the island in a cloud and crossed to the opposite bank or to a nearby smaller island where they alighted on the trees. A favorite tree on the latter gave us an excellent view of them, and it was curious to see the spoonbills as they all faced in the same way (south) and assumed the same position, remaining stationary and almost immovable for a half hour or so.

At almost every step we crushed beneath our feet the empty shells of fresh-water molluscs of which there were a great number on the island, suggesting that these snails formed part of the food of the birds. The shells were chiefly those of *Planorbis tenuis*, a species widely spread in Mexico.

On January 31 we took leave of those persons in Santa Cruz who had shown us particular attentions—Señor Bonilla, Padre Velasco and Señor Miguel Velasquez Rocha, inspector of schools, to whom we were indebted for permission to remain in the schoolhouse after the other members of the Commission had left Santa Cruz. The last-named showed us some rough maps which he had made for his own use in connection with his work as inspector. Maps of Costa Rica, such as that published by the Bureau of American Republics in Washington, 1903, Pittier's map of the same date and of 1912 and an older one carried by Señor Obregón, all contain numerous errors in Guanacaste. Rivers are shown on the wrong side of towns, or flowing in the wrong direction, relative distances between towns are incorrect, etc. Señor Velasquez' maps concerned only the immediate neighborhood of Santa Cruz but, made from personal knowledge, are more accurate than the published ones and gave us considerable information as to local names, stream courses and roads. Señor Villar, of the Commission, was making similar maps at Liberia, to include eventually all Guanacaste.

Señor Bonilla furnished us with three horses and a boy to bring them back and the three of us left Santa Cruz about nine o'clock going in a generally northeast direction to Bolsón, the road passing northwest of the Cerro Tamarindo and to the east of a ridge of hills separating this road from that taken the day before to the Rio de las Cañas. These ridges and also the isolated conical hills, both of which are numerous in this part of the country, were now pale brown and very dry and stood out in such sharp contrast against the blue sky that their extreme edges often looked as if they had been colored white. The road was almost level for the whole distance; much of the way ran through forests but passed very few houses. We saw a few cara blanca monkeys, but the chief object of interest was a pisote which walked rather leisurely across the road in front of us, unaware of our presence until looking around it spied us and quickened its pace. This pisote (probably *Nasua narica bullata*) was black and looked about two feet long exclusive of its black tail which was held fairly high and was apparently a little longer than the body. Its snout was prolonged into a tapering point to which fact the animal owes its technical name of *Nasua*. Its movements were so catlike than when I first caught sight of the body only I thought the creature was a black jaguar. Biolley, in his *Elementos de Historia Natural*, says the pisote is omnivorous, and Belt (*Naturalist in Nicaragua*) describes the methods of this animal in hunting iguanas and other lizards on trees. The pisotes are members of the raccoon family.

We reached Bolsón at 1.40 P. M. and went to the house of Señora Fonseca where we stayed all night. In the dining-room was a watermark five feet above the floor, showing the height to which the nearby rivers had risen in the preceding rainy season.

Bolsón was a poor town of scattered houses built in many

styles of wooden architecture. The plaza had been laid out on a generous scale but was a weedy and stony tract, although possessing a town well with a windmill above it built by the Aermotor Company of Chicago. There were some bare burnt hills to the south of the town from which the ground slopes to a muddy stream emptying into the Rio Bolsón. Señora Fonseca's nephew was the President of the local education board and showed us the boys' school, one of the best structures in the little village, although utterly lacking in decoration other than some large palm leaves inside, relics of the last fiestas. There was a small school library in which, as in the school library at Liberia, I noticed Spanish translations of several of Samuel Smiles' works and Baldwin's *Pedagogy*. Ninety-eight boys attended the Bolsón school in the year just finished. The girls' school was in a separate building a short distance away. Both schools were on the high south side of the plaza and were not reached by the inundations.

Bolsón lies on the south side of the Estero, or Rio, Bolsón, not north as some maps place it. This river is the continuation of the Rio de las Cañas after the latter has been joined by the Rio de las Palmas on its left (north) side. Bolsón was about one kilometer distant from the port where the Puntarenas steamboat called, the wharf lying opposite Puerto Ballena where we disembarked for Liberia on January 8. As the steamer was scheduled to leave at 9 A. M. on the following day we thought it prudent to spend the night at Bolsón rather than at Santa Cruz.

At daybreak, between five and six o'clock, the cocks as usual set up their tremendous crowing. Rarely have I heard them make such a din as here in Guanacaste. The morning of January 19 at Filadelfia will remain in my memory as possibly producing the greatest gallinaceous racket I have ever listened to, although some days at Santa

Cruz were not far behind. This day (February 1), however, in addition to the roosters, I could plainly hear from my bedroom some congo monkeys roaring in the nearby forest before sunrise.

Having taken coffee and provided ourselves with some lunch from Señora Fonseca and the Chinese store, we walked to the wharf. The steamboat "Castro" arrived late and it was ten instead of nine o'clock when she left. She was less crowded and more comfortable than her sister ship in which we came, but like her had only one deck; she might have been fifty feet long. She too was one of the "Vapores Correos de la Empresa de Transportes Maritimes del Golfo de Nicoya de Manuel Barahona y Compañía."

We steamed quickly down the Estero, where the forest reached to the water's edge, and into the Tempisque, attained and left Puerto Humo without sticking on any mud banks, called at Manzanillo at 4.30 P. M. and arrived at Puntarenas about eight. On the Tempisque some cara blanca monkeys watched us from a tree on the very river bank. Near the mouth of the river, the tide, which had been falling since we left Bolsón, had uncovered a long sand bank in mid-stream; on it I counted fourteen crocodiles, some of great size, others small, all looking like logs. Another bank farther down held a smaller number of these reptiles. In the Gulf of Nicoya we passed porpoises several times, and some islands where sea birds nest in numbers, which we did not see on the outbound trip because of the darkness. It was very hot while we stopped at Manzanillo, otherwise the weather on river and gulf was comfortable.

The voyage from Bolsón to Puntarenas ended our travels in Guanacaste. This province formerly belonged to Nicaragua but became a part of Costa Rica in 1820 under the Spanish colonial government. After the Costa Rican declaration of independence in November, 1821, the inhabitants

of Guanacaste including the peninsula of Nicoya voted to remain as part of Costa Rica and the Federal Congress of the then United Provinces of Central America confirmed this arrangement in 1825. Although Guanacaste has remained Costa Rican politically ever since, the province is said still to be more Nicaraguan than Costa Rican. Dr. Sapper states that botanically Guanacaste is like Nicaragua and northern Central America, while the rest of the Costa Rican flora bears a South American character.

Those features in which the inhabitants of Guanacaste resemble Nicaragua and differ from the rest of Costa Rica, so far as I could learn, are: their racial character, the Indian element being furnished by the Chorotega tribe not found east of the Cordillera de Tileran, while there are also many Zambos or the mixture of Chorotegas and African negroes originally brought here as slaves; many peculiar idioms not in use elsewhere in Costa Rica; a farm life of different character; the use of the marimba as a musical instrument; and certain peculiar dances such as the punto already mentioned.

It may be of some interest that after leaving Puntarenas for Guanacaste I saw no butter until I returned to Puntarenas. Costa Ricans generally do not use butter and when served in the hotels of the central part of the country it is chiefly for the use of foreigners. Absence of butter in Guanacaste, therefore, merely means that foreign (European or American) travel is still so slight that hotel keepers have not yet thought it necessary to supply that article. Native cheese was frequently served, however. It was more like cream or "cottage" cheese but, I believe, not boiled or scalded in the preparation. It was put on the table in solid blocks firm enough to be cut into thin slices with a knife.

With the exception of Sunday, January 16, at Hacienda

Guachipelín, we had no rain whatever in Guanacaste. Almost every day was sunshiny throughout, although the sky was by no means always cloudless. The nights were also clear, with brilliant starlight and moonlight, especially the full moon at Santa Cruz.

CHAPTER XXII

CARTHAGO DELETA EST

The central plateaus of Costa Rica, with their healthful and delightful climate, beautiful scenery, rich fertile soil and abundant and varied productions of grain, fruits, vegetables and cattle, are truly a Paradise on earth. But there was a serpent in man's first Paradise and there is one dark shadow over this lovely land,—the disastrous earthquakes that frequently visit it, particularly Cartago and its immediate vicinity.

The earliest earthquakes of which there are any records occurred in 1608, when the recorder (*síndico*) of Cartago complained that "the poor people lived in miserable huts without walls and with leaky roofs of rushes, and had no churches, because all had been broken and destroyed," and a little later are definite records of rebuilding and repairing houses and churches injured by the earthquakes. From 1608 until 1851 indeed, almost the only records of the earthquakes are not of the shocks themselves but of the houses destroyed or the repairs needed and consequently only the more violent shocks are mentioned. Thus in 1620, Cartago was dismantled (*desmantelada*) of houses, in 1637 and 1678 houses were damaged, in 1723, accompanying the eruption of Irazú, there were earthquakes injuring the houses, the destruction of the city being completed by the ashes and sand sifting over it. These records continue at intervals throughout the eighteenth century. On September 2, 1841, Cartago was completely destroyed by violent earthquakes, with a loss of sixteen lives, the total destruction of fifteen hundred houses with eight public buildings and churches,

while five hundred houses were so badly injured that they required removal later.

From 1851 to 1887, there is a series of records of the number of earthquakes during each year, made by personal observation only and without instruments. Most of these were noted in San José and in one year (1876) twenty-four were so recorded, but there is no mention of any particularly strong shocks in Cartago, although doubtless some shocks were felt there.

When the Observatorio Meteorológico Nacional, later the Instituto Físico-Geográfico, was founded in San José in 1888, two seismographs were installed in the Institute, so that from that year there are records both of strong shocks and weak tremblings of the earth. The number so recorded by the instruments in San José varies from thirty-seven in 1888 (including one disastrous shock in Alajuela and San José) to one hundred and eighty-two in 1906, but Cartago was freer from earthquakes than usual during all this period, and it appeared as if the region were becoming more stable. In 1909 the seismographs in San José recorded only four shocks.

We settled in Cartago on May 7, 1909, and experienced the first earthquake there on June 23 about 4 A. M. It was strong enough to waken us by the jerky motion it imparted to the beds but not to cause any particular alarm even among the Costa Ricans. On the fourth of November we felt one slight shock and on the twenty-fifth of the same month there were two. The next occurred on March 1, 1910, and this last, although we did not consider it alarming and remained at work in our room, caused the Costa Ricans to rush out into the street at the very first instant the tremor was felt.

On the thirteenth of April, 1910, while P. was away at Atenas, everyone in Cartago was aroused at 12.36 A. M. by a rather violent earthquake that shook us in our beds and

rumbled like a distant express train. It was decidedly unpleasant, but as we had had lighter earthquakes before and always found them over with one shock I lay still. Some time after there was a second, slight, shock. By this time the people were pouring into the streets and the women were screaming and working themselves into hysterics. This also I had heard and as my room opened directly on the street, at easy jumping distance, by means of an immense casement window, I had no real fear of being hemmed in and indeed thought it was all over. Things were calming down and I had almost fallen into a doze when we heard the roar coming again and at 1.15 there was a really terrific shock. The bed rocked, the walls shook to and fro and groaned, the wooden ceiling creaked, the windows rattled horribly and plaster and tiles began to fall. This time I did not dare to get up but buried my head under the pillow as some protection against tiles in case one should break through the wooden ceiling. As soon as the violent shock was over and one could stand, I rose and dressed after a fashion, standing by the window to be ready to jump if necessary. There were no more hard shocks before I left the room—in fact I was in and out many times gathering more garments—but an almost constant trembling, very disconcerting. With one exception every person in the hotel was out, a most extraordinary pajama and nightgown parade! One by one we slunk back for more clothes, carrying things to the patio or vestibule to put them on. In the streets wailing, shrieking women ran up and down, babies cried, dogs howled and barked and every cock in town crowed. But there was no real disorder. The police were everywhere and efficient; they pressed the horses in the livery stables into service and patrolled the streets well. Although the electric light poles rocked to and fro like drunken things the lights did not go out, which no doubt added greatly to the orderliness.

