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A NATURALIST IN COSTA RICA

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While great political and commercial interest in Central America has been aroused during the past twenty-five years, due to the possibilities of inter-oceanic canals in Panama, Nicaragua or elsewhere, that part of the world has long had an equally great attraction for the biologist. Thomas Belt spent the period of 1868–72 there and as a result produced his "Naturalist in Nicaragua," of which Darwin wrote: "It appears to me the best of all natural history journals which have ever been published."

Belt lived and worked in comparatively low country north of the suggested route for the Nicaraguan canal. To the south of that route, between it and the present Panama canal, rise the mountains of Costa Rica to an altitude of 12,000 feet. Here, by virtue of the great differences in elevation between sea coast and volcanic peak, the resulting differences in temperature and in rainfall, the proximity to the Equator, and the broken character of the surface of the country, thrive a flora and fauna unexcelled in richness and variety by those of any equal area of the earth's surface.

Costa Rica, one of the six republics of Central America, lies between Nicaragua on the north and Panama on the south, and its shores are bathed by the waters of two oceans. It has an area of 23,000 square miles and thus approaches West Virginia, of all the United States, most nearly in extent. The latest estimates credit it with a population of from 300,000 to 335,000. As contrasted with the other Central American republics, Costa Rica has enjoyed a more peaceable existence, freer from political revolution, while sanitary conditions have been improved to a greater extent.

Into the tracts of virgin forest on the lowlands and on the mountain sides great inroads have already been made to obtain clearings for the cultivation of the banana or of coffee, or for pastures or for lumber itself. The lower lying tropical forests are composed of great trees of many different kinds commingled, while at higher elevations are groves of evergreen oaks. In damp open places, chiefly at lower levels, are the so-called wild plantains with inflorescences of flaming red or of golden yellow. The open pastures on hills of the moister Atlantic slopes, as at Turrialba, are clothed with bright green grasses, while in the valleys are brooks or rivers always noisy from the multitude of rocks and stones in the stream beds against which the swift-flowing current dashes. The trees are covered with parasitic and epiphytic plants of many different kinds, often confusing the eye with the variety of foliage. The candelabra-like cecropia trees are characteristic of tropical America. The railroad from Limon, the Atlantic port, to San José, the capital, follows, in much of its course, the valley of the Reventazón River, whose canyon affords magnificent vistas of tropical verdure.

When the railroad was first projected, the line was intended to pass to the north of the two great volcanos, Turrialba and Irazú, and was actually constructed as far as Carrillo on the northern slope of the latter. Frequent floods and changes in the river courses compelled the abandonment of this plan and the road now ascends the valley of the Reventazón to the south of the two mountains. The northern railway is in operation as far as Guapiles. To the west of Guapiles, the Florida road, passable on horseback or on foot, leads through a virgin forest into which we penetrated for a short distance. There were the tall trees whose trunks rose straight fifty or more feet from the ground before branching, which attract the attention of every traveler in the tropics. The foliage meeting that of other trees shuts out the view of the sky except where a clearing had been made by lightning or wind and then, far above our heads, one could see a crown of red or orange flowers surrounded by brightly

colored butterflies. The trees and shrubs were of numerous kinds and many of them bore a profusion of epiphytes. Here and there through the forest trickled streams of clear water, into which a bright-hued humming bird darted ever and anon. The many unfamiliar plants and insects which met our gaze at every step was so distracting at first that I turned from one thing to another, not able to concentrate my attention on any one. It was my first experience in a truly tropical forest and although we had many opportunities to visit similar scenes later, that day's excursion still seems, as I recall it, like a peep into some mysterious fairyland.

Some ten miles south of Limon is the Banana River region. The country is only a few feet above sea level and quite flat. Some of the Fruit Company's farms here bear the familiar-sounding names of Philadelphia North and Philadelphia South. It was early November and there had been an exceptionally long dry spell. Small brightly colored frogs were quite conspicuous in the banana plantations, one species bright red, another bright blue with irregular black spots.