There were no fires for the good reason that there is almost nothing in these houses to burn and never any fires kept in the kitchens at night.

By degrees the Costa Rican families near us drew towards the Plaza and left us Americans near the hotel where we all preferred to remain. Fortunately the night was not exceptionally cold and was clear save for an occasional mist. At two o'clock came another violent shock. I do not know what caused the strange rumbling roar that preceded each hard shock—whether it was actually the rumbling of the shaken earth or of the walls as the wave motion struck one house after another, but the roar was present and was one of the most nerve-racking parts of the experience. Once out on the streets, in fact, we thought there was practically no danger from earthquakes here, as the houses were so low and the streets so wide that the risk from tiles or falling walls seemed almost nothing. Indoors, at least in the well-built houses, the chief danger appeared to be in falling plaster or in tiles that might conceivably be driven through the wooden ceilings. The natives pulled out mattresses and blankets and bunked more or less comfortably in the street. Some brought tables and made little sheltered beds for the children by pinning blankets around the table legs. We Americans from the hotel, a picturesque, blanket-draped tribe of Indians, walked up and down the street and as nothing more happened for nearly an hour some of us ventured to return to our rooms, but were quickly driven out again by another violent shock. After this warning we fetched out chairs and camped in the street and as the next four or five shocks were quite mild we fell asleep under the stars, until we began to slip back to our rooms about five o'clock.

In the morning, after coffee, we walked about the streets and were amazed that such earthquakes did so little damage, relatively. The tile roofs suffered terribly—looking through

our ceiling ventilator we could see the sky between the ribs of the roof. Plaster was cracked and in one room in the hotel a whole side fell. In the storeroom, in drug stores and crockery shops there was much breakage. A number of churches lost corners or minarets or images; one had the arches over the windows badly cracked and was no doubt much weakened. The new, still unfinished Peace Palace had one wall cracked and parts of the ornamental railing around the roof thrown down. Seventeen poorly built small houses were completely demolished as well as many outstanding walls and outbuildings. No one was killed or injured.

P. returned from Atenas on the evening of the thirteenth, reporting that the shocks were so slight there that he did not think it worth while to get up. As Atenas is only thirty miles away the extremely local character of these earthquakes is apparent.

In the twenty-four hours after the first shock, I counted thirty well-marked and distinct earthquakes, by "coffee" on the fourteenth, thirty-five. Between these were many little tremors whose beginning and end could not be felt. Earthquakes continued until we left for Juan Viñas on April 24, with gradually decreasing intensity and frequency. For five nights following the thirteenth we dared not undress, but took such rest as we could on mattresses on the floor and later on a bed in a patio covered with galvanized iron, which we all supposed safe. How little we knew!

After thirty-six hours of earthquakes the town was on the edge of hysteria. The wildest rumors circulated—Poás and Irazú were in eruption (though we could not see how anybody could believe that Irazú could be in eruption and no one in Cartago either see, hear or smell it)—the volcanoes in Chiriquí were in eruption—the tail of the comet (Halley's comet, which was visible about noon on the

thirteenth) had struck the earth—the end of the world was approaching—and so on. A large proportion of the population had moved outdoors and there was plenty of time and opportunity to distribute and embroider these legends. As it was also said that all wires were down, no one knew how the information had been received. It soon proved that wires were not down and that Cartago had suffered more than most places and when the full reports came in it appeared that the disturbance was localized in the central valleys. It was stated that both Poás and Irazú showed a slight but unmistakable column of steam, at 1.30 A. M. on the thirteenth, immediately after the third and most violent shock, which was credible enough. A “rosy glow in the sky” was also spoken of, but certainly there was no such glow visible to us.

On the morning of April 15 there was a tremendous outburst of bombs, ringing of bells and so on and a large religious procession passed through the streets, accompanied by a greater number of people than we saw following any of the Easter processions. This was a special service to implore the intercession of the saints and prevent the recurrence of earthquakes.

A more thorough examination of the town and the neighboring country showed that the damage was greater than we had at first thought. Few houses were actually thrown down, but many had lost much of their roofing and plaster or were so badly cracked that repairs seemed out of the question. Many families left their houses and camped nearby, in all sorts of temporary shelters. The Government shipped a number of army tents and quantities of canvas, but these were not sufficient, so that tents were constructed of old quilts, carpets, hides, sheets, blankets, boards, scraps of galvanized iron, boxes, coffee sacks—any and everything that could by any possibility be stretched or fastened to



Felipe Martin's Shop, "El Irazú," Cartago.
"El Irazú" after the Earthquake of May 4, 1910.



El Calle Real, Cartago, looking west.
El Calle Real on May 5, 1910.



The Church of San Francisco, Cartago.
San Francisco on May 5, 1910.



The Overturned Tower of Carmen Church, Cartago.
The Wrecked Schoolhouse next to Weldon's Hotel.

keep out wind. Many an ox-cart, with its tongue propped on a box, sheltered two layers of people—one below between the wheels, a second in the cart itself. In the poorer parts of Cartago were regular gypsy-like encampments, families cooking on improvised hearths of paving stones while the dogs skulked about trying to improve the opportunity by snatching at the cooking viands. The plazas were as full of carts and tents as they could be placed. The square containing the Peace Palace was surrounded by a thick wall about three feet high, topped with a low iron fence. This wall was a favorite place for the tents, which were built against it so that it formed one side. The big bandstand in the main plaza sheltered at least a dozen families; canvas enclosed it and the space within was partitioned off by quilts hung on ropes. Six of the guests at the hotel had a tent made and set up in this park, sleeping on benches or on mattresses laid on boards. They had plenty of company as there were many other tents close by, but as this canvas was not waterproof their tents were not very serviceable. The immediate fear of earthquakes having a little abated, thieving began and we heard the police shooting at thieves. There was no real disorder, however, and astonishingly little squabbling or crowding to get good places for tents. The most destitute families were supplied with food by the government.

The thirteenth, fourteenth and the morning of the fifteenth of April were clear with flying clouds. The afternoon of the fifteenth, however, was increasingly cloudy, hazy, sultry, and hot, with a strange, blinding glare and muttering thunder. The signs proved only too truthful and before five o'clock the dreaded rain began, light at first but soon settling into a steady hard downpour that lasted several hours, with a few intervals of mist. The effect of such a rain upon the shattered roofs may be imagined. In a very short time the water was pouring into our room in streams. Fortunately

the covered patio near our door, having a galvanized roof, was still dry, and we carried our trunks there, covered them and by hard work we kept specimens and clothing dry. In spite of bathtub, pails and pitchers the greater part of the floor of our room was soon like a lake until the water found its way through to the ground below. The rains caused much discomfort and suffering in the town for there were few roofs not leaking badly and many of the improvised tents afforded no protection against even a moderate shower. Workmen to set tiles were at a premium the following days and we considered ourselves very lucky to have our own particular leak repaired on the third day of the rains.

The constant succession of shakings seemed to have no bad effect on our menagerie and another *Mecistogaster* transformed successfully on the morning of April 18.

The accounts of great and serious changes in the crater of Irazú, with tales of eruptions, slides, yawning crevices and the like, together with the constant earthquakes, kept the town in a fever of apprehension. However on April 20 Professor Tristán accompanied by Sr. A. Rudin, made an official investigation of the craters. They found that the volcano was absolutely normal and quiescent, with no trace of any increased activity. Similar reports of new volcanoes opening on the hillside of Paraiso, with numerous hot springs, were equally unfounded.

From April 24 to May 1 we were both at Juan Viñas, A. returning alone to Cartago on May 1. When I looked about the town then I was impressed with the number of houses marked with yellow chalk or paint. All houses so marked had been condemned as unsafe by the board of government engineers who had examined every room in every house in Cartago. Our hotel had been pronounced quite safe. The poorer houses were constructed of adobe, or sun-dried, bricks alone, plastered inside and out. The better houses,

of which the hotel and a large house opposite, both built by the Troyo family, were excellent examples, had bamboo poles built into the walls. The bamboo served to bind the bricks together and greatly increased both the strength and elasticity of the structure. In our hotel some of the walls were fully three feet thick and two-foot walls were frequent. Some of the inner partitions, such as the one between our room and the next, were actually built of fire-burnt brick and the whole seemed exceedingly strong. No portion of it was marked by the engineers to be taken down or rebuilt, and indeed one of them asserted no earthquake could possibly throw down such buildings.

We had only felt a few slight shocks at Juan Viñas and when I returned to Cartago everyone seemed to think the worst was over, since the rains had begun and there was a steady decrease in both numbers and intensity of the quakes. Many people whose houses had not been badly injured had returned to them, although the squares and plazas and poorer streets were still full of tents and temporary shelters which were occupied by the refugees from condemned houses. This apparent improvement continued until the fourth of May, when we felt three shocks, at noon, at one and at four o'clock in the afternoon, sufficiently strong to bring people running into the streets again.

P. returned from Juan Viñas late in the afternoon of May 4 and after a delayed dinner we went to our room about six-thirty to read the letters which had accumulated during his absence. As we sat there, as close as possible to the single electric bulb, there came—without the slightest preliminary roar or faint shock—a most terrific earthquake. The lights went out instantly. Because we happened to face that way we rushed toward the door but it was impossible to stand. The motion was entirely up and down, not lateral, and we were thrown to the floor on hands and knees

at once and could only crouch and cower between the foot of the beds and the partition. The air was instantly filled with plaster dust and mortar, while the crash of falling walls and buildings was deafening. The shock seemed to last ten minutes (though the real duration was sixteen seconds). As soon as it had diminished enough for us to stand we made for our window, over piles of débris and the furniture that had been pushed out of place and found it possible to open shutters and sashes and in another minute we were safely in the street, having escaped without a scratch. How miraculous this escape was we did not realize until later, when we learned that the solid brick partition between our room and that adjoining had fallen entirely into our room across the very place where we had been sitting. The other partition was wooden and there was a board ceiling, so that we had, quite unconsciously, reached about the safest place possible.

We were among the first out, but the rest followed very quickly. Everyone who had or could get to a street window of course came out that way, but a number could not. The Weldon family, forced to come through passages, were slightly bruised by falling bricks. In a rear room, opening by its door on the main patio and by its window on the kitchen patio, were a young man, his wife and two-months-old baby. This room, when examined by the engineers and builders after the earthquakes of April 13, was said to have the strongest walls in the town—walls which it was practically impossible for any earthquake to shake. But with the first of this shock, the whole corner of this room with its two-foot walls fell in upon the beds. The baby had been laid down to sleep upon the bed, but as it was fretful the mother picked it up again and just had it in her arms when the crash came and the walls crushed the bed where the child was lying a moment before. By the help of one of the servants

who took the baby out through the window and then helped the parents out, they also escaped unhurt. Three other maids were imprisoned in the kitchen by the falling of the walls and it took an hour's work to liberate them. Unfortunately Mr. Weldon was hit across the back by a beam and was very sick all night. The boiler connections burst and flooded the kitchen fire, putting it out instantly, by great good fortune.

The streets were full of terror-stricken people, but it was remarkable that on this night, with infinitely greater cause, there was much less hysteria and excitement than on April 13. Everyone seemed stunned and crushed, and even from the wounded there was little screaming. Of the full extent of the catastrophe we were of course ignorant until morning. The streets were dark, there was no moon and too much cloud for the starlight to have any effect at all. We could see that all the shops opposite were demolished, we knew the whole interior of the hotel was absolutely wrecked, we could make out that a shop on the lower corner of our square, "El Irazú," was also in ruins, and as this was the best-built part of Cartago, with the thickest, strongest walls, we could imagine what the rest of the town must be like.

It soon began to mist and rain and be very cold. As our closet was immediately by the window, P. climbed into the room and brought our warmest wraps and blankets. Others did the same. Some knocked in the parlor windows and handed out couches and chairs. The big doors opening into a passage where firewood was stored were battered in, wood brought out and a fire built in the street. Owing to the lack of combustible material in these houses there was little danger of fire and although the police warned us to keep it low—which of course we would have done in any case—they made no further objection to it. On the contrary they came to it frequently during the night to warm

themselves or to get brands to light their torches or cigars. We sat about this fire until daylight. The young mother with her baby in her arms sat in the middle of a high-backed sofa, so that her husband on one side and A. on the other helped to keep her and the child warm. That we were successful was proved by the little creature's sleeping almost continuously, waking only to be nursed and when a sharper shock than usual made us all jump and so woke him suddenly. The ground trembled constantly and every now and then came a sharper shock, though none compared with the first in intensity. The night continued cold and windy and alternated between starlight with low clouds and light rains but fortunately we had no hard rain.

When we had opportunity to think about it, P. and I were very unhappy at the probability that all our collections were ruined and our year's work lost, particularly when some of the younger men who went through our room with lights told us the whole partition was down. Although we had climbed over the débris of this wall in our escape we had, in the darkness, no idea of what we were climbing over. We feared it had crushed the "instrument trunk" where specimens and notes were stored, for this trunk had been standing against the brick partition.

As the gray light of morning came we could see the desolation all about us and a heart-rending sight it was. Literally the whole town was in ruins. There were few places where so much of the walls and roof remained intact as in Weldon's Hotel and the house opposite. Almost everywhere else the walls crumpled in and the roof crashed through, leaving of the house nothing but a heap of shapeless ruins, often with only the faintest hint that it ever had been a house at all.

The churches were all in ruins. The façade of San Nicolas fell bodily into the church. The façade of San Francisco

was much broken and the roof and side walls crumbled to pieces. The Soledad suffered least, but its towers fell. The most extraordinary ruin was that of the Carmen church, where the whole top of one tower was broken squarely off and thrown upside down on the railroad track, where it remained as *one solid piece*, its four "feet" up in the air. This tower cap was fully ten feet on a side and somewhat higher and as it was not possible to remove it from the tracks without blasting it to bits, and the authorities feared the effects of the blast on the ruins while so many bodies remained unrecovered, it was necessary to build a switch around it to permit the passing of trains. The beautiful new Peace Palace, not quite finished, which was to have been dedicated in a few weeks, was levelled to the ground.

As soon as there was the faintest gleam of light parties of men with shovels and picks began to dig in every heap where there was reason to suppose people were still alive, though more often they found only corpses and all day long these were carried through the streets in heaps and cartloads. When the news reached San José on the night of the fourth, partly by messengers as the wires near Cartago were down, the President of the Republic, Don Cleto González-Viquez, started at once for Cartago with such doctors and supplies as could be gathered at short notice, traveling by rail as far as the train could run—there were fissures and cracks across the tracks—and walking the rest of the way. During the following day a number of soldiers arrived from San José, some with shovels, crowbars and pickaxes to dig out the wounded and dead, others with their guns and ball-cart-ridges to patrol the streets. In the two nights we were in the streets after the earthquake there was no disorder. The people were quiet, orderly, there was little thieving and no looting so far as we could see or hear and we heard no shooting.

With daylight we began to explore our room to determine the extent of the damage. The falling wall carried with it the tumbler shelf so that the larvæ, the rearings of many months, were all killed—with one extraordinary exception. A bottle of new *Cora* larvæ which P. brought with him the evening before from Juan Viñas—the rarest thing we had—was found on the floor, unbroken and with the larvæ alive! The preserved specimens were uninjured, likewise the notes and memoranda, negatives (which were fortunately all films) and drawings. We handed three trunks from our room out of the window in safety. Two others were in the iron-roofed patio where we slept (for greater safety!) after the earthquakes in April. Our bed there was crushed to scrap iron by the mass of bricks and tiles from the wrecked public school next to the hotel, which carried the galvanized iron roof with it. The two trunks were so buried under bricks and stone that there was no getting at them without a crowbar and shovel, but later we found a man to dig them out. One was so crushed and broken that it could not be used again, and a pretty Indian dish from a grave on Irazú, which it contained, was broken to bits but otherwise its contents were uninjured, including our journal. We packed up in the street as well as we could, discarding many things and handing many clothes to passers-by who were obviously in need of them. There were many astonishing things in our room. The bureau, which had stood against the wall, was simply pushed into the middle of the room and there was no trouble in opening the drawers. Little boxes of specimens on the table were uninjured and even one envelope pinned up to the tape holding the electric light back in place was safe. P.'s tin collecting case, which had been standing on the instrument trunk, was perched on top of the mass of bricks and rubbish, unscratched.

The chickens in the rear patio were still alive and some



The Central American Court of Justice, Cartago, after May 4, 1910.



The Panteón, Cartago.

A Fragment of Pottery from the Indian Grave near Santa Barbara de Santa Cruz, about actual size.

were fetched out, killed, plucked and cooked over the street fire which was kept going all the time. One of the maids, a Jamaican, seemed absolutely indifferent to the risk of falling walls and made trip after trip to the kitchen and storeroom. She stayed with us all day and promised to come on succeeding days. Of course she obtained food for herself and her little son by so doing, but there were few servants who stayed for any consideration. She made us coffee, cooked and helped pack and was invaluable. During the late morning two men from the hotel, who had been away hunting, rode in with a deer, half of which was given to the Weldon party. Faithful Emily made it into a venison stew, in which many beside the hotel group participated.

After the packing, three iron bedsteads with their springs and mattresses were passed out through the windows and set up in the street. Upright boards were fastened to head and foot, and others across these, and the structures so formed were covered with pieces of galvanized iron from the wrecked roofs lying inside the hotel. More iron, quilts and other odds and ends made sides. Small baggage and our two trunks containing specimens were run under the beds to be kept dry, other trunks were piled along the sides and boards laid against them. This kept all our salvage safe from thieves, who had begun to appear. It rained at intervals all day, but lightly, so that packing was little interfered with, and all day there were almost constant earthquake shocks and trembles of varying intensity.

In the meantime, railroad communication with San José had been restored and we were delighted to have a visit from Professor Tristán, who had come to see how some of his relatives and we had fared. He was astounded when he saw the condition of our room. This visit gave us the opportunity to take leave in person of the one who did most and so much to make our year in Costa Rica

successful. May we meet again under happier surroundings!

Late in the day, work had begun on the construction of the track around the fallen tower of Carmen church. The up-train from Limón arrived as far as this tower and some of the guests from Weldon's went aboard and stayed there all night, the train eventually making its way to San José when the siding was completed. As it grew dark we threw ourselves, wrapped in blankets, across the covered beds in the street and slept, though brokenly, through the night; there was hardly any rain.

About 10.30 on the morning of May 6 the train for Limón arrived and, finally settled in the chair car, we took our farewell view of Cartago, just a year to the day of the week since we came to make our headquarters at Weldon's. How different the scene! As we moved eastward from the station we passed through a part of the town containing less substantial houses and, looking down some of the streets, one could not see a single house standing on either side for their whole length. Instead were heaps of adobe bricks, roof beams, bamboo frames, tiles and sometimes galvanized iron roofs mixed together indiscriminately, while streets and patios had makeshift shelters of most varied construction around which stood groups of survivors watching the passing train. It was a most sorrowful and distressing sight, especially to those who like ourselves had lived here for months and come to have an affection for the town and its beautiful surroundings.

The village of Paraiso was not near enough to the tracks to enable us to see how extensive the damage was there. But the great single tower of the church, which had been a landmark visible for miles around, was gone and we could see that the east end of the church had also collapsed. East of Paraiso we saw little evidence of the work of the earth-

quake, as the houses near the track were of wood and wooden buildings, including the few in Cartago of that material, suffered very little or not at all.

The early reports of the number killed, as given for example in the *National Geographic Magazine* for June, 1910, stated that over six hundred bodies had been taken from the ruins of Cartago and a hundred and twenty more from Paraiso. Fortunately this seems to have been an exaggeration. The official report in *La Gaceta* for October 29, 1910, accepted by Don Cleto González-Viquez, gives the total number of killed in the two places as two hundred and seventy-two.

* * * * *

To a country of the size and population of Costa Rica, the total destruction of a prosperous and flourishing city, the second in importance in the republic, might have been considered an overwhelming misfortune. But the spirit of the Costa Ricans was undaunted. "Let us reconstruct Cartago!" was at once the cry, and reconstruction did begin immediately. For ourselves,—in spite of its sorrowful conclusion, our Costa Rican year was the best we have lived and our most cherished dream is of returning to the Enchanted Land.

APPENDIX I

AUTHORS' ITINERARY WITH NOTES ON WEATHER IN PLACES OTHER THAN CARTAGO

April 17, 1909-May 17, 1910

April	17.	Left New York.
"	22.	Great Inagua.
"	23.	Cape Hayti.
"	24.	Port au Prince.
"	26.	Kingston, Ja.
"	28.	Colon, C. Z.
"	30.	Greytown, Nic.
May	1.	Landed at Limón, C. R.
"	1-3.	Limón.
"	3-7.	San José.
"	7-15.	Cartago.
"	16.	" A.; San José and La Verbena, P., rain in p. m.
"	17-19.	"
"	20.	" " Agua Caliente and south, P.
"	21.	" " Juan Viñas, P.
"	22-31.	" P. to Tierra Blanca May 30.
June	1.	" A., Guápiles, P. (shower at La Junta).
"	2.	" " " " rain after 2 p. m.
"	3.	" " " "
"	4.	" " " " rain after 2 p. m.
"	5.	" " " " " " 3 p. m.
"	6.	" " Guácimo, P. no rain.
"	7.	" " " " showers in p. m.
"	8.	" " " " and return, P., rain from 6.30 a. m., continuing to Turrialba.
"	9-22.	" June 20 to "Laguna Icorres."
"	23.	Juan Viñas, rain 3.00-4.30 p. m.
"	24.	" " clear.
"	25.	" " "

June	26.	Juan Viñas,	clear until light rains about 5.30 p. m.
"	27.	" "	cloudy, light rain after 5 p. m.
"	28.	" "	cloud at times, rain after 6 p. m., hard at night.
"	29.	" "	rain after 6 p. m.
"	30.	" "	and Cartago.
July	1-11.	Cartago;	to Laguna Icorres July 6, El Alto July 7, Tierra Blanca July 10.
"	12.	Cartago, A.;	Tierra Blanca, P.
"	13.	" "	" " and Sabanilla, P.
"	14.	" "	" " " Cot, P.
"	15.	" "	" " " Irazú, P.
"	16-20.	"	"
"	21.	Juan Viñas,	rain all day.
"	22.	" "	" " after 3 p. m.
"	23.	" "	" " 4 p. m.
"	24.	Cartago, A.;	Turrialba, P.; no rain.
"	25.	" "	" " heavy rain after 2.30 p. m.
"	26.	" "	" " " " " " 3 p. m.
"	27.	Juan Viñas.	
"	28.	" "	no rain.
"	29.	" "	rain before 9 a. m., after 3.30 p. m.
"	30.	" "	rain at night.
"	31.	" "	little rain until 6 p. m., heavy.
Aug.	1.	" "	light showers during night.
"	2.	" "	hard rain after 4.30 p. m.
"	3.	" "	and Cartago; cloud all day, light rains up to 8 a. m. and at times during day.
"	4-6.	Cartago.	
"	7.	" A.;	Peralta, P.; rain after 2.30 p. m.
"	8.	" "	" " " " 3 p. m.
"	9.	" "	" " " 2.15-3.30 and after 6 p. m.
"	10.	" "	" and Cartago, P.; rain Tucurrique to Cartago.
"	11.	Cartago.	
"	12.	Cartago, A.,	Cartago and San José, P.
"	13.	" "	Turrúcares, P., rain after 2.30 p. m.
"	14.	" "	" " " " 3 p. m.
"	15.	" "	" " no rain.
"	16.	" "	" " " " until 6 p. m.