Peralta, at about 1,100 feet elevation on the railroad to San José, will always be remembered as the place where I saw my first monkey, my first armadillo, my first basilisk, my first toucan and other interesting creatures in the wild state. The forest is still close to the railroad and the Reventazón here, and these animals were probably not more than half a mile away from the trains and locomotives.

On the Atlantic side of Costa Rica Juan Viñas was our most productive locality. Many a favorable place for a naturalist in Costa Rica is discounted by the lack of accommodations, unless, indeed, he is able to bear the considerable expense of transporting tents and provisions to the place where he would be. Juan Viñas is accessible by the railroad; the station lies at one edge of the floor of an old crater. From the level of the track a zig-zag cart road took us through the forest of the canyon side to the turbulent, rock-filled Rio Reventazón, 800 feet below. The village of Juan Viñas and the top of the canyon

are 600 to 700 feet above the railroad, so that we had a vertical range of 1,500 feet for exploration within easy reach.

Among the epiphytic plants, the members of the Bromelia, or pineapple, family are especially interesting on account of the food and shelter which they afford to many kinds of animals, and the inter-relations of these animals. On the moister Atlantic slope of Costa Rica, bromeliads are quite abundant, growing on the branches and trunks of trees in the hedgerows around Cartago, in the cool woods of mountains like Irazú, 11,000 feet above the sea, and in the warm tropical forests of much lower elevation. Sometimes they are situated close to the ground, or 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 leaves, often two or more feet long, taper gradually to near the tip, are toothed or spined on their straight edges, bright green or beautiful pink or red, and spring from a very short stalk so that their bases are pressed closely together. Between the leaf-bases rain water is usually present, and in all localities various forms of animal life take refuge there. Cockroaches, earwigs, katydid-like insects, larvæ of beetles, of moths, of flies and of mosquitos, ants, snails, earthworms, scorpions both true and false, centipedes and even snakes of poisonous repute are common *bromeliadicoli* which we met in our examinations. The length and toughness of the leaves and their sharp spines made it necessary to carry a heavy knife to investigate these plants properly. In October, 1909, we were gladdened by the discovery of undoubted dragon-fly larvæ, in a bromeliad below Juan Viñas, which were carried carefully to Cartago and placed in jars, each containing a little water and a small bromeliad. We fed them with "blood worms," the bright red young of certain flies, readily obtained from a dirty ditch near the town. The first lot of larvæ died out in about two months, but a second lot, from nearly the same locality in December, found our jars sufficiently endurable to complete their growth and to transform into the winged insects in early April. Two of them made this change about 8 o'clock on two bright mornings, and

thus we could photograph them in the act. The exuvia from which the adult emerged and also the larva, when within it, was four-fifths of an inch long, and when the dragon-fly first detached itself it likewise had the same length, but in one and a half hours' expansion, due, some believe, to inspired and also swallowed air, increased the length of its body to three and one-eighth inches and of each wing to two inches. The larva is not longer than those of many other insects, but the adult is conspicuously longer, and this great increase in length is thus a matter of a relatively short time at the period of transformation.

Nothing had been known previously of the early stages of this species (*Mecistogaster modestus*), or of its allies, a group limited to tropical America and remarkable for the length and slenderness of the body and wings of the adults. Mr. O. W. Barrett, however, had suggested, in 1900, that possibly the larvæ lived in the water which is retained between the leaf-bases of bromeliads. This suggestion and the learning from a letter from Mr. F. Knab, of the United States National Museum, that he had recently raised dragon-fly larvæ from such a source in Mexico, were the immediate causes which led us to a careful search among these plants.