- Aug. 17. Cartago and San José.
 " 18-24. "
 " 21, 25. " and San Isidro del Tejar.
 " 26-31. "
- Sept. 1. To Alajuela, rain in p. m.
 " 2. Alajuela, light showers in p. m.
 " 3. "
 " 4. " rain after 3.30 p. m.
 " 5. " shower at 2 p. m.
 " 6. " heavy rain after 3 p. m.
 " 7. " P. to "El Cerro"; showers 1.30-3 p. m.
 " 8. " rain after 4 p. m.
 " 9. " " " 3 p. m.
 " 10. " A., Cartago, P.
 " 11. " " " "
 " 12. " " " "
 " 13. " " " and Alajuela, P.; rain after 3 p. m.
 " 14. " rain after 5 p. m.
 " 15. " no rain.
 " 16. " and Cartago.
 " 17-21. Cartago; San Isidro del Tejar on Sept. 20.
 " 22. " and Jimenez Lecheria, rain 1-4 p. m.
 " 23. Irazú and Cartago, rain on Irazú after 12 m.
 " 24. Cartago.
 " 25. " Ochomogo, P.
 " 26-27. "
 " 28. Juan Viñas, rain from 2 p. m.
 " 29. " " no rain.
 " 30. " " showers 10-10.30 a. m. and after 4 p. m.
- Oct. 1. " "
 " 2. " " and Turrialba, rain at T. after 1.45 p. m.
 " 3. Cartago, A., Juan Viñas, P., heavy rain 5-9 p. m.
 " 4. " " " " " rain 2-2.30 p. m., and after
 6 p. m.
 " 5. Cartago, A., Juan Viñas, P., cloud and showers until noon,
 bright sun in afternoon.
 " 6-8. Cartago, A.
 " 9. " and Cot.
 " 10-13. " P. to Paraiso Oct. 11.

- Oct. 14. Cartago and San José.
 " 15. To Orotina and Bonnefil Farm, Surubres; rain from 3.30 p. m.
 " 16. Bonnefil Farm, no rain until 6 p. m.
 " 17. " " rain at 1.20 p. m.
 " 18. " " " 2.30-8 p. m.
 " 19. " " " 5-10 p. m., very light showers earlier.
 " 20. " " " from 3.30 p. m.
 " 21. " " showers during afternoon.
 " 22. To Orotina, rain from 10 a. m., all day.
 " 23. " San José, light showers, bright sun much of day.
 " 24. San José and Cartago.
 " 25-Nov. 2. Cartago, A. to Orosi Oct. 26
- Nov. 3. " A.; P. to Limón.
 " 4. " " Phila. South Farm, P., short shower 5 p. m.
 " 5. " " " " " " cloudy, high wind, light rain in evening.
 " 6. Cartago, A.; Phila. South Farm, P., cloudy after 3 p. m., light showers after dark.
 " 7. Cartago, A.; Phila. South Farm, P., no rain, cloudy after 2 p. m.
 " 8. Cartago, A.; Phila. South Farm, P., heavy rain and high wind at night.
 " 9. Cartago, A.; Phila. South Farm, P., no rain, bright nearly all day.
 " 10. Cartago, A.; Phila. South Farm, P., rain from dark to 9.30 p. m.
 " 11. Cartago, A., to Cartago, P.
 " 12-14. " "
 " 15. To La Emilia, rain Peralta to La Junta.
 " 16. La Emilia, light showers after dark.
 " 17. " " heavy rain 2-4 a. m., showers all day.
 " 18. " " rain after 1 p. m.
 " 19. " " showers all day.
 " 20. To Cartago, showers at Santiago.
 " 21-Dec. 1. Cartago.
- Dec. 2. Cartago, A.; Juan Viñas, P.
 " 3-6. " P. to Carpintera Dec. 4.
 " 7. " and Alajuela, mostly clear, light showers in p. m.

- Dec. 8. Alajuela, no rain, mostly clear.
 " 9. " and Santa Barbara, A.; mostly clear, rain after
 9 p. m.
 " 10. Alajuela and Cartago.
 " 11-16. Cartago.
 " 17. " A.; Juan Viñas, P., clear, bright and hot.
 " 18. " " San José, P.
 " 19. " " Turrúcares, P., clear and warm.
 " 20. " " " " " exc. light cloud 5 p. m.
 " 21. " " " and Atenas, P., clear.
 " 22. " " " P., clear and hot.
 " 23. " " " " " " " warm.
 " 24-Jan. 4. Cartago.
- Jan. 5. " A., San José, P.
 " 6. " " to Esparta, P.
 " 7. " " " Puntarenas, P.
 " 8. Alajuela, A., to Puerto Ballena and Filadelfia, P.
 " 9. " " " Liberia, P.
 " 10. " " " " cloud in a. m.
 " 11. " " " "
 " 12. " " " "
 " 13. " " " "
 " 14. " " " and Hacienda Guachipelín, P.
 " 15. " " Hacienda Guachipelín, P.
 " 16. " " " " showers, high winds.
 " 17. Cartago, A., to Liberia, P.
 " 18. " " " Filadelfia, P.
 " 19. To Alajuela, A., to Santa Cruz, P.
 " 20. Alajuela, A., Santa Cruz, P.
 " 21. " " " " "
 " 22. " and Carrizal, A., Santa Cruz, P.
 " 23. " A., Santa Cruz, P.
 " 24. " " " " "
 " 25. " " " " "
 " 26. " and Poás, A., Santa Cruz, P. Temp. at S. C. 19° C.
 (= 66.2 F.) at 7 a. m.; 31° C. (= 87.8° F.) at 4 p. m.
 " 27. Poás and Alajuela, A., Santa Cruz, P.
 " 28. Alajuela, A., Santa Cruz, P.
 " 29. Cartago, " " " "

- Jan. 30. Cartago, A., Santa Cruz and Rio de las Cañas, P.
 “ 31. Alajuela, “ to Bolsón, P.
- Feb. 1. “ “ “ Puntarenas, P.
 “ 2. “ “ “ Esparta, P.
 “ 3. “ “ “ Cartago, P.
 “ 4. “ “ “ Alajuela, P.
 “ 5-6. “
 “ 7. “ A., to Cartago, P.
 “ 8-13. Cartago; Jocosal, Feb. 11.
 “ 14. “ A., Juan Viñas, P.; rain early morning and early
 afternoon and after 7 p. m., sun 3-6 p. m.
 “ 15. Juan Viñas, rain early morning, sun and cloud rest of day,
 bright moonlight.
 “ 16. Juan Viñas, no rain, mist and cloud in early morning, sun-
 shine most of day.
 “ 17. Juan Viñas, light rain before 8 a. m., then sun and cloud.
 “ 18. “ “ no rain, sun and cloud.
 “ 19-24. Cartago.
 “ 25. San José.
 “ 26. Heredia, Quebrada Seca; bright sun.
 “ 27. San José and Cartago.
 “ 28. Cartago, Jocosal and Navarro.
- Mar. 1-2. “
 “ 3. To Cachí, clear to 1.30 p. m., then cloudy and showery.
 “ 4. Cachí, “Susanland,” Rio Reventazón; no rain, some sun.
 “ 5. “ Rio Reventazón; no rain, much sun.
 “ 6. “ Orosi Falls; cloudy, showers.
 “ 7. “ Rio Reventazón; clear most of day.
 “ 8. “ Peña Blanca; clear a. m., cloud p. m.
 “ 9. “ valley of Naranjo.
 “ 10. To Cartago; clear.
 “ 11. Cartago.
 “ 12. “ Alajuela and return; clear.
 “ 13. “
 “ 14. “ Dulce Nombre, Las Concavas and Navarro.
 “ 15. “ Llano Grande.
 “ 16-18. “ Tres Rios and Carpintera on Mar. 17.
 “ 19. “ A., Juan Viñas, P., sun and cloud in afternoon,
 mist 8 p. m.

- Mar. 20. Cartago, A., Juan Viñas, P., cloud and sun.
 " 21. " " " " " fair.
 " 22. " " " " " clear until 3 p. m., light rains
 about 3.30 p. m.
 " 23. Cartago, A., Peralta, P., rain after 4 p. m. and at night.
 " 24. " " " " " " " " " " " "
 " 25. " " " " " " 7 " " " " "
 " 26. " " to Juan Viñas, P., rain after dark.
 " 27. " " " Cartago, P.
 " 28. " " " Alajuela, P.
 " 29. " " " Cartago, P.
 " 30. "
 " 31. To Irazú crater, clear until 1 p. m., after 5 p. m.
- April 1. Irazú, fair until 10.30, mist and rain rest of day.
 " 2. To Cartago, mist and rain on crater.
 " 3-7. Cartago, P. to Tierra Blanca April 6.
 " 8. " A., Atenas, P., clear.
 " 9. " " and Turrúcares, P., clear.
 " 10. " " " " " "
 " 11. " and San Isidro del Tejar, A., Atenas and Rio
 Tizate, P., clear except short time in p. m.
 " 12. Cartago, Jocosal and Navarro, A., Atenas and Cebadilla, P.
 clear.
 " 13. Cartago, A., to Cartago, P.
 " 14-19. " ; P. to San Isidro del Tejar, April 18, light rain.
 " 20. " and Paraiso, P.
 " 21-23. "
 " 24. Juan Viñas, cloudy, rain after 5 p. m.
 " 25. " " hard showers, rain or mist nearly all day.
 " 26. " " occasional sunshine, mostly cloudy.
 " 27. " " cloud and mist, rain at night.
 " 28. " " cloud and mist, little sun.
 " 29. " " cloudy, at times dense mist or light rain, no
 sunshine.
 " 30. " " sunshine in a. m., cloud after 1.30 p.m.; to
 Cartago, A.
- May 1. Cartago, A., Juan Viñas, P., sunny until 1.30 p. m.
 " 2. " " " " " cloud and sun, light showers
 after 3.30 p. m.

- May 3. Cartago, A., Juan Viñas, P., cloud and sun, rain 4-8 p. m.
“ 4. “ “ “ “ “ and Cartago, P., sunny until
3.30 p. m. (Cartago destroyed by earthquake).
“ 5. Cartago.
“ 6. To Limón, showers beyond Turrialba.
“ 7. Limón, mostly clear.
“ 8. “
“ 9. Left Limón.
“ 10. Colon, C. Z.
“ 12. Kingston, Ja.
“ 17. New York.

APPENDIX II

CARTAGO WEATHER RECORDS, MAY 8, 1909—MAY 5, 1910

Our temperature records at Cartago were obtained from a self-registering, mercurial, combined maximum and minimum thermometer, without any maker's name attached, bearing the legend "Made in Germany" on its wooden support. The instrument was kept on the outer surface of a solid wooden shutter inside of the glass casement window sashes. The pane of glass immediately opposite the thermometer had been removed and its place occupied by a fine metallic wire netting. The window faced the east. In line with it, at the opposite end of the room, was a door communicating with a patio; over the door was a transom, always open, although covered with mosquito netting. There was therefore a more or less continuously circulating current of air through the room and over the thermometer. The shutter to which the thermometer was attached was usually opened into the room. The instrument rarely, if ever, was exposed to the direct rays of the sun.

Thanks to the officials of the U. S. Weather Bureau at Philadelphia our instrument was compared with standard maximum and minimum thermometers for seven consecutive days in May, 1910, with the following results:

Our Thermometer		Standard	
Max.	Min.	Max.	Min.
62.8 F.	54.9 F.	63.0 F.	55.1 F.
77.0 F.	59.0 F.	77.2 F.	61.0 F.
70.4 F.	58.8 F.	70.5 F.	58.6 F.
75.0 F.	56.8 F.	75.1 F.	56.9 F.
57.5 F.	55.4 F.	57.7 F.	55.6 F.
60.3 F.	55.2 F.	59.9 F.	56.0 F.
58.4 F.	54.3 F.	58.1 F.	54.2 F.

- May 8. Rain from 4.30 p. m., at times heavy.
" 9. Rain, 10.30 a. m., 2.30 p. m. and later, sometimes heavy.

- May 10. Rain about 2 p. m., light; 8 p. m., heavy.
 " 11. Light rain about 5 p. m.
 " 12. Steady rain beginning 5 p. m.
 " 13. No rain.
 " 14. Rain began 3.30 p. m.
 " 15. No rain.
 " 16. " "
 " 17. " "
 " 18. " "
 " 19. " "
 " 20. " " at Cartago but fairly hard showers on south bank
 of Rio Agua Caliente.
 " 21. Light showers 4.30-5.00 p. m.
 " 22. Rain 3-9 p. m.
 " 23. " 2.10-4.30 p. m.
 " 24. No rain.
 " 25. Light showers after 3 p. m.
 " 26. Fine misty rain 11 a. m.-3 p. m., cloud all day except for
 one hour's sunshine.
 " 27. Little sunshine, cloud most of day, rain after 6 p. m.
 " 28. Morning sunny; rain after 2.30 p. m. at times hard.
 " 29. " " rain after noon.
 " 30. Heavy clouds 3 p. m., rain and mist after 6 p. m.
 " 31. Pale sunshine in morning, showers after 1.30 p. m.
- June 9. Light shower about 6 p. m.
 " 10. Rain and mist after 5.30 p. m.
 " 11. Morning bright, showers after 3 p. m.
 " 12. Rain, often hard, thunder and lightning after 3 p. m.
 " 13. No rain.
 " 14. " " (Irazú clear until 6.15 p. m.).
 " 15. " sunshine, heavy clouds, rain 9.30 a. m.-3 p. m.
 " 16. Bright most of day.
 " 17.
 " 18. Bright most of day.
 " 19. Rain about 5 p. m.
 " 20. " beginning 2 p. m.
 " 21. No sunshine, showers from 7.30 a. m.
 " 22. Cloudy all day, little rain.
 " 30. Rain 6-7 p. m.

Date	Time of Reading	Temp. at Reading	Max. Temp.	Min. Temp.	Rain	
July	1	8.30 p. m.	68	76	66	
"	2	7.30 p. m.	65		65	None.
"	3	7.30 p. m.	65	77	62	3-4 p. m., hard at times; slight shower, 7.45 p. m.
"	4	6.15 p. m.	68	71	62	None.
"	5	6.00 p. m.	65	74	63	4.30-
"	6	6.00 p. m.	63	74	61	None.
"	7	6.00 p. m.	64	69	61	Showers 12-3 p. m.
"	8	6.00 p. m.	65	71	58	Showers 11-12 a. m.
"	9	7.10 p. m.	65	74	58	Light showers 7-8 p. m.
"	10	6.00 p. m.	69	78	62	None.
"	11	6.00 p. m.	70	73	62.5	Showers 6.30-9 a. m. and after 9 p. m.
"	12	6.00 p. m.	64	76	61	After 3.00 p. m., often hard.
"	13	5.45 p. m.	63	70	61	12.30-8.30, hard and steady.
"	14	6.00 p. m.	63	68	58	12-3.15 p. m.
"	15	6.00 p. m.	66	75	59	None.
"	16	10.00 p. m.	63	72	61	None.
"	17	6.00 p. m.	63	69	62	6.30-10 p. m. +
"	18	6.00 p. m.	69	74	60	
"	19	6.00 p. m.	69	75	61	
"	20	6.15 p. m.	63	70	61	11 a. m.-3 p. m.
Aug.	4	6.00 p. m.	64	74	63	After 3 p. m.
"	5	6.00 p. m.	67	75	61	
"	6	6.00 p. m.	66.5	76	61	Light showers in p. m.
"	7	6.00 p. m.	66.5	78	63	3-4.30
"	8	9.00 p. m.	66	75	63	3-4
"	9	6.15 p. m.	67	74	62	Light and heavy, very heavy during night.
"	10	6.00 p. m.	65	73	64	3-
"	11	6.00 p. m.	67	74	61	3-5 p. m.
"	12	8.00 p. m.	65	76	62	3-5 p. m., very hard after 7.

Date	Time of Reading	Temp. at Reading	Max. Temp.	Min. Temp.	Rain	
Aug.	13	6.00 p. m.	62	75	62	11 a. m.-9 p. m., very heavy.
"	14	6.00 p. m.	66	72	58	3-5 light.
"	15	6.00 p. m.	68	76	62	3-4.30 light.
"	16	6.00 p. m.	68	76	61	3.30-4 p. m.
"	17	6.20 p. m.	67	75	61	In p. m.
"	18	5.30 p. m.	68	75	63	1.30-9 p. m.
"	19	6.00 p. m.	67	74	62	2-6 p. m.
"	20	6.00 p. m.	67	75	63	2.30-9 p. m.
"	21	6.00 p. m.	68	75	65	7-10 p. m.
"	22	6.00 p. m.	68	74	63	Light, after 6 p. m.
"	23	6.00 p. m.	67	77	65	4-9 p. m.
"	24	5.30 ¹	65	79	64	3-10 p. m.
"	25	5.45	67	73	64	3.30-
"	26	6.00	63	76	63	3-9 p. m.
"	27	6.00	67	76.5	62	3-4 p. m., light.
"	28	6.00	69	78	64	6.30-10 p. m., thunder and lightning.
"	29	6.00	67	75	63	4.30-
"	30	6.00	67	76	64	None.
"	31	6.00	66	73	65	2-3 p. m., light.
Sept.	11					4-7 p. m., heavy.
"	12					4-8 p. m.
"	18	6.10	71	78	65	4-5 p. m.
"	19	6.00	70	77	65	None.
"	20	6.00	70	76	66	Showers, 7-8 p. m.
"	21	6.00	69	76	65	None.
"	22, 23	6.00	68	78	62	After 2 p. m. on 23d.
"	24	6.00	68	75	64	1-2; 6-10 p. m., heavy rains in night.
"	25	7.00	69	76	63	1-2 p. m., light.
"	26	6.00	69	78	63	4 p. m., all night
"	27	6.00	68	72	65	until 8 a. m.; 11 a. m.-
Oct.	3					1 p. m.-
"	4	6.00	66	72	61	10-11 a. m.; 12-6 p. m.

¹ From this date on all the hours given for time of reading are p. m.

Date	Time of Reading	Temp. at Reading	Max. Temp.	Min. Temp.	Rain	
Oct.	5	6.00 p. m.	67	72	63	Light in a. m.; p. m.—
"	6	6.00	67	74	63	After 12 noon.
"	7	6.10	65	74	63	11.30, at intervals during afternoon, heavy 5.15-8. +
"	8	6.00	67	74	62	Showers after 2 p. m.
"	9	6.00	68	75	64	Showers after 1.30 p. m.
"	10	6.00	68	75	64	Showers after 3 p. m.
"	11	6.00	68	74	64	Showers after 1.30 p. m.
"	12	6.00	65	76	64	Light showers.
"	13	6.00	66	73	61	None; sunshine nearly all day.
"	14-24	6.10	70	78	58	Very light showers at 6 p. m. on Oct. 24.
"	25	5.30	69	79	65	Very light shower.
"	26	6.00	66	76	64	Showers 4-6 p. m.
"	27	6.00	65	73	64	Light showers 3-4 p. m.
"	28	6.00	65	75	63	4 p. m.
"	29	6.00	68	73	65	12-1 p. m.; 3-10 p. m. +
"	30	6.00	66	71	64	3-6 p. m.; 7-9 p. m. light.
"	31	6.00	66	75	64	3 p. m.—; excessively heavy for 1½ hours
Nov.	1	6.00	66	74	64	12-
"	2	6.00	64	73	62	1-3.30 p. m. in light showers.
"	3	6.00	65	72	62	6-9 a. m.
"	4	6.00	63	72	62	4-7 p. m. light showers.
"	5	6.00	63	73	61	12-3 p. m.
"	6	6.00	65	72	61	2-7 p. m.
"	7	6.00	65	75	62	2-3 p. m. light.
"	8	6.00	65	73	63	12-1, 4-9 p. m.
"	9	6.00	68	76	62	After 7 p. m.

Date	Time of Reading	Temp. at Reading	Max. Temp.	Min. Temp.	Rain
Nov. 10	6.00 p. m.	68	76	64	Until 9 a. m.; 4 p. m.-
" 11	6.00	63	70	63	In early morning.
" 12	6.00	64	71	61	" " "
" 13	6.00	62	70	59	6-
" 14	8.30	61	71	59	
" 15-20	6.00	59	71	56	Rain on Nov. 20
" 21	6.00	65	74	58	2-7 p. m.
" 22	6.00	66	74	63	2 p. m., light showers.
" 23	6.00	61	68	61	Until 8 a. m.; 12 p. m.-
" 24	6.00	60	64	60	At intervals all day.
" 25	6.00	61	66	59	All day except between 2 and 4 p. m.
" 26	6.00	61	64	58	All day.
" 27	6.00	62	65	58	" "
" 28	6.00	59	63	58	" "
" 29	6.00	60	68	56	Clear 8 a. m.-4 p. m., rain 4-6 p. m.
" 30	6.00	60	64	57	At intervals all day.
Dec. 1	6.00	58	65	55	Until 9 a. m.; fog and cloud all day.
" 2	6.00	60	68	57	Cloud and mist until 11 a. m.; clear until 4 p. m.
" 3	6.00	60	68	57	Cloud until 10 a. m.; clear from 10 a. m. until 5 p. m.
" 4	6.00	58.5	69	53	Clear all day.
" 5	6.00	62	70	55	" " "
" 6	6.00	61	74	56	" until 4 p. m., rain 30 min.
" 7-10	7	61	69	55	Rain Dec. 10 after 7 p. m.
" 11	6.00	62	64	59	Rain and cloud all day.
" 12	6.30	62	67	58	After 3 cloud and mist.