These dragon-fly larvæ feed upon mosquito larvæ living in the same water; both sorts of larvæ are cannibalistic and also devour other insects and small crustaceans which, as cotenants or as occasional visitors, come their way. In the drier parts of the Bromelias lives a caterpillar at the expense of the plant itself. *Apterostigma* ants cultivate a fungus which grows on the excrement of the caterpillar and parts of this fungus furnish nourishment to the cultivators. Other, larger and fiercer, *Odontomachus* ants rush to attack the naturalist when he investigates their bromelian home, spreading wide their toothed jaws and snapping them together with a click. Vegetable débris and even earth, perhaps from the feet of birds, gather between the bromelia leaves and earthworms find a congenial abode in the mixture. The bromelia-dwelling beetle *Pachyteles* has imitated the ants in so far as it has developed an antenna-

cleaner on its front legs, consisting of a notch on the tibia lined with hairs through which the antenna may be drawn, and prevented from slipping by a conveniently placed spine on the femur.

The numerous streams of Costa Rica are frequently interrupted by waterfalls of varying height, and these are often spots of the greatest attractiveness to the botanist and the zoologist. The *Thaumatoneura* dragon-flies in all stages of their existence appear to be confined to certain waterfalls, fluttering about in the spray and laying their eggs in the roots and stems of plants which are constantly bathed by water. The larvæ clamber over the rocks of the face of the fall and, attaining their fullness of growth, transform to the winged condition still within reach of the spray.

The adult insect was first made known by Mr. Robert McLachlan, F. R. S., of London, in 1897. His description was made from a single specimen, bearing no label, obtained at a sale, so that Mr. McLachlan was unable to say whence it came, "but as the pin (or rather skewer!) was similar to those used for some other insects in the same collection which were of Chinese or Japanese origin," he hazarded "the conjecture that it may belong to the same region." In 1900, Mr. McLachlan was able to announce that the real habitat of the insect was Chiriqui in Panama. About 1903, Mr. C. F. Underwood collected two species of *Thaumatoneura* at Carrillo, in Costa Rica, and his specimens, coming into the possession of Dr. F. D. Godman, of London, were sent to me and so were included in a volume of the *Biologia Centrali-Americana*. On the first day of our arrival at Juan Viñas, in June, 1909, our entomological friends, Messrs. W. Schaus and J. Barnes, presented me with a couple of *Thaumatoneura* which they had just collected at a small waterfall nearby. Thereafter our visits to Juan Viñas always included one or more examinations of the small streams which fall almost vertically over the steep rock faces of the canyon of the Rio Reventazón. The sides of the canyon are covered almost everywhere with vegetation, including trees of a hundred or

more feet in height, and the descending streams are bordered with a great variety of plants. Close to and within the spray of some of these small waterfalls lives *Thaumatoneura*. It is not an actively moving insect. We have watched the same individual remain motionless for half an hour upon a leaf or twig, even at midday, the spray collecting upon its body and hanging in a drop from the hind end. The eggs are laid apparently within the roots or stems of plants which hang vertically within the waterfall, but we were never able to find them. In June we found a larva which we strongly suspected to be that of *Thaumatoneura*, and, as usual, transported it to Cartago, but it did not live long. All through the following year we sought for *Thaumatoneura* larvæ until, in late April, 1910, we found them transforming at the foot of what we knew as our "high waterfall." This was a nearly vertical fall descending from the top of the canyon, but about one hundred feet above the railroad track (which occupies 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 hillside far below the track. After exceptionally heavy rains in the hills above, the stream flowed over the surface almost as far as the track. Up over these boulders we climbed to the foot of the actual fall, where there was a vertical rock wall thickly overgrown with moss and *Commelina*, and on this rock face we found our long-sought larvæ. Two days after our discovery, a landslide occurred—it was after the earthquakes of mid-April—large masses of rock falling and changing all the details of this spot, and leaving the approach so dangerous that we did not dare to climb to our favorite locality again. But we had our *Thaumatoneura* larva previously unknown!