Date	Time of Reading	Temp. at Reading	Max. Temp.	Min. Temp.	Rain
Dec. 13	5.45 p. m.	63	66	58	Cloud and mist all day.
" 14	6.00	61	69	57	Clear all day.
" 15	6.00	61	67	57	None—partly cloudy to clear.
" 16	6.00	60	69	55	None—partly cloudy clear after 8.30 p. m.
" 17	6.00	60	68	54	None.
" 18	6.00	60	70	55	" mostly clear.
" 19	6.00	65	74	56	Clear.
" 20	6.00	66	72	62	"
" 21	6.30	63	72	58	None.
" 22	6.00	64	75	59	Clear; rain after 7.30 p. m.
" 23	5.30	59	68	57	Clear 8.30 a. m.—3 p. m.; rain and mist.
" 24	6.00	59	66	56	Cloud and mist until noon, clear.
" 25	6.00	62	69	55	Light rain and mist to 12; after noon clear.
" 26	5.30	58	62	58	Mist, drizzle and high east wind all day.
" 27	6.00	58	64	57	Mist, drizzle until 2 p. m.; then some sunshine.
" 28	6.45	62	69	56	Cloud and sun until 4 p. m., then rain.
" 29	6.00	60	63	59	All day.
" 30	6.00	59	61	54	" "
" 31	5.30	57	60	54.5	" "
Jan. 1	5.30	58	61	55	Rain or mist all day.
" 2	6.00	59	62	56	Until 5—clearing.
" 3	6.15	58	67	58	Clear.
" 4	6.00	61	68	53	Clear—some showers.

Date	Time of Reading	Temp. at Reading	Max. Temp.	Min. Temp.	Rain
Jan. 5	7.00 p. m.	60	68	57	In a. m., clear in middle of day.
" 6	6.00	60	72	57	Before 9 a. m.; clear 9 a. m.-3 p. m.; then rain.
" 7-17	5.30	60	68	53	Jan. 17 clear until 3 p. m., rain after 4 and all night.
" 18	5.40	59	68	56	Clear 9 a. m.-3 p. m.; showers.
" 19-29	5.45	60	72	51	Clear.
" 30	8.00	58	72	52	
" 31					
Feb. 3	10.00	56	70	56	After 7 p. m. on Feb. 8.
" 4-8	6.00	62	70	53	
" 9	6.00	60	68	57	In early morning; late afternoon and night.
" 10	6.00	62	69	57	Slight showers in morning.
" 11	5.45	64	70	56	Clear.
" 12	6.00	58	69	57	" most of day; rain in late afternoon.
" 13	5.45	60	68	55	Clear until 6 p. m., then rain.
" 14	6.00	60	63	55	Until 3 p. m., often hard.
" 15					In early morning.
" 15-18	6.00	64	71	54	Clear Feb. 18, mist late p. m.
" 19	6.00	61	69	58	Clear.
" 20	6.25	61	71	59	None, clear 7 a. m.-4 p. m., cloud before and after.
" 21	6.10	62	71	54	Clear.
" 22	6.00	63	71	56	"

Date	Time of Reading	Temp. at Reading	Max. Temp.	Min. Temp.	Rain
Feb. 23	6.00 p. m.	62	69	58	Until 10 a. m., clear after.
" 24	6.00	62	70	58	Cloud to 9 a. m., clear until 6 p. m. mist.
" 25-27	6.00	63	71	57	Clear Feb. 27 after 10 a. m.
" 28	6.00	64	72	57	
Mar. 1	6.00	60	69	56	Mist, fine rain until 10 a. m., clear after; earthquake 3.30 p. m.
" 2	6.00	62	71	55.5	Clear all day.
" 3-10	6.00	65	73	53	
" 11	6.00	65	73	62	Clear.
" 12	6.30	63	72	59	
" 13	6.00	64	72	57	Clear.
" 14	6.00	60	70	58	Light rain 4-5 p. m., cloud most of day.
" 15	6.15	59	68	56	Alternate cloud and sun.
" 16	6.00	60	69	53	Fair.
" 17	7.30	58.5	68	54	Fair to clear.
" 18	6.00	58.5	69	55	" " "
" 19	6.00	59	69	54	Clear.
" 20	6.00	59.5	70	55	"
" 21	6.00	60	71	56	"
" 22	6.00	61	71	55	Fair to clear.
" 23	6.00	60	71	56	Clear.
" 24	6.00	62	69	54	" to fair.
" 25	6.00	60	71	55	Clear 11-12 a. m., rest of day cloudy.
" 26	6.00	59	70	55	3.30-4.00 p. m., cloud all day.
" 27	6.00	58	69	57	Mist and cloud to 9.30 a. m., hard rain 1.45-2.45, then light.

Date	Time of Reading	Temp. at Reading	Max. Temp.	Min. Temp.	Rain
Mar. 28	6.00 p. m.	61	71	55	Clear until 3.30, rain 6-7 p. m.
" 29	6.00	62	72	56	Mist and cloud to 10 a. m., fair after.
" 30	6.00	60.5	71	57	Fair to clear, rain 4.30-
" 31-Apr. 2	6.00	59	70	57	
April 3	6.00	61	69	57	Mist and cloud to 10 a. m., clear.
" 4	6.00	63	69	55	Clear—fair in even'g.
" 5	6.00	64	74	59	" " " "
" 6	6.00	64	74	57	" " " "
" 7	6.00	64	67	59	Cloud, mist or rain all day.
" 8	6.00	63	69	58	Fair to clear after 10 a. m.
" 9	6.00	64	70	55	Clear.
" 10	6.00	64	71	55	"
" 11	6.00	64	73	55	"
" 12	6.00	65	73	56	"
" 13	9.00	63	74	55	" (Severe earthquakes).
" 14	6.00	65	71	60.5	" to fair (some shocks).
" 15	6.00	66	73	59	Alternating sunshine and mist.
" 16	6.00	66	71	62	Heavy 4.30-5 p. m., rest of day fair to cloudy.
" 17	6.00	65	73	60	At intervals after 2 p. m., otherwise fair.
" 18	6.00	63	70	60	1.30-3 p. m., fair.
" 19	6.00	61	71	56	Fair to clear, evening misty.
" 20	6.00	61	70	58	Fair to clear until 5 p. m., then rain and mist.

Date	Time of Reading	Temp. at Reading	Max. Temp.	Min. Temp.	Rain
April 21	6.00 p. m.	62	66	57	Fair to misty.
" 22	5.30	63	69	59	" " "
" 23	6.20	64.5	71	60	"
" 24					Hard before 7 a. m.
" 24-30	6.00	64	73	54	Cloud after 4 p. m. April 30.
May 1	6.00	63	73	58	Clear.
" 2	6.00	63	74	58	" to fair.
" 3	6.00	62	72	59	" " "
" 4	6.30	63	72	59	" (Great earth- quake, Cartago destroyed.)
" 5					Showers all day.
Range of Temperature recorded			79 on Aug. 24 and Oct. 25	51 betw. Jan. 19-29	

APPENDIX III

PAPERS BASED IN WHOLE OR IN PART ON THE COLLECTIONS MADE BY THE AUTHORS IN COSTA RICA

CALVERT, PHILIP P. Zoölogical Researches in Costa Rica. Old Penn Weekly Review, Univ. Pa., IX, 165-170. Philadelphia, Nov. 12, 1910.

— A Naturalist in Costa Rica. Op. cit. XII, 357-358, Dec. 13, 1913.

— A Naturalist in Costa Rica. Univ. Pa. Bulletins (15) no. 3, part 5, 63-75. Philadelphia, Feby. [April], 1915.

OSCOFF, PROF. Doctor Philip P. Calvert. Paginas Illustr. VII, Nr. 242, 18. San José, 16 de Mayo, 1910. [On his work in C. R.]

TRISTÁN, J. Fid. [Investigaciones del Dr. Philip P. Calvert en Costa Rica.] Memoria de Fomento, 1910, 107-108. San José, Costa Rica. Tipografía Nacional.

CALVERT, PHILIP P. [Entomological Researches in Costa Rica.] Ent. News, XXI, 334-337. Philadelphia, July, 1910.

— An Entomologist in Costa Rica. Annals Ent. Soc. Amer. VI, 1-4. Columbus, Ohio, March, 1913.

— [Eye-size and habit in Odonata and Lepidoptera.] Ent. News, XXV, 479-480. Philadelphia, Dec., 1914.

CHAMBERLIN, R. V. On a Collection of Myriopods from Costa Rica. Trans. Amer. Ent. Soc., XL, 185-194, pl. ii. Philadelphia, June 26, 1914. [15 spp., 7 new.]

BANKS, NATHAN. Notes on some Costa Rican Arachnida. Proc. Acad. Nat. Sci. Philadelphia, 1913, 676-687, pls. xxviii-xxx. Dec., 1913. [Araneina: 31 spp., Phalangida: 6 spp. (1 new), Pseudoscorpionida: 2 spp. (1 new), Scorpionida: 2 spp., Solpugida: 1 sp., Acarina: 6 spp. (5 new).]

- BORELLI, ALFREDO. Descrizione di una nuova specie di Forficola di Costa Rica. Boll. Mus. Zoöl. Anat. comp. Univ. Torino, XXV, no. 623, 3 pp. 12 Luglio, 1910. [*Sparatta calverti*, n. sp.]
- REHN, J. A. G., and HEBARD, M. A Revision of the Orthopterous Group Insaræ (Tettigoniidæ, Phaneropterinæ). Trans. Amer. Ent. Soc. XL, pp. 37-184. No. 2. Philadelphia, May, 1914. [C. R. material, pp. 60, 61.]
- A Synopsis of the Species of the Genus *Conocephalus* found in America south of the Southern Border of the United States. Op. cit. XLI, pp. 225-290. Pls. xxi-xxiv. No. 2, June, 1915. [C. R. material, pp. 248, 264.]
- CALVERT, PHILIP P. The First Central American Corduline. Ent. News, XX, 409-412, 5 text-figs. Philadelphia, Dec., 1909. [*Neocordulia longipollex*, n. sp.]
- A Plant-dwelling Odonate Larva. Op. cit. XXI, 264. June, 1910. [Announcement of breeding of *Mecistogaster modestus*.]
- Plant-Dwelling Odonate Larvæ. T. C., 365-366. Oct., 1910. [*Mecistogaster modestus*, etc.]
- Studies on Costa Rican Odonata. I. The Larva of *Cora*. Op. cit. XXII, 49-64, pls. ii, iii. Feb., 1911.
- Newly found Odonate larvæ of special interest from Costa Rica. Science (n. s.) XXIII, 388. Lancaster, Pa., March 10, 1911.
- [Odonata at high altitudes in Costa Rica.] Ent. News, XXII, 380-381. Philadelphia, Oct., 1911.
- Studies on Costa Rican Odonata. II. The Habits of the Plant-dwelling Larva of *Mecistogaster modestus*. T. C., 402-411. 1 text-fig. Nov., 1911.
- Studies on Costa Rican Odonata. III. Structure and Transformation of the Larva of *Mecistogaster modestus*. T. c. 449-460, pls. xviii-xix. Dec., 1911.
- Studies on Costa Rican Odonata. IV. *Erpetogomphus* in Costa Rica, with Descriptions of a New Species having Complex Structural Mating Adaptations. Op. cit., XXIII, 289-295, pl. xvii, July, 1912. [*E. tristani*, n. sp.]
- Studies on Costa Rican Odonata. V. The Waterfall-Dwellers: *Thaumatoneura* imagos and possible male dimorphism. Op. cit., xxv, 337-348, pl. xiv. Oct., 1914.
- Studies on Costa Rican Odonata. VI. The Waterfall-Dwellers: The Transformation, External Features and Attached Diatoms of *Thaumatoneura* Larva. Op. cit., XXVI, 295-305, pl. xi. July, 1915.