Near the *Thaumatoneura* waterfalls often hangs the "eye of the bull" (*Mucuna*), a vine which derives its popular name from the large round black seeds in its six-inch pods, pods and flowers before them hanging at the end of a separate stalk which may be several feet in length. There are unnumbered caterpillars and beetles of striking form and color. Such is the Harlequin

beetle, two and a half or more inches in length, with a gay coat of dark gray, pale pink and pale green. Its antennæ and front legs are twice as long as its body. It can produce a clicking sound by rubbing two parts of its thorax on each other. Its grub feeds inside rubber trees. One such beetle was itself the home of two species of mites and one of pseudoscorpions, living beneath its wing covers. Another is the Hercules beetle, larger in size, the male with great horns on head and prothorax, which contentedly lived in confinement gnawing at sugar cane. Winged and unwinged walking-sticks abound, the former flashing coral red organs of flight, a pale green wingless one clinging to vegetation like an insect sloth.

Relatives of the *Apterostigma* ants, but more advanced, are the leaf-cutters, familiar to all who have visited tropical America, whose mound-covered nests were first shown by Belt to contain spaces wherein fungus is cultivated by the busy insects on the plant fragments which they laboriously collect. Almost equally well known are the *Pseudomyrma* ants, dwellers in the Bull's horn thorn, obtaining from the plant several kinds of nourishment and severely attacking, by both ends of their anatomy, the unfortunates who come in contact with the thorn.

Cartago was a clean and healthy town of perhaps 10,000 people, with well-paved streets in its central part, an abundance of clear water piped to the houses, an underground drainage system and was lighted with electricity. It was a vacation resort for those employed on the Panama Canal and contained a number of hotels. In one of these we had our headquarters, and to its managers, Mr. and Mrs. Joseph Weldon, we were indebted for many kindnesses and comforts. Situated on the railroad and nearly midway between the Atlantic and the Pacific, Cartago furnished a convenient starting point for excursions in many directions. To the north was the great volcanic mass of Irazú, whose southern slopes are now covered with pastures and cultivated fields, but its northern side is still largely forest-clad. Its great crater, 3,936 feet in diameter according to Dr. Karl Sapper, contains two large daughter craters and nine grand-

daughter craters. One of the last-named discharges steam and sulphurous vapors intermittently. The summit is about twelve miles from Cartago, and the slope is sufficiently gradual to enable one to make the entire journey on horseback. A magnificent panorama is visible from the top when the mountain is free from clouds, but favorable weather conditions are quite uncertain, as our three visits in July, September and March distinctly showed. The biological interests of Irazú proved to be botanical rather than zoological.

Most of the volcanoes of Costa Rica are round-topped, not to say flat-topped, and their slopes usually gradual. Some have been inactive for many years (like Irazú, 1723); others, although in eruption more recently (Turrialba, 1866), display their power at long intervals, while Poás every few years sends forth a column of steam, water or ashes. The craters of Irazú are in part clothed with vegetation quite unsuggestive of their actual character. Poás possesses a deep-laid crater lake and is looked on as an elevated geyser. One of its outbursts occurred while Mrs. Calvert was with our good friends, Mr. and Mrs. J. B. Clark, near Alajuela, whose house we had come to regard as our second home in Costa Rica. They lived some ten miles from the volcano, and in January, 1910, she witnessed a picturesque eruption of ashes. Accompanying her hosts to the crater on the following day, for the eruption lasted but half an hour, they found all the vegetation ash-covered as if with snow and all the birds and insects flown from the mountain slopes.

San José, the capital of Costa Rica, lies on the Pacific side of the country, thirteen miles west of Cartago, at an altitude of 3,800 feet. Professor J. Fidel Tristán, Director of the College for Young Ladies here, was our untiring friend, aiding us with advice and information, accompanying us on many an excursion, procuring maps, guides, shelter and friends for us, which made our stay in the country far more productive than it otherwise would have been. A naturalist himself, he did all in his power to further our researches. Professor Anastasio Alfaro, Director, and M. Ad. Tonduz, botanist, at the Museo Nacional, respec-

tively, were most kind in indentifying animals and plants for us, and another good friend was the ornithologist, Señor Don Jose Zeladón.