- CALVERT, Studies on Costa Rican Odonata. VII. The Waterfall-Dwellers: The Internal Organs of Thaumatonera Larva and the Respiration and Rectal Tracheation of Zygopterous Larvæ in general. T. c., 385-395, pls. xv-xvii, Nov., 1914; 435-447, Dec., 1915.
- WILLIAMSON, E. B. Notes on Neotropical Dragonflies, or Odonata. Proc. U. S. Nat. Mus. XLVIII, 601-638, pls. 38-44. Washington, May 12, 1915. [*Protoneura amatoria*, p. 623, and *Psaironeura remissa*, p. 629, from C. R.]
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- BANKS, N. Neuroptera and Trichoptera from Costa Rica. Ent. News, XXV, 149-150. Philadelphia, April, 1914. [10 spp. Neuroptera (incl. 1 n. sp.), 2 spp. Trichoptera collected by Calverts and by Lankester.]
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- CHAMPION, G. C. Coleoptera, etc., in Bromeliads. Entom. Month. Mag. (2) XXIV, 2-7. London, Jan., 1913. [7 spp. Coleop. taken in C. R. bromeliads, pp. 2, 3, 5.]
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- WHEELER, W. M. Three New Ants from Mexico and Central America. Psyche, XVIII, 203-208. Cambridge, Mass., Dec., 1911. [*Apterostigma calverti*, n. sp., p. 207.]
- Observations on the Central American Acacia Ants. Trans. 2nd Intern. Cong. Ent. 1912, 109-139. Oxford, 1913. [*Pseudomyrma* from C. R., pp. 115-118. Bibliography, 136-139.]
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- KNAB, FREDERICK. The Lepidopterous Caterpillar in the Bromeliad from Costa Rica. Ent. News, XXIV, p. 467. Philadelphia, Dec., 1913. [*Castnia*(?) sp.]
- SCHAUS, W. New Species of Heterocera from Costa Rica. X. Ann. Mag. Nat. Hist. (8) VIII, 208-231. London, Aug., 1911. [*Oroscopta calverti* n. sp., p. 224.]
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- ALEXANDER, CHAS. P. On the tropical American Rhipidiæ (Tipulidæ, Dipt.) Bull. Brooklyn Ent. Soc. VIII, 6-17, pl. i. Oct., 1912. [*Rhipidia calverti* n. sp., 8.]
- A Synopsis of part of the Neotropical Crane-flies of the sub-family Limnobiinæ. Proc. U. S. Nat. Mus. XLIV, 481-550. No. 1966.

- Washington, April 30, 1913. [*Erioptera (Mesocyphona) caloptera* Say: *femoranigra* n. subsp., 518.]
- ALEXANDER, The Crane-flies collected in Costa Rica by Dr. P. P. Calvert. (Tipulidæ, Diptera.) Journ. N. York Ent. Soc. XXII, 116-124, pl. ii. June, 1914. [20 spp., 6 new.]
- CRESSON, E. T., Jr. Descriptions of Several New Neotropical Acalyptrate Diptera. Ent. News, XXIII, 389-396. Nov., 1912. [*Syringogaster* n. gen., *S. rufa*, *S. brunnea*, n. spp. 392-394.]
- and MALLOCH, J. R. Costa Rican Diptera collected by Philip P. Calvert, Ph. D., 1909-1910. Introductory Remarks by E. T. Cresson, Jr. Trans. Amer. Ent. Soc. XL, 1-8. [Includes list of Localities where Diptera were collected, pp. 1-8.] Paper I. A Partial Report on the Borboridæ, Phoridæ and Agromyzidæ by J. R. Malloch. T. c., 8-36, pl. i. Philadelphia, March 23, 1914. [Borboridæ: 24 spp. (16 new), Phoridæ: 20 spp. (17 new, 2 n. gen.), Agromyzidæ: 1 sp. (new).]
- CRESSON, E. T., Jr. Descriptions of New Genera and Species of the Dipterous Family Ephydridæ. I. Entom. News, XXV, 241-250, pl. x. June, 1914. [1 n. gen., 5 n. spp.]
- Studies in American Ephydridæ I. Synopsis of the genus *Paralimna*. Trans. Amer. Ent. Soc. XLII, 101-124, pl. ix. March, 1916. [7 spp. from C. R., 5 of them new.]
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FOWLER, HENRY W. Cold-Blooded Vertebrates from Florida, the West Indies, Costa Rica, and eastern Brazil. Proc. Acad. Nat. Sci. Philadelphia, 1915, 244-269. April. [Costa Rica: 3 spp. Decapod Crustacea, 2 spp. fishes, 3 spp. Batrachia, 2 spp. snakes, 261-2.]

Other papers are in course of preparation.

APPENDIX IV

A LIST OF SELECTED LITERATURE RELATING CHIEFLY TO THE NATURAL HISTORY OF COSTA RICA, EXCLUSIVE OF THAT CITED IN APPENDIX III

Many of the works listed contain references to previous literature, which is therefore usually not mentioned here.

Books and articles which we have not been able to examine, personally or by proxy, are marked with an asterisk (*).

The principal Costa Rican publications in which articles on natural history have appeared are

Anales del Museo Nacional, Republica de Costa Rica. Tomo I, 1887. San José. (1888).

Anales del Instituto Físico Geográfico Nacional de Costa Rica. Tomo II, 1889. San José. [This forms both Tomo II of the Anales del Museo Nacional and Tomo II of the Boletín Trimestral del Instituto Meteorológico Nacional. See below, and also *ante*, page 28.]

Anales del Instituto Físico-Geográfico y del Museo Nacional de Costa Rica. Tomo III, 1890 (1892), Tomo IV, 1891 (1893). San José.

Anales del Instituto Físico Geográfico Nacional de Costa Rica. Tomo V-IX. San José, 1892-1896.

Boletín del Instituto Físico-Geográfico de Costa Rica. Tomo I-III. San José, 1901-1903. [In addition to articles listed below, contain many others on agriculture, boundary with Panama, etc.]

Boletín de Fomento. Órgano del Ministerio de Fomento. Año I, Número 1 (Enero de 1911)—Año IV, Número 4 (Abril de 1914). San José.

Boletín de la Sociedad Nacional de Agricultura. Año I, II. San José, 1906, 1907. [Also separate publications by the same society.]

Boletín Trimestral del Instituto Meteorológico Nacional. Números 1-4. San José, 1888, 1889. [Continued as Anales del Instituto Físico-Geográfico as noted above.]

Informes del Museo Nacional de Costa Rica. San José. [Not numbered or pagged serially; various dates.]

Memorias de Fomento presentadas al Congreso Constitucional. San José [Annual issues; various sizes. Recent issues contain many views in C. R.]

Paginas Ilustradas. Revista semanal de Ciencias, Artes y Literatura. San José. From Jan. 1, 1904, on.

WORKS INCLUDING, OR BEARING ON, COSTA RICA BUT OF WIDER OR OF DIFFERENT SCOPE

PHILLIPS, P. LEE. A List of Books, Magazine Articles, and Maps relating to Central America, including the Republics of Costa Rica, Guatemala, Honduras, Nicaragua and Salvador. 1800-1900. Compiled for the Bureau of the American Republics. Washington: Government Printing Office, 1902. [Previous bibliographies cited, p. 3; 251 titles on Central America in general, pp. 9-22, 236 titles on C. R., pp. 33-45; both lists under authors' names arranged alphabetically.]

BIOLLEY, PABLO. Bibliografía Obras publicadas en el extranjero acerca de la República de Costa Rica durante el Siglo XIX. Revista de Costa Rica en el siglo XIX, Tomo I, pp. 363-404. Tipografía Nacional, San José de Costa Rica. MCMII. [334 titles arranged chronologically from 1826 to 1900, pp. 367-404. This list is much more important for natural history than Phillips' although by no means confined to that subject.]

Bulletin of the International Bureau of the American Republics. Vols. I-XXXI, no. 3, Washington, Oct., 1893-Oct., 1910. [Continued with Vol. XXXI, no. 4 as] Bulletin of the Pan-American Union. [Contains current notes and occasional articles chiefly on political, industrial, commercial and legal conditions in C. R.]

DAVIS, ARTHUR POWELL. Hydrography of the American Isthmus. Rep. U. S. Geol. Surv. XXII, pt. 4, 507-630, 13 pls. 1900-01. Washington, 1902. [General physical characteristics of Central America, temperature and rainfall data for C. R.]

GANNETT, HENRY. A List of Altitudes in Mexico and Central and South America. Bull. Intern. Bur. Amer. Repub. XVII, Sept., 1904. 62 pp.

*MCALLISTER, M. HALL. The Coast Sierra from California to Panama. Sierra Club Bull. IV, 264-273. San Francisco., 1903.

*SAPPER, KARL. Die geographische Forschung in Mittel-Amerika im 19. Jahrhundert. Verh. Deut. Geogr. Tag. XIII, 285-302, Berlin, 1901.

SAPPER, KARL. Die mittelamerikanische Landschaft. Geogr. Zeitschr. VIII, 489-515, taf. 10-13. Leipzig, 1902.

— Der Einfluss des Menschen auf die Gestaltung des mexicanisch-mittelamerikanischen Landschaftsbildes. Globus, LXXXIX, 149-152. Braunschweig, 1906, 15 März.

- DOMVILLE-FIFE, CHARLES W. Guatemala and the States of Central America. London: Francis Griffiths, 1913. 8vo. 310 pp. Illustr.
- * HERBERTSON, F. D. and A. J. Descriptive geographies from original sources. Central and South America and the West Indies. London (Black) 1902. pp. xxxiv, 240. [The text is made up of extracts from works descriptive of regions concerned.]
- KEANE, A. H. Central and South America. Vol. 2. Central America and the West Indies. New Issue. London, Stanford, 1901, pp. xxiv, 496. 16mo.
- SIEVERS, WILHELM. Süd und Mittelamerika. 2te Auflage, Leipzig u. Wien Bibliogr. Institut 1903. pp. xiv, 665. Illustr. [General description of Central America under various topics 572-615, bibliography 629-630.] *3te Auflage. 8vo. pp. 567 mit Karten u. Abbildungen. Leipzig, Bibliogr. Institut., 1914.

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- HALSEY, FREDERIC M. The Railways of South and Central America. A Manual containing Statistics and other Information concerning the Important Railways of South and Central America, Mexico and the West Indies. F. E. Fitch, 47 Broad St., New York, 1914.
- Intercontinental Railway Commission. Report. Washington, 1898. 3 vols. text, 3 vols. maps. [C. R.: Vol. I, pt. I, pp. 68-72, 2 phot. figs., map II; Vol. I, pt. II, 195-212, 6 phot. figs.; 8 large scale maps of Pacific C. R. from Nicaraguan boundary to Boca Savegre in volume of maps accompanying report of Corps no. 1; Vol. II, pp. 84-102, 7 phot. views, 1 text map; 5 large scale maps of Pacific C. R. from Boca del Portalon to David, Panama, and 3 profiles in volume of maps accompanying report of Corps no. 2.]

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- BELT, THOMAS. The Naturalist in Nicaragua: A narrative of a Residence at the Gold Mines of Chontales; Journeys in the Savannahs and Forests. With observations on Animals and Plants in reference to the theory of evolution of living forms. With map and illustrations London: John Murray, Albemarle Street. 1874. 16mo. pp. xvi, 403.
- Ibid. Second Edition, Revised and Corrected. London: Edward Bumpus. 1888. 16mo. pp. xxxii, 403. [Preface contains a memoir of Belt and List of his works. Frontispiece a portrait of Belt.]
- The Naturalist in Nicaragua with an Introduction by Anthony Belt, F. L. S. in: Everyman's Library edited by Ernest Rhys. London. J. M. Dent and Sons, Ltd. New York, E. P. Dutton & Co. No

date. 16mo. pp. xxiv, 306. [Introduction comprises a memoir of T. Belt and a list of his works.]