It was doubtless due to Professor Tristán that, with the approval of the then President of the Republic, Señor Don Cleto Gonsalez Viquez, and his Minister of Education, Señor Don Ricardo Fernandez Guardia, I was permitted to accompany a Commission for examining the qualifications of teachers of the public schools to the Province of Guanacaste in January. The members of the Commission, Professors Obregón, Perez Martin, Orozco and Tristán and Señor Villar, were most agreeable and courteous companions and the month spent with them was highly interesting and instructive.

Guanacaste is the northwestern of the Provinces of Costa Rica and borders the Pacific and Nicaragua. It has been visited by but few naturalists. From San José we went by train forty-one miles to Orotina, thence by horse and mule fifteen miles to Esparta—a gap in the transcontinental railway here existed at that time (January, 1910)—thence by rail again to Puntarenas on the Gulf of Nicoya, an arm of the Pacific. A small steamboat took us northwestwardly to the head of the Gulf and up the Rio Tempisque to Puerto Ballena. Here we mounted horses and reached another Filadelfia where we spent the night. A hot ride for six hours through a mostly open country brought us to Liberia, the capital of the province, on the following day. While the Commission held examinations, I was busied in collecting insects, finding here, as everywhere in Costa Rica, many hitherto unknown for this country. An interesting side trip with Professor Tristán was to the foot of the almost eternally cloud-veiled volcano Rincon de la Vieja and its solfataras. From Liberia we went to Santa Cruz in the upper part of the Peninsula of Nicoya, thence to Bolsón, and back to Puntarenas by the steamer. Monkeys, especially the deep-voiced howlers, whose calls, when I first heard them, I took for the bellowings of bulls, and parrots, including brightly colored macaws, are common in Guanacaste, and it was a frequent occurrence to

meet them as we passed through the forests or even more open roads. It is said that the abundance of monkeys here is largely due to their not being used as food for man to the same extent as on the Atlantic side.

The late Professor Paul Biolley, a native of Switzerland, who died in San José in 1908, was an active naturalist in Costa Rica for twenty-three years. To him many a student in Europe and the United States was indebted for material for study, and I, too, am glad to acknowledge my obligations to him. Vacation from school in Costa Rica is in December, January and February, and in these months Professor Biolley frequently visited the lower portions of the Pacific slope. For the sake of being able to compare data from another time of the year with his results, we made a visit to one of his collecting grounds, Surubres, in October, a possibility due to Professor Tristán and to Señor Don Pedro Bonnefil and his sister Señorita Bonnefil. Their charmingly situated hacienda, with a large higueron (Ficus tree) before the door, shedding its leaves at this time as new leaf buds were opening; with the little Rio Surubres near by, reached by a steep path down through a patch of forest, where our feet sank into a thick carpet of maiden-hair ferns, selaginellas and wild begonias with delicate pink blossoms; and, far off toward the sunset, the gulf and the peninsula of Nicoya, and beyond the latter the shining Pacific are memories which are rendered still brighter by the recollection of the hospitality which we enjoyed.

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Eleven and a half months had passed in our paradise and our appreciation of its charms was increasing daily. Yet we never valued it so highly, of course, as we did after we were driven out of it.

The 13th of April, 1910, came. I was near Turrúcares; Mrs. Calvert at Cartago, thirty-five miles apart. At about half-past twelve in the morning began a series of earthquakes of varying intensity and interval. Although I was awakened by them, they did not seem sufficiently severe to induce me to

leave my bed in the second story of a frame house, but at San José and Cartago they were stronger and everyone fled to the streets, where Mrs. Calvert and others from Weldon's Hotel passed the night. Walls were cracked, plaster fell, the universal tile roofs were disarranged or thrown off and poorly-built adobe houses were demolished. It was a nerve-racking experience, and it is now difficult, for those of us who passed through the sequel three weeks later, to understand how we continued to live there in the intervening time.