BOVALLIUS, CARL. Resa i Central-Amerika, 1881-1883. Upsala, 1887. R. Almqvist & J. Wiksell's Boktryckeri. Forra Delen, pp. xii, 1-275, med 75 illustrationer och 2 kartor. Senare Delen, pp. xii, 277-483, med 133 illustrationer och 4 kartor. 12mo.

COCKBURN, JOHN. A Journey over Land, from the Gulf of Honduras to the Great South-Sea. Performed by John Cockburn and Five other Englishmen, viz. Thomas Rounce, Richard Bannister, John Holland, Thomas Robinson, and John Ballman; Who were taken by a Spanish Guarda-Costa, in the John and Jane, Edward Burt Master, and set on Shoar at a Place called Porto-Cavalo, naked and wounded, as mentioned in several Newspapers of October, 1731. . . . London. Printed for C. Rivington, at the Bible and Crown in St. Paul's Church-yard. M.DCC.XXXV. 12mo. pp. viii, 264. [Cockburn passed through the western part of C. R. from Nicaragua to Panama. His account is one of the earliest in English of the country.]

FISCHER, EMIL S. Beobachtungen und Daten von meiner Studienreise nach Panama u. Costa Rica. Mitt. Geogr. Gesel. Wien XLVIII, 434-481, 1 taf. 1905. [The author was commercial secretary of the Austrian commission at the St. Louis Exposition of 1904.]

MOZANS, H. J. Up the Orinoco and Down the Magdalena. New York and London. D. Appleton and Company, 1910. 8vo. pp. xvii, 439. Illustr. [Bibliography, 429-433. Chap. XIV on C. R.]

*OERSTED, ANDERS SANDOE. L'Amérique centrale, recherches sur sa flore et sa géographie physique: resultats d'un voyage dans les Etats de Costa Rica et de Nicaragua, executé pendant les années 1846-1848. Copenhague, 1863. Folio. Première Livraison. [For Summaries of Oersted's travels see Biol. Cent. Amer., Bot. IV (in English), Pittier, Plantas Usuales de Costa Rica, pp. 1-11 (in Spanish), and Durand and Pittier, Prim. Flor. Costar. Fasc. I (in French—the longest).]

SAPPER, KARL. Mittelamerikanische Reisen und Studien aus den Jahren 1888 bis 1900. Mit einem Titelbilde, 60 Abbildungen und 4 Karten. Braunschweig Druck und Verlag von Friedrich Vieweg und Sohn, 1902. 8vo. pp. xiv, 426. [From his long residence in Central America, Dr. Sapper ranks as one of the most experienced travelers therein.]

STEPHENS, JOHN L. Incidents of Travel in Central America, Chiapas and Yucatan. Illustrated by Numerous Engravings. 2 vols. New

York: Harper and Brothers, Publishers. 1st edit., 1841. 12th edit., 1850. 8vo.

WILDA, JOHANNES. Amerika-Wanderungen eines Deutschen I. In der Mitte des Kontinents. 2te Auflage Allgemeiner Verein für Deutsche Literatur. Berlin, 1906. 12mo. pp. vii+367, 1 Karte, Portrait. Illustr.

Biologia Centrali-Americana; or, Contributions to the knowledge of the Fauna and Flora of Mexico and Central America. Edited by F. Ducane Godman and Osbert Salvin. [Edited by F. D. Godman alone after the death of Salvin in 1898.] London: Published for the Editor by R. H. Porter and Dulau & Co. 4to. 64 vols. (52 Zoölogy, 5 Botany, 6 Archæology, 1 Introductory). 1879-1915. [Deals with the plants higher than the cellular cryptogams, terrestrial and fresh-water vertebrates, molluscs, insects, arachnids and myriopods, the chief Indian remains in Guatemala and the archaic Maya inscriptions. Some groups of insects are omitted. Forty-eight authors in addition to the editors.]

Mission Scientifique au Mexique et dans l'Amérique Centrale. Ouvrage publié par ordre de S. M. l'Empereur et par les soins du Ministre de l'Instruction Publique. 4to. 3 vols. Paris, 1868-1870. 8 vols., Publié par ordre du Ministre de l'Instruction Publique 1870-1909. [Geology of Guatemala, Salvador, Nic., C. R. Linguistics, Maya writing, grammar. Orthoptera, Myriopoda, Mexican Cryptogams and Gramineæ, Fishes, Reptiles, Batrachia, Xiphosura, Crustacea.]

ADAMS, F. U. Conquests of the Tropics. New York: Doubleday, Page & Co. 1914. 12mo. pp. xii, 368. Illustr. [The story of the banana trade developed by the United Fruit Company in Central America.]

*FORZANO, FRANCESCO. Appunti di geografia economica dell'America centrale. Roma (officine poligrafica italiana), 1906.

GENERAL DESCRIPTIONS OF COSTA RICA

ALFARO COOPER, J. M. Anuario Estadístico Año, 1910. Tomo XIV. Tipografía Nacional San José, Costa Rica. MCMXI. 4to. pp. xxxii, 222, 11.

FERNANDEZ GUARDIA, RICARDO. Cuentos Ticos. Short Stories of Costa Rica. The Translation and Introductory Sketch by Gray Casement.

- Cleveland. The Burrows Brothers Company, 1908. Second Edition. [First edition 1904.] 16mo. 293 pp., map of C. R. at back. Many illustrations. [Pp. 1-72, an appreciative sketch of C. R.; pp. 75-293, ten stories of C. R. life. "Ticos" is a Central American nickname for Costa Ricans.]
- REID, W. A. As Tourist and Trader see Costa Rica. Bull. Pan Amer. Union, XXXIX, 849-862. Illustr. Dec., 1914.
- SEGARRA, J., y JULIÁ, J. Excursión por América. Costarica Edicion Ilustrada. S. José de Costarica. Imprenta de Avelino Alsina. 1907. 8vo. 633 pp. 1 map.
- WAGNER, MORITZ, und SCHERZER, CARL. Die Republik Costa Rica in Central-Amerika mit besonderer Berücksichtigung der Naturverhältnisse und der Frage der deutschen Auswanderung und Colonisation. Reisestudien und Skizzen aus den Jahren 1853 und 1854. Mit einer Karte. Leipzig, Arnoldische Buchhandlung. 1856. 12mo. pp. xvi, 578. [Considered by Pittier "as even to-day (1908) the most interesting that has been published on C. R."]
- ZAMORA, FERNANDO. Album de Vistas de Costa Rica con notas de información. Views of Costa Rica. An Album with Information. San José, C. R. 1909. [Title page, five pages of text and description of each of the (100) views, all in both Spanish and English.]

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- COX, F. N. (British Consul). Diplomatic and Consular Reports. Costa Rica. Annual Series, nos. 2776, 3077, 3444, 3615, 4321, 4800. London, 1902-1911. [Data on construction of railroads, exports, etc.]
- HARRISON, P. G. (British Consul). Diplomatic and Consular Reports, Costa Rica. Annual Series, no. 2661. London, 1901. [Data on construction of Pacific Railway.]
- MERRY, W. L. [U. S. Minister]. Trade and Industry in Costa Rica. Consular Reports, LXII, 245-248. No. 233. Washington, 1900. [Data on railways.]

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- TRISTÁN, JOSÉ M. Ciudades de Costa Rica. San José. Paginas Ilustradas, V. pp. 3176-3178, 8 de Marzo, 1908, No. 188 and subsequent numbers.
- HALE, ALBERT. Latin American Municipalities. San José de Costa Rica. Bull. Pan. Amer. Union XXXII, pp. 1006-1022. June, 1911, 12 illustr.

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- PITTIER, HENRI F. *Kostarika. Beiträge zur Orographie und Hydrographie. Petermann's Mitteilungen, Ergänzungsheft Nr. 175. Gotha, 1912. Pp. ii, 48; 2 tafeln. (Ergänzungsband XXXVII.) [Tafel I. Mapa de Costa Rica. Escala 1:500,000, orographical in 10 colors; this is the most recent map of C. R. Tafel 2. Six profile views, 1 on the Atlantic, 5 on the Pacific side.]*
- ALFARO, A. *El río María Aguilar. Boletín Fom., III, No. 5, pp. 325-328, 2 figs. 1912-1913.*
- (Autores Varios). *Lecturas Geográficas. Primera Serie. Imprenta Alsina. San José, Costa Rica, 1914. Small 16mo. 89 pp. [Descriptive of Costa Rica; similar in plan to the Herbertsons' Descriptive Geographies cited above.]*
- BOVALLIUS, CARL. [See under Ethnology.]
- FRANTZIUS, A. V. *Der geographisch-kartographische Standpunkt von Costa-Rica. Peterm. Mitt. XV, pp. 81-84. Taf. V (map) Gotha, 1869. [The footnotes form a bibliography.]*
- GUTIÉRREZ, P. N. *Parte de trabajos astronómicos y geodésicos hechos y recopilados por el Ingeniero Topógrafo que suscribe para el mapa y Geografía de Costa Rica. 8vo. 5 pp., not numbered. [Place and date on 5th page:] San José, 20 de diciembre de 1913. [Altitudes, latitudes and longitudes of various places in C. R.]*
- Intercontinental Railway Commission. [See above.]
- NORIEGA, FELIX F. *Diccionario Geográfico de Costa Rica. San José, Costa Rica Imprenta de Avelino Alsina, 1904. 12mo. pp. xi, 249. [List of sources, viii-ix; alphabetically arranged dictionary of localities in C. R., 1-235; List of Gobernadores and Jefes del Estado 1508-1904, 237-247.]*
- PITTIER, H. *Apuntaciones sobre el clima y la geografía de la República de Costa Rica. III. (E.) Resultados de las observaciones y exploraciones efectuadas en el año de 1888. Boletín Trimest. Inst. Meteor. Nac. Nr. 4, pp. 41-62. 1889.*
- PITTIER, ENRIQUE.¹ *Primer Ensayo de un mapa de declinación magnética en Costa Rica. Bol. Inst. Fis. Geogr. C. R. I, pp. 10-31. 1901. 1 map.*
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¹ Prof. Pittier's first name variously appears as Henri, Henry, Enrique, in publications in different languages.

qualquier fecha. Bol. Inst. Fis. Geogr. C. R. II, pp. 186-188. San José, 1902.

VALENTINI, FELIPE. Zur Geographie von Costarica. Peterm. Mitt., 1861, pp. 358-359. Gotha. [Chiefly the author's own observations in Guanacaste, correcting details of previous maps.]

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SYSTEMATIC LIST OF PLANTS AND ANIMALS MENTIONED

Where vernacular names have been used in the text, they are added in parentheses to each scientific name. Additional references to such species may be found under the vernacular names in the Index. Numbers in parentheses refer to pages nearest illustrations.

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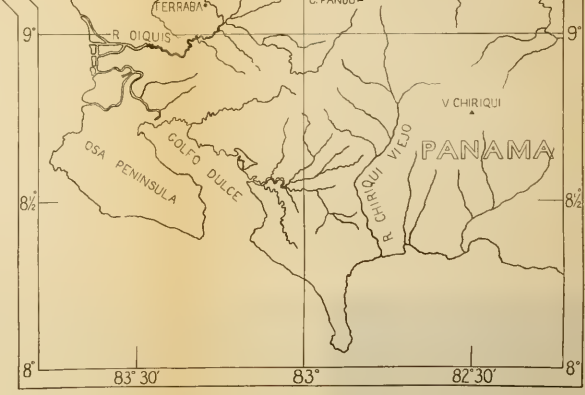
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