Earth tremors continued, not a day passing without them, but as they were generally of decreasing intensity, we hoped that the worst was over. About 185 were recorded by the seismograph at San José between April 13th and May 3d. We went to Juan Viñas again, with most successful results for our investigations. Mrs. Calvert returned to Cartago on April 30th, I on May 4th, reaching there about 5.30 P. M. We had dinner as usual and, having gone back to our room, had seated ourselves to look over the mail that had arrived during our absence. While so engaged, at 6.50 P. M., without the slightest preliminary sound or tremor, came a most terrific earthquake. The electric lights within and without were instantly extinguished, owing to the derangement of the dynamos. As we tried to escape we were thrown to the floor, which seemed to rise and fall under us. There was a roar of falling walls and the air was filled with the dust of plaster. We could do nothing but lie where we had fallen until the shaking ceased. Then we rose and, climbing over the piles of débris, made our way to the window opening on the street and so escaped. Three walls and the ceiling of our room were still in place, a fourth, of brick, fell, but, fortunately, not on us. We remained in the street all night, the ground quivering incessantly with now and then a sharp shock, but less severe than the first. We realized that the town was utterly destroyed, but not until morning broke could we see how much, and how little, was left that we could recognize. The number of lives lost in Cartago and the surrounding villages was 272.

The full story of such an event is too long for this place. We lost the shelf-full of larvæ that we were rearing, but, wonderful to relate, little else, although some of our trunks were buried out of sight under fallen bricks and mortar. We spent May 5th in rescuing all that we could from the ruins and slept in the street that night. The railroad to Limon having been reopened on the 6th, we took the first train to the coast that day. It was hard to lose the three more months that we had expected to stay in Costa Rica; it was sadder to see the fearful ruin of a country we had come to love so well. Although Cartago and its environs had suffered most, the whole central portion of Costa Rica had been shaken severely, and for weeks afterward the inhabitants were afraid to return to their houses, and spent most of the time in open places, under tents and all sorts of makeshift shelters. Under such circumstances, with the approach of the rainy season, the fear of further earthquakes and of pestilence resulting from the decay of bodies buried in the ruins, it seemed best that we should depart, and we sailed from Limon on May 9th for New York.

THE ENGLISH BIBLE AS LITERATURE

By Josiah H. Penniman

Professor of English Literature and Vice-Provost of the University of Pennsylvania

The Bible is the world's Greatest Book. It has the widest circulation. It is stated that 28,000,000 copies of the Bible were sold in 1912–13, about half that number being in the English language.

There must be some reason for this, apart from the zeal of those who desire to propagate a religious faith. That very zeal must arise from the qualities which the book possesses to portray, and interpret man to himself, and to set forth the highest and noblest thoughts of man about his ultimate destiny. It is only great thoughts that can rise to find expression in great literature, and the Bible is the greatest literature.

When James VI of Scotland, the son of Mary Queen of Scots, became, on the death of Queen Elizabeth in 1603, James I of England, there were in existence and in use in addition to partial translation of the Bible in Anglo-Saxon:

John Wycliffe's translation, circulated in manuscript only, about 1360 to 1384.

William Tindale's New Testament, 1525.

William Tindale's Pentateuch, 1530.

Miles Coverdale's Bible, 1535, the first complete printed English Bible.

Matthew's (John Rogers) Bible, 1537.

The Great Bible, 1539.

Taverner's Bible, 1539.

Whittingham's New Testament, 1557.

The Genevan Bible, 1560.

The Bishops' Bible, 1568.

The Rheims, or Douay, New Testament, 1582; the Old Testament, 1609–10.